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# A FLEXIBLE DEMAND SYSTEM AND VAT SIMULATIONS FROM SPANISH MICRODATA.

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**ABSTRACT**

The system of indirect taxation in Spain is undergoing major reforms in order to comply with European Community Harmonisation standards and also as a means of revenue adjustment for the Treasury. The availability of data on household budget surveys allows the estimation of an Almost Ideal Demand System with which we simulate the impact of two hypothetical tax reforms on the welfare of Spanish households, patterns of demand and tax revenue.

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## 1. Introduction.

The impact of changes in the system of indirect taxation within E.C. countries has been an issue of interest for quite a few years, especially given the emphasis which the European Commission has placed on the harmonisation of VAT rates as a prior step towards the creation of a single market.

The study of the impact of such harmonisation on Spanish households was the original motivation for this research. Upon E.C. membership in 1986, the existing system of indirect taxation was replaced by V.A.T., which was set at 12%, 6% and 33% for the standard, reduced and luxury rates respectively. Since then the government has changed the standard rate to 15% (via an intermediate change to 13%) and in January 1993, a new rate of 3% for articles of first necessity will be proposed to the Parliament.

There are three basic policy issues associated to these and similar changes. First, the impact on households' welfare. Second, the potential change in consumption patterns which might be itself a policy objective as is the case with environmental taxes. And finally, the effects on Treasury revenue and on inflation. While the third of these issues can be addressed by means of forecasting devices based on aggregate estimations (see Burgos et.al. [1992]), knowledge at the micro level is needed to obtain an accurate picture of who, and by how much, are the losers (or even winners) after a fiscal reform and of the potential changes in the structure of demand.

The availability of data on expenditure at the household level for Spain offers the possibility of obtaining a simulation device with which to tackle the three questions above. Such a device consists of a system of equations explaining how households allocate expenditure to different consumption categories as a function of price, income and demographic characteristics on which the effect of price can be simulated.

The structure of this paper is the following. In section 2, we present the overall framework of consumer behaviour in which our demand system is cast. Then a convenient functional form for such a demand system is introduced in section 3. The advantages of using microdata are debated in section 4 and the econometric treatment is explained in section 5, where estimates of the model are presented. Section 6 is devoted to an explanation of the simulation methodology for both welfare and revenue. A presentation of the consequences for welfare and revenue for two reforms concludes the paper.

Many of the properties of the data we use are discussed along with some econometric or theoretical issues. A complementary account can be found in appendix 1. Appendix 2 discusses the issue of price multicollinearity.

## 2. Modelling framework.

In this section we provide a picture of the main features of the modelling exercise in terms of separability assumptions and choice of consumption goods.

We shall be concerned with the modelling of expenditure on non-durable goods. At the micro level, it is difficult to devise a model for the consumption of durable goods. Most existing literature usually addresses the rate of usage of such goods and/or the decision to own them separately[3]. The studies that address these two issues jointly require single commodity sophisticated modelling and rely on the existence of rich data[4].

Including durable goods within our demand system would prove to be a very difficult task even if we could count with an appropriate model. Our data source does only collect information on purchases during reference periods of up to one quarter. In these circumstances, not only does recorded expenditure on cars, housing or appliances not measure the flow of services that those goods yield but even ownership cannot be identified due to the incidence of zero records from infrequency of purchase.

We also exclude tobacco and petrol from our system. Previous experience from Spanish data (Labeaga, [1991]) suggests that these two expenditure categories follow a peculiar consumption pattern in the sense that a proportion of households do not consider them as items of consumption because the household is non-smoking and/or the household does not own a car. In the absence of qualitative information about these characteristics, these two goods are best treated in a single equation context.

Thus we assume expenditure on the remaining non-durable goods to be weakly separable from the rest of expenditure decisions. Preferences are weakly separable if the direct utility function can be written in the following form (see Phlips [1974])

$$U(x_1,\dots,x_n)=F[(U_1(q_1)\dots,U_k(q_k)]); \qquad (1)$$

or equivalently, if the marginal rate of substitution between any two goods belonging to the same group is independent of the level of consumption of goods outside the group. This can be shown to imply[5] that the allocation of expenditure amongst items of one particular group is made without reference to prices or quantities outside the group. Such allocation depends only on outlay going to the group under consideration and the relative prices of its components.

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[3] See Baker et al. (1988, 1989) and Baker and Blundell (1991).

[4] See Dubin and McFadden (1984) and King (1980).

[5] See Deaton and Muellbauer (1980,a).

Weak separability justifies the use of the concept of two-stage budgeting (see figure 1). The latter refers to the idea of agents allocating expenditure amongst broad groups first and then to commodities within each of those groups in a sequential process.

It should be said that while econometrically convenient, this assumption is in some ways restrictive for it is unlikely that durable expenditure decisions, (or even labour supply decisions) bear no substitution effects on expenditure on transport or leisure goods, as a good deal of empirical evidence suggests (see Blundell and Walker [1982] Browning and Meghir [1991] and Atkinson and Stern [1980]).

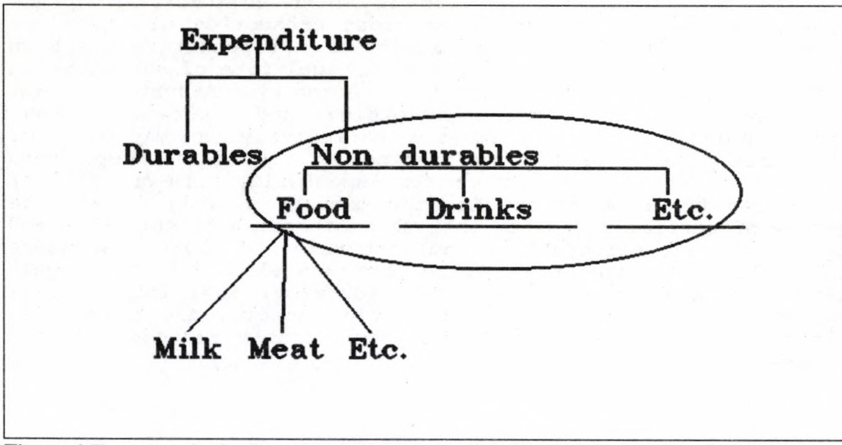


**Figure 1**.Two stage budgeting. We shall be estimating the circled stage, i.e. the allocation of expenditure on non durable goods amongst its sub groups.

A possible alternative would be to estimate expenditure on non-durable goods conditional on durable tenure decisions (and/or on labour supply). The advantages of this methodology are laid out in Browning and Meghir [1991]. For the purposes of our analysis, we would simply get around the unrealistic assumption of weak separability[6] without modelling explicitly the determination of the conditioning variables. Unfortunately, as mentioned above, our data source does not contain information on tenure of durable goods, it only records whether there has been some expenditure on those commodities within the reference period. Therefore we cannot use the conditional approach and are forced to invoke weak separability. The process of allocation of expenditure will consist in a first stage where savings, labour supply and durable goods tenure are determined and a second stage

[6] Because we would let the MRS of non durable goods depend on the tenure of durable ones and on labour decisions.

where the remaining expenditure is split between a range of non-durable categories.
This whole process can be viewed within a life-cycle consistent framework in which preferences are intertemporally separable. Current demands are expressed as a function of a variable that reflects past decisions and future anticipations of economic circumstances. In our analysis such a variable is current expenditure and the influence of the past and expectations about the future can be inserted in the model by letting the first stage of the process depend on interest rates, lagged prices, unemployment indicators and other macroeconomic variables (see Blundell [1988])[7].

There remains the question of which commodity groupings should be chosen. When defining broad categories of goods, we make use of weak separability again; once expenditure has been allocated to the group "food", the marginal rate of substitution between milk and bread will not be affected by consumption of any item in the broad group "clothing and footwear", say, interactions between groups are exclusively income effects. Therefore, one rule to be followed is always to keep items bearing either substitution or complementarity with one another always in the same group. For the moment, we seek to isolate groups of particular policy interest. Attending to this rule and to the current structure of indirect taxes in Spain, we choose the following categories: food and non-alcoholic beverages, alcoholic beverages, clothing and footwear, fuel for housing, household non durable goods, public transport, and a residual category collecting the remaining non durable expenditure (see also appendix 2).

[7] Criticisms of this intertemporal separability approach are based on the fact that the potential effects of habits are ruled out. Also, to some extent, this static representation has been blamed for rejections of homogeneity, because consumers might need some adjustment period to escape money illusion.

### 3. Functional form.

One of the innovations of this research with respect to previous demand studies of Spanish data is the fact that we estimate a demand system with flexible price responses. The need to do so and the chosen functional form are discussed below.

What we might expect from our demand system is the ability to obtain a realistic picture of the substitution, own price and income effects that may arise after a change in the structure of relative prices. In this sense, some forms of preferences can only be a second best option for our analysis. In particular, to use
additively separable preferences, that is

$$U(q_1 \ldots q_n) = F[\textstyle\sum_s U_s(q_s)] \qquad \textbf{(2)}$$

would imply that cross-price derivatives are proportional to income derivatives in such a way that the factor of proportionality is independent of the good whose response we want to measure (see Phlips [1974]). This can be shown to exclude the possibility of negative expenditure elasticities and negative substitution effects, thus inferior goods and complementarity are ruled out a priori and clearly this is too strong an economic assumption to impose on the data (see Deaton [1974]).

Previous exercises with Spanish data (see Labeaga and López [1992]) have used the Linear Expenditure System (L.E.S.) which has also been extensively used in the demand-analysis literature ever since its creation by Stone (1954). One of its main attractions of this model is the ability to retrieve its parameters from small samples (most of its applications to recent dates have been aggregate data studies) without much price variation.

However, this model incorporates the undesirable additive separability properties alluded to previously. In particular, if concavity is to be preserved in the model, all marginal propensities to consume must be positive, therefore inferior goods are ruled out. Similarly, the parametric requirements of concavity makes cross-price elasticities always positive which means that all goods are forced to be substitutes (see Deaton and Muelbauer, 1980,a).

In this study we use the Almost Ideal Model (A.I.M.) of Deaton and Muellbauer (1980,b). This is originated from an approximation to a cost function taking the form

$$\log c(u,p) = \alpha_0 + \sum \alpha_k \log p_k + 1/2 \sum_k \sum_l \gamma^*_{kl} \log p_k \log p_l + u\beta_0 \prod p_k^{\beta_k} \qquad \textbf{(3)}$$

whose demand equations in budget share form for the $i^{th}$ good are given by

$$w_i=\alpha_i+\sum_j \gamma_{ij}\log p_j+\beta_i\log(\frac{x}{P}) \tag{4}$$

where

$$\log P=\alpha_0+\sum_k \alpha_k\log p_k+1/2\sum_k \sum_l \gamma_{kl}\log p_k\log p_l; \quad \gamma_{ij}=1/2(\gamma^*_{ij}+\gamma^*_{ji}); \tag{5}$$

and x, p are total expenditure and prices respectively.
With the following theoretical restrictions:

$$\begin{array}{ll} \textit{Adding up} & \sum_i \alpha_i=1, \quad \sum_j \gamma_{ij}=0, \quad \sum_i \beta_i=0 \\ \textit{Homogeneity} & \sum_j \gamma ij=0 \\ \textit{Symmetry} & \gamma_{ij}=\gamma_{ji} \\ \textit{Negativity} & s_{ij}<0 \quad \forall i=j \\ \multicolumn{2}{l}{\textit{where } s_{ij} \textit{ are compensated elasticities}} \end{array} \tag{6}$$

There is a number of reasons why this is the most appropriate choice of functional form for the purposes of this study. Firstly, the preferences from which the A.I.M. is derived (see Deaton and Muellbauer [1980,a] for a discussion of PIGLOG preferences) do not embody additive separability and therefore permit flexible price responses. Also, its Engel curves belong to the Working-Leser form, i.e. linear in the logarithm of total expenditure and thus non-linear in expenditure. The theoretical reason why this is desirable is that linear Engel Curves (in expenditure) imply that marginal propensities to consume are constant and identical for all individuals so that every agent spends the same proportion out of every extra unit of income at all his levels of income and moreover, this spending pattern is the same for poor and rich households for every particular good. Apart from being theoretically unreasonable, this property has also been empirically rejected (see Blundell and Ray, 1984). Another consideration concerning flexibility is the rank of a demand system. This concept can be defined as the number of linearly independent functions of income entering individual Engel Curves (see Forni and Brighi [1990]). In this sense the A.I.M. is rank two and the L.E.S. is rank one. There is now a body of evidence pointing towards demand systems having rank three (see Lewbel 1991 for the non parametric case and Blundell et. al. 1990 for the A.I.M. case). A convenient extension to the standard model, for which we also present estimates to allow comparison, would be the following

$$w_i=\alpha_i+\beta_i\log x+\delta_i(\log x)^2+\sum_j \gamma_{ij}\log p_j \tag{7}$$

We will therefore be dealing with a functional form which precludes the imposition of a priori implausible price responses on the data and maximises the degree of flexibility in income responses.

In addition, the A.I.M. can be integrated back to a cost function, which proves crucial when studying the welfare impact of tax reforms.

## 4. Data.

Perhaps more important than the choice of functional form is the choice of data on which the model is estimated. There is not usually much of a choice here apart from aggregate data but in the case of Spain we also count on a series of cross sections of family budget surveys (see appendices 1 and 2). In this section we debate the advantages of using microdata.

The demand system is estimated on microdata exclusively and in our opinion this is desirable for the following reasons. Firstly, the size of aggregate data sets restricts the number of parameters that can be estimated[8]. This might be of no importance when we want to retrieve a single demand equation, but if we want to consider a wide range of commodities, the virtually unlimited number of degrees of freedom microdata sets offer makes a significant difference. Secondly, there is the problem of aggregation. The use of aggregate data to retrieve estimates of demand systems rests on the assumption that there exist functions which relate aggregate consumption to prices and aggregate expenditure or some index summarising the effects of the distribution of individual expenditures. The conditions under which such functions exist have been surveyed by Forni and Brighi (1990). As these authors point out, these conditions place restrictions on micro demand functions and these restrictions in many cases preclude the use of estimated demand systems for simulations in which a certain degree of flexibility in both price and expenditure responses needs to be attained. Systems derived from Gorman Polar Form cost functions, the L.E.S. for example, satisfy exact aggregation conditions because they display linear Engel Curves and these are assumed to have the same slope for all agents. Therefore aggregate consumption depends on aggregate expenditure regardless of the distribution of the latter amongst the population. This, as explained above, has very restrictive implications. On the other hand, members of the Price Independent Generalised Linear (see Muellbauer [1975]) family of preferences, a special case of which is the A.I.M. model, allow for exact aggregation without imposing such severe restrictions, because the effects on demand of the distribution of income are accounted for (see Deaton and Muellbauer [1980,a]). On the practical side, such effects must be retrieved from microdata, therefore the use of aggregate data to retrieve an A.I.M. would only be theoretically consistent if microdata was available too. Thirdly, the exclusion of demographic explanatory variables (which may be correlated with total expenditure and prices) makes difficult the separation of income-and-price effects from the effects of the former. In order to avoid this "aggregation bias" the use of microdata for our exercise is fully justified.

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[8] It is not unlikely to find aggregate data studies in which the number of equations is kept to a minimum in order to avoid running out of degrees of freedom. An example in the Spanish literature is Lorenzo (1988).

We will, therefore, use a pool of cross-sections on family budget surveys. As mentioned in the introduction, details about sampling design and the nature of the collected information can be found in the appendices to this paper.

## 5. Econometric implementation.

The theoretical advantages of microdata discussed above take their toll in terms of a specific economic treatment. In this section we discuss such treatment with regard to the theoretical restrictions for the demand system and the nature of the survey information.

The restrictions that ensure the integrability of demand equations back to utility or cost functions must be satisfied if our estimates are to be used for welfare analysis (equation no.7 for the A.I.M.).

Adding-up is a cross-equation restriction that is immediately satisfied if Working-Leser type models are estimated with linear methods (see Deaton and Muellbauer [1980,a]). Homogeneity is a single-equation restriction and as such it can be imposed and checked using an F-test. Symmetry requires cross-equation restrictions. These can be imposed by means of a minimum-distance method such as the Chi-squared; this is a two step method whereby estimates satisfying the other single-equation restrictions are obtained at a first stage, together with their covariance matrix, which are used at a second stage to impose symmetry (see Blundell et. al, [1990]).

In principle, therefore, we could retrieve estimates using OLS on each equation and then impose symmetry. However, the use of microdata presents the problem of households recording zero expenditures even after aggregating into broad categories, and it is well known that when the dependent variable is censored or truncated, OLS yields biased estimates. Therefore it is crucial to treat the problem of zero records adequately and the first measure is to establish of the following which is their cause.

Zeroes might arise for any of the following reasons:

1. Because the household is maximising utility at zero consumption for its current budget (corner solution).

2. Because the household does not participate in the consumption of some commodity (the case of non-smoking households for instance).

3. Because no purchase has been made during the monitoring period although the household is a regular consumer of the good (infrequency of purchase).

The rotating-panel[9] nature of the data we use can elucidate to some extent which of these reasons apply. The following table shows the proportion of positive expenditures on the categories we estimate after one quarter and after aggregating over eight quarters for the set of households which cooperate during eight quarters in the "Encuesta Continua de Presupuestos Familiares" (a total of 1123 out of 13711).

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[9] See appendix 1.

**TABLE 1. PROPORTION OF HOUSEHOLDS RECORDING POSITIVE EXPENDITURES ON EACH GOOD IN ONE QUARTER AND OVER EIGHT QUARTERS.**

| Category | In one quarter. | Over eight quarters. |
|---|---|---|
| Food and refreshments | .994 | .999 |
| Alcoholic beverages | .700 | .951 |
| Clothing and footwear | .900 | .990 |
| Fuel for housing | .990 | 1.00 |
| Household non durable | .780 | .970 |
| Public transport | .460 | .800 |
| Other non durable goods | .780 | .960 |

N.b. Table obtained from the 1123 households which collaborate over eight quarters.
The monitoring period for food, alcohol, household non-durable, public transport and other non-durable goods is one week. For fuel it is one month.

We note that the majority of households records a positive purchase for all categories over the eight quarters, with the exception of public transport, for which 20% of households remain with zero records. Given the monitoring periods at the bottom of the table, it is easy to infer that most of the zero records for these categories will be due to too short (relative to the average frequency of purchase) a monitoring period or to too long an interval between purchases for the affected households.
When infrequency of purchase is present, Keen (1987) has shown that OLS yields biased estimators because of the existence of correlation between the error term and the total expenditure regressor and that in order to overcome this problem total expenditure can be instrumented successfully with total income, which in principle should display less correlation with the error term since this variable is not affected by the decision to purchase.

Thus, the A.I.M. is estimated by three-stages least squares (which in this case is equivalent to two-stages least squares equation by equation because each equation contains the same variables on its right hand-side). We provide a number of exogenous variables ranging from total income to seasonal dummies and demographic characteristics which determine total non-durable expenditure in the first stage of the allocation of expenditure. Also, a number of important demographics are introduced into the model to help explain the budget shares.

The model is non-linear in its original form but one of the features that have made it popular is the relative ease with which it can be transformed into a linear form for estimation.

Ever since the model's origins, the following approximation to log P in equation (6) has been used (see Deaton and Muellbauer [1980,a] or Blundell et al. [1990]).

$$\log P = \sum_k w_k \log p_k \qquad \textbf{(8)}$$

In line with those previous studies, we will also apply the approximation, that is, we construct an Individual Stone Index to deflate expenditure[10].

With respect to the imposition of theoretical restrictions the following points are relevant:

In order to avoid the singularity of the error variance matrix (because of the additivity of the system, any equation is a linear combination of the others), the last equation is left out in estimation and its parameters are retrieved from the adding-up restriction which, as mentioned before is satisfied automatically by linear estimators. The homogeneity restriction is imposed by entering all prices relative to that of the excluded good, and it is tested by means of a Fisher test against the unrestricted model, equation by equation, before imposing or testing symmetry.

Symmetry, which is a whole system restriction, is imposed by the minimum-distance method embodied in the SYSLIN procedure of SAS ETS econometric software and again tested by means of an F-test[11].

### 5.1. Model estimates.

The following tables present the estimation results for the Almost Ideal model we use in the simulation analysis.

The first column in the tables contains the homogeneity-restricted rank 2 model, and consequently the seventh price parameter is not estimated directly but can be calculated from the homogeneity restriction. The second column contains the symmetry-restricted price parameters. These are obtained by imposing the system-wide restriction on the homogeneity-restricted parameters. The third column contains the real expenditure term of the rank 3 model as well as two interactions between demographics and real expenditure for the purpose of comparison with the rank 2 version.

The parameters on the demographic and price variables for this version are statistically equivalent to those of the rank 2 version and hence are omitted from the table.

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[10] We are aware of the possibility of introducing a bias when using this procedure. The problem reduces to a case of omitted-variables bias, as investigated by Pashardes (1992).

[11] Since the resulting compensated elasticities vary for each household, we might find that some households do not adhere to concavity conditions.

R-squared values, the mean budget share and the F-statistic for the homogeneity restriction are supplied too. T-statistics are supplied within brackets.

The following variables are used to explain budget shares:
1. Constant shifters:
Number of children in the household.
Number of members in the household.
Number of earners of income in the household.
Age of the head of the household
Own Employment: Dummy activated if the head is self-employed.
Unskilled: Dummy activated if the head is an unskilled worker.
Not active: Dummy activated if the head is out of the labour force.
2. Slope:
Log of real expenditure and its square: natural logarithm of total expenditure deflated by the Stone index.
LP(food)...: natural logarithm of prices relative to the price of the seventh good.
3. Interactions with the expenditure term in rank 3 version:
Child*lrx: Interaction of the number of children with log of real expenditure.
Age*lrx: Interaction of age of head with log of real expenditure.

| TABLE A.I.M.1 FOOD AND NON-ALCOHOLIC BEVERAGES | | | |
|---|---|---|---|
| | RANK 2 | | RANK 3 |
| Variable | Homogeneous | Symmetric | |
| Constant | 1.82 (24.9) | | |
| # Children | -.001 (.62) | | |
| # Members | .02 (22.0) | | |
| # Earners | -.003 (1.8) | | |
| Age of head | .0007 (6.0) | | |
| Own employ. | -.004 (1.2) | | |
| Unskilled | .004 (.72) | | |
| Not active | -.005 (1.5) | | |
| Log real ex. | -.128 (37.0) | | .038 (.56) |
| " square | - | | -.0092 (2.77) |
| Child*lrx | - | | .0019 (.59) |
| Age*lrx | - | | .00004 (.1) |
| LP(food) | -.051 (4.38) | .068 (11.75) | |
| LP(alcohol) | -.041 (.79) | .013 (4.8) | |
| LP(clothing) | -.512 (2.60) | .037 (4.7) | |
| LP(fuel) | .005 (.11) | -.014 (3.97) | |
| LP(ndurable) | -.212 (2.1) | .012 (2.87) | |
| LP(transpt.) | .447 (8.41) | .004 (4.8) | |

Mean share=.539. Adjusted R-squared= .217
$F(1,\infty)$ test for Homogeneity= 1.09
$F(15,\infty)$ test for symmetry after homogeneity= 17.97
Parameters on demographic variables do not change across the three versions and are given only in the first column.

| TABLE A.I.M.2 ALCOHOLIC BEVERAGES | | | |
|---|---|---|---|
| | RANK 2 | | RANK 3 |
| Variable | Homogeneous | Symmetric | |
| Constant | .070 (3.28) | | |
| # Children | -.001 (3.86) | | |
| # Members | .0008 (2.30) | | |
| # Earners | .0014 (2.78) | | |
| Age of head | -.0001 (3.68) | | |
| Own employ. | -.0005 (.56) | | |
| Unskilled | .0051 (2.61) | | |
| Not active | -.0008 (.74) | | |
| Log real ex. | -.003 (3.58) | | .0537 (2.71) |
| " square | - | | -.0032 (3.32) |
| Child*lrx | - | | .0017 (1.79) |
| Age*lrx | - | | .0000004 (.06) |
| Log P1 | .0005 (.14) | .0131 (4.8) | |
| Log P2 | .011 (.71) | -.001 (.13) | |
| LP(clothing) | -.133 (2.23) | -.048 (1.64) | |
| LP(fuel) | -.0127 (.86) | -.016 (1.85) | |
| LP(ndurable) | -.069 (2.41) | -.020 (1.48) | |
| LP(transpt.) | .050 (3.20) | -.006 (.78) | |

Mean share=.026. Adjusted R-squared= .013
$F(1, \infty)$ test for Homogeneity= 0.02
$F(15, \infty)$ test for symmetry after homogeneity= 17.97
Parameters on demographic variables do not change across the three versions and are given only in the first column.

| TABLE A.I.M.3 CLOTHING AND FOOTWEAR | | | |
|---|---|---|---|
| | RANK 2 | | RANK 3 |
| Variable | Homogeneous | Symmetric | |
| Constant | -.3695 (5.66) | | |
| # Children | .0005 (.38) | | |
| # Members | -.0053 (4.98) | | |
| # Earners | .0004 (.28) | | |
| Age of head | -.0009 (9.04) | | |
| Own employ. | .0023 (.79) | | |
| Unskilled | .013 (2.23) | | |
| Not active | .002 (.60) | | |
| Log real ex. | .054 (17.80) | | -.0370 (.62) |
| " square | - | | .005 (1.82) |
| Child*lrx | - | | -.0039 (1.35) |
| Age*lrx | - | | .00003 (.18) |
| Log P1 | .024 (2.32) | .0371 (4.74) | |
| Log P2 | -.070 (1.48) | -.048 (1.64) | |
| LP(clothing) | .059 (.34) | .018 (.16) | |
| LP(fuel) | -.018 (.41) | .004 (.01) | |
| LP(ndurable) | .101 (1.17) | .080 (1.70) | |
| LP(transpt.) | .106 (2.25) | .041 (1.38) | |

Mean share=.168. Adjusted R-squared= .123
$F(1,\infty)$ test for Homogeneity= 4.22
$F(15,\infty)$ test for symmetry after homogeneity= 17.97
Parameters on demographic variables do not change across the three versions and are given only in the first column.

| TABLE A.I.M.4 FUEL FOR DOMESTIC USE | | | |
|---|---|---|---|
| | RANK 2 | | RANK 3 |
| Variable | Homogeneous | Symmetric | |
| Constant | .164 (5.63) | | |
| # Children | .002 (3.28) | | |
| # Members | -.0053 (11.21) | | |
| # Earners | .0006 (.93) | | |
| Age of head | .0001 (2.74) | | |
| Own employ. | .006 (4.70) | | |
| Unskilled | -.007 (2.69) | | |
| Not active | .002 (1.97) | | |
| Log real ex. | -.0079 (5.74) | | -.080 (2.93) |
| " square | - | | .004 (3.27) |
| Child*lrx | - | | .001 (1.00) |
| Age*lrx | - | | -.0001 (1.89) |
| Log P1 | -.0059 (1.27) | -.014 (3.97) | |
| Log P2 | -.015 (.747) | -.0169 (1.85) | |
| LP(clothing) | .0186 (.23) | .004 (.168) | |
| LP(fuel) | .0337 (1.69) | .028 (1.73) | |
| LP(ndurable) | -.008 (.22) | -.008 (.50) | |
| LP(transpt.) | .020 (.98) | .060 (5.9) | |

Mean share=.060. Adjusted R-squared= .061
$F(1,\infty)$ test for Homogeneity= 0.36
$F(15,\infty)$ test for symmetry after homogeneity= 17.97
Parameters on demographic variables do not change across the three versions and are given only in the first column.

| TABLE A.I.M.5 HOUSEHOLD NON-DURABLE GOODS | | | |
|---|---|---|---|
| | RANK 2 | | RANK 3 |
| Variable | Homogeneous | Symmetric | |
| Constant | -.256<br>(7.37) | | |
| # Children | .010<br>(12.56) | | |
| # Members | -.009<br>(16.2) | | |
| # Earners | .002<br>(2.51) | | |
| Age of head | .0003<br>(6.7) | | |
| Own employ. | .0062<br>(3.82) | | |
| Unskilled | .008<br>(2.79) | | |
| Not active | .0063<br>(3.53) | | |
| Log real ex. | .0236<br>(14.37) | | -.016<br>(-.50) |
| " square | - | | .003<br>(1.92) |
| Child*lrx | - | | .004<br>(3.40) |
| Age*lrx | - | | -.0003<br>(3.34) |
| Log P1 | .0189<br>(3.42) | .0128<br>(2.87) | |
| Log P2 | .0064<br>(.256) | -.0205<br>(-1.48) | |
| LP(clothing) | .0253<br>(.27) | .080<br>(1.70) | |
| LP(fuel) | -.0001<br>(.005) | -.008<br>(.50) | |
| LP(ndurable) | .038<br>(.83) | .055<br>(1.81) | |
| LP(transpt.) | -.082<br>(3.27) | -.058<br>(-4.10) | |

Mean share=.048. Adjusted R-squared= .040
$F(1,\infty)$ test for Homogeneity= 0.14
$F(15,\infty)$ test for symmetry after homogeneity= 17.97
Parameters on demographic variables do not change across the three versions and are given only in the first column.

| TABLE A.I.M.6 PUBLIC TRANSPORT | | | |
|---|---|---|---|
| | RANK 2 | | RANK 3 |
| Variable | Homogeneous | Symmetric | |
| Constant | .0377 (1.33) | | |
| # Children | -.0071 (10.99) | | |
| # Members | .001 (3.90) | | |
| # Earners | .0009 (1.40) | | |
| Age of head | -.00032 (6.99) | | |
| Own employ. | -.006 (4.67) | | |
| Unskilled | -.008 (3.38) | | |
| Not active | .002 (1.50) | | |
| Log real ex. | .003 (2.28) | | -.1018 (3.82) |
| " square | - | | .005 (3.84) |
| Child*lrx | - | | -.0011 (.895) |
| Age*lrx | - | | .0002 (3.01) |
| Log P1 | -.002 (.44) | .004 (1.13) | |
| Log P2 | -.004 (.22) | -.006 (.078) | |
| LP(clothing) | -.085 (1.12) | .041 (1.38) | |
| LP(fuel) | .063 (3.28) | .060 (5.96) | |
| LP(ndurable) | -.137 (3.65) | -.058 (4.10) | |
| LP(transpt.) | .025 (1.24) | -.006 (.53) | |

Mean share=.022.Adjusted R-squared= .027
$F(1,\infty)$ test for Homogeneity= 7.17
$F(15,\infty)$ test for symmetry after homogeneity= 17.97
Parameters on demographic variables do not change across the three versions and are given only in the first column.

| TABLE A.I.M.7 OTHER NON-DURABLE GOODS | | | |
|---|---|---|---|
| | RANK 2 | | RANK 3 |
| Variable | Homogeneous | Symmetric | |
| Constant | -.473 (5.36) | | |
| # Children | -.0026 (1.32) | | |
| # Members | -.009 (6.39) | | |
| # Earners | -.002 (1.09) | | |
| Age of head | .0001 (1.30) | | |
| Own employ. | -.003 (.95) | | |
| Unskilled | -.016 (2.01) | | |
| Not active | -.0069 (1.52) | | |
| Log real ex. | .058 (13.9) | | .143 (1.77) |
| " square | - | | -.0053 (1.34) |
| Child*lrx | - | | -.0049 (1.24) |
| Age*lrx | - | | .0002 (.71) |
| Log P1 | .015 (1.10) | -.12 | |
| Log P2 | .114 (1.80) | .077 | |
| LP(clothing) | .627 (2.65) | -.132 | |
| LP(fuel) | -.071 (1.19) | -.053 | |
| LP(ndurable) | .287 (2.46) | -.061 | |
| LP(transpt.) | -.568 (8.89) | -.035 | |

Mean share=.133. Adjusted R-squared= .126
$F(1,\infty)$ test for Homogeneity= 3.73
$F(15,\infty)$ test for symmetry after homogeneity= 17.97
Parameters on demographic variables do not change across the three versions and are given only in the first column.

with respect to the rank 2 model we find that the homogeneity restriction cannot be rejected except for the case of public transport. This has to be interpreted with regard to the significance of the price parameters in the model.

It is generally accepted that with microdata samples the threshold of significance has to be raised proportionately with the number of observations. A commonly used criterion is that a critical value equal to the logarithm of the square root of the number of observations should be used (see e.g. Atkison et al. [1989]), which in our case is 3.05. In these circumstances only two parameters would appear to be significant in the food, household non-durable goods and public transport equations; one parameter in the alcohol and residual equations and none in the clothing and fuel equations. However, if we were to take the usual threshold of 2, we would find a substantial number of significant parameters. In all equations the price parameters are jointly significantly different from zero. We attribute the lack of significance of some parameters to the multicollinearity that can be detected in the price series during the time span of our sample (see appendix 2).
Therefore the acceptance of the homogeneity restriction should be treated with caution for it might be due to a lack of strong significance in some parameters or on the other hand it could be a sign of the adequacy of microdata to describe consumer behaviour consonant with other studies (see Blundell et al. [1990]).

The case of the test for symmetry however is of a clear rejection of the null hypothesis[12]. Thus we force this restriction upon the data in order to obtain integrability conditions.

The real expenditure parameters are well determined in all equations as we would expect given the amount of variation in expenditure within the sample.The effects of prices and real expenditure on each household are given by their respective elasticities according to the following expressions.

$$e_i^h = \frac{\beta_i}{w_i^h} + 1; \qquad e_{h_{ii}} = \frac{\gamma_{ii}}{w^{h_i}} - 1; \qquad (9)$$

The following table presents such effects calculated at the mean of the sample together with results from other Spanish and European Studies for the sake of comparison.

[12] The test statistic is F(15,∞ )=17.97 against a critical value of F(15,∞)=1.67 at the 1%.

**TABLE 2. EXPENDITURE ELASTICITIES.**

| Category | A.I.M. This study | Other Spanish studies | United Kingdom (2) | France (3) |
|---|---|---|---|---|
| Food | .76 | .66 | .53 | .48 |
| Alcohol | .88 | .92 | 1.30 | n.a. |
| Clothing | 1.32 | 1.15 | 1.05 | 1.16 |
| Fuel | .86 | .85 | .13 | .59 |
| H. non-dur. | 1.49 | n.a. | n.a. | 1.41 |
| P. Transport | 1.13 | 1.50 | 1.74 | .80 |
| Other goods | 1.43 | 1.30 | 1.00 | 1.36 |

"H. non-dur" is short for household non-durable goods.
The figures under "other Spanish Studies" are taken from Abadia (1985).
Figures for the U.K. and France have been supplied by the Institute for Fiscal Studies. London.

**TABLE 3. OWN PRICE ELASTICITIES.**

| Category | A.I.M. This study | Other Spanish studies | United Kingdom | France |
|---|---|---|---|---|
| Food | -.87 | | -.85 | -.39 |
| Alcohol | -1.03 | -.67 | -1.02 | n.a. |
| Clothing | -.89 | n.a. | -.75 | -.98 |
| Fuel | -.53 | -.80 | -.18 | -.12 |
| H. non-dur. | .14 | n.a. | n.a. | -.62 |
| P. Transport | -1.27 | -.75 | -.95 | -.07 |
| Other goods | 1.43 | n.a. | -.15 | -.49 |
| | | n.a. | | |

"H. non-dur" is short for household non-durable goods.
The figures under "Other Spanish studies" are taken from Rebollo (1983).
Figures for the U.K. and France have been supplied by the Institute for Fiscal Studies. London.

Looking at expenditure elasticities, our study suggests that food, alcohol and fuel are necessity goods whereas clothing, household non-durable goods, public transport and other goods are luxuries. This matches the classification arising from the results of the previous Spanish study cited above. The pattern is similar to that of the U.K. except for alcohol, which seems to be a luxury in Britain. The results for France do not diverge much except for the case of public transport.

As far as price elasticities go, the pattern is similar to the U.K. and France in that food, fuel and clothing are relatively price inelastic but public transport seems to be more elastic in Spain. Our model displays two positive own-price elasticities, but it is easy to see that this might be a result of low significance in the corresponding price parameter rather than odd behaviour.

With respect to the effect of demographic variables, we find that children have a significant effect on the predicted share of several equations: for instance, one additional child increases the share of household non-durable goods by one percentage point. Every additional member increases the share of food by 2% and has a significant effect on the rest of expenditure categories. In the case of alcohol and household non-durable goods, one extra earner increases the share by nearly 5% of its mean. The age of the head has a significant positive impact in the case of food, fuel, household non durable goods and a negative one in the case of alcohol, clothing and public transport.The effect of self-employment is to increase spending by approximately 10% of the mean share in the case of fuel and household non durable goods and it decreases the predicted share by 25% of the mean in the case of public transport. Unskilled workers spend 20% percent more out of total expenditure on alcohol, 10% more on clothing and fuel, 15% more on household non durable goods, 36% less on public transport and roughly 10% less on the residual category than the base household. Being out of the labour market only has a significant impact for expenditure on household non-durable goods, for which it increases the predicted share by approximately 10% of the mean share with respect to the base household.

With respect to the appropriateness of the rank 3 model, we find that the parameters on the squared log of real expenditure term are significantly different from zero (on the above criterion) in the case of alcohol, fuel and public transport. It would also be possible to use a rank 3 model for revenue and welfare simulation since a cost function is available in the work of Banks et. al. (1992). However, we choose to use the rank 2 model for the current exercise leaving experiments with the rank 3 version for subsequent research.

Having estimated a complete demand system, we now proceed to carry out the tax simulations.

## 6. Tax simulations.

The next sections describe the methodology of the tax simulation routine and present the results for two tax reforms which we consider of particular interest. The first reform consists in a projected tax scenario for 1993[13], which we envisage as an increase in two percentage points for the standard VAT rate at 12% and an increase in 3 points for the reduced rate at 6%. The second reform is defined as revenue neutral, that is, we find a single tax rate which, if levied on every good, yields the same revenue as in the initial situation. Since we do not include goods with the special rate at 33%, we deal only with reduced and standard rates. For the current analysis we ignore excise duties since they affect only alcohol out of our seven categories. The following table outlines the two VAT reforms.

**TABLE 4. CHANGE IN RATES FOR THE SIMULATED REFORMS.**

| Category | Initial rate. | Reform 1 | Reform 2 |
|---|---|---|---|
| Food and refreshments | 6% | 9% | 9% |
| Alcoholic beverages | 12% | 14% | 9% |
| Clothing and footwear | 12% | 14% | 9% |
| Fuel for housing | 12% | 14% | 9% |
| Household non-durable | 12% | 14% | 9% |
| Public transport | 6% | 9% | 9% |
| Other non-durable goods | 12% | 14% | 9% |

### 6.1 Definition of the reforms.

The basic assumption in this study and similar ones (see Baker et al. [1990]) about how taxes affect consumers is that supply is perfectly inelastic and therefore retail prices fully reflect changes in taxes.

The treatment of the excluded goods in this simulation consists in assuming that their pre-reform level of expenditure remains fixed. The alternative would be to assume that it is the quantity that remains fixed and consequently the total expenditure on the categories in our system would be affected.

[13] As mentioned in the introduction, 1993 rates will be of 15% and 6% (standard and reduced respectively) with the possibility of a super-reduced rate for food subject to parliamentary approval. This has only recently been made public, hence our improvised scenario.

Thus, tax reforms can be defined as the following linear mapping of the budget set (expenditure allocated to non-durable goods and prices) for every household

$$\{y_h^0, p^0\} \mapsto \{y_h^0, p^1\}; \tag{10}$$

Let $p_i^0$ be the pre reform retail price of the i[th] good, then it can be expressed as

$$p_i^0 = (1+v_i^0)q_i = q_i + qv^0; \tag{12}$$

where $v_i^0, q_i$ are the initial VAT rate and the net of tax price of good i. Therefore, if $v_i^1$ is the new tax rate, the after tax price is given by

$$p_i^1 = (1+v_i^1)q_i; \tag{15}$$

Or

$$p_i^1 = p_i^0 + \Delta p_i^0; \tag{16}$$

where

$$\frac{\Delta p_i^0}{p_i^0} = \frac{q_i(v_i^1 - v_i^0)}{(1+v_i^0)q_i} = \frac{(v_i^1 - v_i^0)}{1+v_i^0}; \tag{17}$$

therefore

$$p_i^1 = p_i^0 \frac{(v_i^1 - v_i^0)}{1+v_i^0} + p_i^0; \tag{18}$$

It is clear that this way of modelling the effect of taxes on prices is open to many criticisms since, to the best of our knowledge, there is no theoretical nor empirical argument why suppliers may not absorb part of the tax increase. In the absence of evidence of this issue, our assumption allows us to proceed with the exercise.

### 6.2. Welfare and revenue simulation.

The issue we consider as far as the welfare implications of the tax reforms are concerned is the money metric impact of the price changes on households, in particular, we calculate the equivalent gain for every household. This concept is defined as the amount of money that the household would have paid (or accepted) in order to remain at the initial level of utility with the final set of prices. This is easily computable since we have an estimated cost function[14]. First we calculate equivalent income which is implicitly defined as:

$$v(p^r, y_e) = v(p, y);$$

*where:*
*v(.) = indirect utility;*
*$p^r$ is a reference price vector;* **(19)**
*thus inverting:*

$$y_e = c(v, p^r) = c(p^r, p, y);$$

that is, the level of budget which at the reference price level (initial price level in our case) is equivalent in terms of utility to the actual budget of the household at the final prices.

For the A.I.M. cost function, equivalent income is given by:

$$\log y_e = \alpha_0 + \sum_k \alpha_k \log p_k^r + 1/2 \sum_k \sum_j \gamma_{kj} \log p_k^r \log p_j^r + \prod_k \left(\frac{p_k^r}{p_k}\right)^{\beta_k} (\log y - \alpha_0 - \sum_k \alpha_k \log p_k - 1/2 \sum_k \sum_j \gamma_{kj} \log p_k \log p_j); \quad (20)$$

Then equivalent gain for any household is naturally

$$EG^h = Y_0^h - y_e^h \quad (21)$$

*where $y_0^h$ is initial expenditure;*

Concerning the particularities of revenue simulation, the first step consists in calculating the new predicted budget shares using the parameter estimates of the rank 2 Almost Ideal Model and the new prices. When doing this, we must take into consideration the fact that the model does not predict shares in a perfect manner. In these circumstances there is not a clear preference for using predicted shares against observed shares when calculating the new levels of revenue. Since we are interested in price and real expenditure effects, we opt for separating these components from the overall expenditure on each commodity and then inserting their calculated new effect in the part of expenditure explained by demographic characteristics (which are not affected by the reform) and the stochastic

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[14] The methodology followed here is that of King (1983).

component. Thus we define the share prediction error as[15]

$$e_i = w_i^0 - \hat{w}_i(p^0, x^0, \gamma_i, \beta_i, \lambda_i) =$$
$$e_i = w_i^0 - \sum_j \gamma_{ij} \log p_j^0 - \beta_i \log\left(\frac{x}{P^0}\right) \qquad (22)$$

that is, the part of each share not explained by prices and real expenditures or equivalently, the component of the share explained by household characteristics, geographical, seasonal and other non-price and non-real expenditure variables plus the residual.

[15] See Baker et. al. (1990).

Thus, the post-reform shares are defined as

$$w_i^1=\left[\sum_j \gamma_{ij}\log p_j^1+\beta_i\log\frac{x}{P^1}\right]+e_i; \qquad \textbf{(23)}$$

Once the new shares have been computed, the levels of revenue from every household are calculated according to the following expression

$$TR_h=\sum_i \left(\frac{v_i^1}{v_i^1+1}\right)E_i^1; \qquad \textbf{(24)}$$

where $E_i^1$ is the post-reform level of expenditure on the $i^{th}$ category and $\left(\frac{v_i^1}{v_i^1+1}\right)$ is the implicit VAT rate.

### 6.3 Simulation results.

The following charts contain the simulation results in 1989 pesetas per quarter by deciles of expenditure and by a demographic breakdown. The first two columns in each table show the pattern of observed expenditures and the rest of columns show the increase in tax payment after the changes in behaviour simulated for reforms 1 and 2.

| TABLE SIM.1. FOOD AND NON-ALCOHOLIC BEVERAGES. | | | | | | |
|---|---|---|---|---|---|---|
| | Initial pattern | | REFORM 1 | | REFORM 2 | |
| Decile | Expenditure | Share | Δ tax | % total | Δ tax | % total |
| 1 | 40112 | 63.2 | 1039 | 1.63 | 1059 | 1.67 |
| 2 | 68220 | 61.8 | 1770 | 1.60 | 1804 | 1.63 |
| 3 | 86255 | 58.9 | 2241 | 1.53 | 2285 | 1.56 |
| 4 | 101576 | 56.9 | 2641 | 1.48 | 2693 | 1.51 |
| 5 | 117852 | 56.3 | 3066 | 1.46 | 3127 | 1.49 |
| 6 | 130424 | 53.4 | 3398 | 1.39 | 3465 | 1.41 |
| 7 | 149677 | 52.2 | 3903 | 1.36 | 3979 | 1.38 |
| 8 | 167201 | 49.3 | 4367 | 1.28 | 4450 | 1.31 |
| 9 | 188523 | 45.2 | 4934 | 1.18 | 5028 | 1.20 |
| 10 | 253868 | 36.8 | 6691 | .97 | 6789 | .98 |
| Retired | 99459 | 52.0 | 2599 | 1.36 | 2639 | 1.38 |
| 0 Children | 131476 | 47.3 | 3435 | 1.23 | 3500 | 1.25 |
| 1 " | 145099 | 48.3 | 3788 | 1.26 | 3862 | 1.28 |
| 2 " | 143696 | 47.9 | 3752 | 1.25 | 3824 | 1.27 |
| 3 " | 160698 | 48.3 | 4208 | 1.26 | 4282 | 1.28 |
| 4 " | 185875 | 55.8 | 4850 | 1.45 | 4932 | 1.48 |

N.B. Reform 1 changes 6% for 9% and 12% for 14%.
Reform 2 sets all rates at 9%.
Simulations carried out with rank 2 model
Decile breakdown is by expenditure.
Increment of tax column shows the increase in tax with respect to the pre reform situation.
Percentage of total is the proportion of the above increment over total expenditure. expenditure

| TABLE SIM.2. ALCOHOLIC BEVERAGES. | | | | | | |
|---|---|---|---|---|---|---|
| | Initial pattern | | REFORM 1 | | REFORM 2 | |
| Decile | Expenditure | Share | Δ tax | % total | Δ tax | % total |
| 1 | 1862 | 2.93 | 25 | .04 | -45 | .07 |
| 2 | 3014 | 2.73 | 40 | .03 | -73 | .06 |
| 3 | 4623 | 3.15 | 62 | .04 | -112 | .07 |
| 4 | 5446 | 3.05 | 72 | .04 | -131 | .07 |
| 5 | 7156 | 3.42 | 96 | .04 | -172 | .08 |
| 6 | 7995 | 3.27 | 106 | .04 | -191 | .07 |
| 7 | 9518 | 3.32 | 128 | .04 | -227 | .07 |
| 8 | 10536 | 3.11 | 142 | .04 | -250 | .07 |
| 9 | 12536 | 3.00 | 173 | .04 | -295 | .07 |
| 10 | 20309 | 2.95 | 291 | .04 | -476 | .06 |
| Retired | 5985 | 3.13 | 82 | .04 | -144 | .07 |
| 0 Children | 8737 | 3.14 | 121 | .04 | -207 | .07 |
| 1 " | 9696 | 3.23 | 132 | .04 | -230 | .07 |
| 2 " | 8893 | 2.96 | 119 | .03 | -210 | .07 |
| 3 " | 9549 | 2.86 | 126 | .03 | -226 | .06 |
| 4 " | 5870 | 1.76 | 74 | .02 | -138 | .04 |

N.B. Reform 1 changes 6% for 9% and 12% for 14%.
Reform 2 sets all rates at 9%.
Simulations carried out with rank 2 model
Decile breakdown is by expenditure.
Increment of tax column shows the increase in tax with respect to the pre reform situation.
Percentage of total is the proportion of the above increment over total expenditure. expenditure.

| TABLE SIM.3. CLOTHING AND FOOTWEAR. | | | | | | |
|---|---|---|---|---|---|---|
| | Initial pattern | | REFORM 1 | | REFORM 2 | |
| Decile | Expenditure | Share | Δ tax | % total | Δ tax | % total |
| 1 | 6293 | 9.9 | 98 | .15 | -134 | .21 |
| 2 | 15216 | 13.7 | 236 | .21 | -338 | .30 |
| 3 | 22374 | 15.2 | 347 | .23 | -502 | .34 |
| 4 | 30911 | 17.3 | 480 | .26 | -700 | .39 |
| 5 | 36407 | 17.4 | 565 | .27 | -825 | .39 |
| 6 | 50781 | 20.7 | 789 | .32 | -1165 | .47 |
| 7 | 61314 | 21.3 | 952 | .33 | -1409 | .49 |
| 8 | 82765 | 24.4 | 1285 | .37 | -1917 | .56 |
| 9 | 108632 | 26.0 | 1688 | .40 | -2522 | .60 |
| 10 | 186146 | 27.0 | 2890 | .42 | -4317 | .62 |
| Retired | 31188 | 16.3 | 486 | .25 | -700 | .36 |
| 0 Children | 63510 | 22.8 | 983 | .35 | -1463 | .52 |
| 1 " | 73794 | 24.5 | 1145 | .38 | -1709 | .56 |
| 2 " | 75047 | 25.0 | 1168 | .38 | -1739 | .58 |
| 3 " | 68838 | 20.6 | 1074 | .32 | -1575 | .47 |
| 4 " | 73446 | 22.0 | 1152 | .34 | -1693 | .50 |

N.B. Reform 1 changes 6% for 9% and 12% for 14%.
Reform 2 sets all rates at 9%.
Simulations carried out with rank 2 model
Decile breakdown is by expenditure.
Increment of tax column shows the increase in tax with respect to the pre reform situation.
Percentage of total is the proportion of the above increment over total expenditure.

| TABLE SIM.4. FUEL FOR DOMESTIC USE. | | | | | | |
|---|---|---|---|---|---|---|
| | Initial pattern | | REFORM 1 | | REFORM 2 | |
| Decile | Expenditure | Share | Δ tax | % total | Δ tax | % total |
| 1 | 6404 | 10.9 | 120 | .19 | -138 | .21 |
| 2 | 8394 | 7.6 | 168 | .14 | -175 | .15 |
| 3 | 9418 | 6.4 | 188 | .12 | -191 | .13 |
| 4 | 10665 | 5.9 | 214 | .12 | -215 | .12 |
| 5 | 11343 | 5.4 | 231 | .11 | -225 | .10 |
| 6 | 12432 | 5.0 | 254 | .10 | -244 | .10 |
| 7 | 12606 | 4.3 | 264 | .09 | -240 | .08 |
| 8 | 13760 | 4.0 | 290 | .08 | -258 | .07 |
| 9 | 15847 | 3.8 | 333 | .05 | -294 | .07 |
| 10 | 18389 | 2.6 | 403 | .10 | -302 | .04 |
| Retired | 10338 | 5.4 | 209 | .09 | -205 | .10 |
| 0 Children | 12073 | 4.3 | 251 | .09 | -230 | .08 |
| 1 " | 13165 | 4.3 | 271 | .08 | -252 | .08 |
| 2 " | 12370 | 4.1 | 257 | .07 | -233 | .07 |
| 3 " | 11978 | 3.5 | 255 | .07 | -214 | .06 |
| 4 " | 12305 | 3.7 | 264 | .07 | -219 | .06 |

N.B. Reform 1 changes 6% for 9% and 12% for 14%.
Reform 2 sets all rates at 9%.
Simulations carried out with rank 2 model
Decile breakdown is by expenditure.
Increment of tax column shows the increase in tax with respect to the pre reform situation.
Percentage of total is the proportion of the above increment over total expenditure.

| TABLE SIM.5. HOUSEHOLD NON-DURABLE GOODS. | | | | | | |
|---|---|---|---|---|---|---|
| | Initial pattern | | REFORM 1 | | REFORM 2 | |
| Decile | Expenditure | Share | Δ tax | % total | Δ tax | % total |
| 1 | 2738 | 4.31 | 49 | .07 | -73 | .11 |
| 2 | 4143 | 3.75 | 74 | .06 | -112 | .10 |
| 3 | 5865 | 4.00 | 101 | .06 | -162 | .11 |
| 4 | 8789 | 4.92 | 146 | .08 | -241 | .13 |
| 5 | 9143 | 4.37 | 151 | .07 | -256 | .12 |
| 6 | 9055 | 3.70 | 148 | .06 | -259 | .10 |
| 7 | 10732 | 3.74 | 173 | .06 | -308 | .10 |
| 8 | 13765 | 4.06 | 218 | .06 | -396 | .11 |
| 9 | 19326 | 4.63 | 300 | .07 | -544 | .13 |
| 10 | 34371 | 4.99 | 514 | .07 | -962 | .13 |
| Retired | 8139 | 4.26 | 135 | .07 | -226 | .11 |
| 0 Children | 10654 | 3.83 | 172 | .06 | -304 | .10 |
| 1 " | 12663 | 4.21 | 199 | .06 | -360 | .12 |
| 2 " | 15779 | 5.26 | 243 | .08 | -437 | .14 |
| 3 " | 22270 | 6.68 | 338 | .10 | -604 | .18 |
| 4 " | 15413 | 4.63 | 230 | .06 | -438 | .13 |

N.B. Reform 1 changes 6% for 9% and 12% for 14%.
Reform 2 sets all rates at 9%.
Simulations carried out with rank 2 model
Decile breakdown is by expenditure.
Increment of tax column shows the increase in tax with respect to the pre reform situation.
Percentage of total is the proportion of the above increment over total expenditure.

| TABLE SIM.6. PUBLIC TRANSPORT. | | | | | | |
|---|---|---|---|---|---|---|
| | Initial pattern | | REFORM 1 | | REFORM 2 | |
| Decile | Expenditure | Share | Δ tax | % total | Δ tax | % total |
| 1 | 863 | 1.36 | 40 | .06 | 18 | .02 |
| 2 | 2246 | 2.03 | 89 | .08 | 48 | .04 |
| 3 | 3686 | 2.51 | *^T 35 | .09 | 79 | .05 |
| 4 | 3494 | 1.95 | 138 | .07 | 72 | .04 |
| 5 | 4599 | 2.19 | 174 | .08 | 97 | .04 |
| 6 | 5821 | 2.38 | 214 | .08 | 117 | .04 |
| 7 | 4666 | 1.62 | 194 | .06 | 81 | .02 |
| 8 | 5948 | 1.75 | 238 | .07 | 104 | .03 |
| 9 | 9708 | 2.32 | 352 | .08 | 187 | .04 |
| 10 | 14369 | 2.08 | 526 | .07 | 261 | .03 |
| Retired | 3397 | 1.77 | 135 | .07 | 65 | .03 |
| 0 Children | 7231 | 2.60 | 255 | .09 | 143 | .05 |
| 1 " | 6021 | 2.00 | 231 | .07 | 112 | .03 |
| 2 " | 4373 | 1.45 | 189 | .06 | 81 | .02 |
| 3 " | 5336 | 1.60 | 223 | .06 | 95 | .02 |
| 4 " | 4558 | 1.37 | 206 | .06 | 86 | .02 |

N.B. Reform 1 changes 6% for 9% and 12% for 14%.
Reform 2 sets all rates at 9%.
Simulations carried out with rank 2 model
Decile breakdown is by expenditure.
Increment of tax column shows the increase in tax with respect to the pre reform situation.
Percentage of total is the proportion of the above increment over total expenditure.

| TABLE SIM.7. OTHER NON-DURABLE GOODS. | | | | | | |
|---|---|---|---|---|---|---|
| | Initial pattern | | REFORM 1 | | REFORM 2 | |
| Decile | Expenditure | Share | Δ tax | % total | Δ tax | % total |
| 1 | 5139 | 8.10 | 52 | .08 | -137 | .21 |
| 2 | 9055 | 8.21 | 89 | .08 | -245 | .22 |
| 3 | 14182 | 9.68 | 151 | .10 | -378 | .25 |
| 4 | 17427 | 9.77 | 190 | .10 | -461 | .25 |
| 5 | 22597 | 10.80 | 255 | .12 | -595 | .28 |
| 6 | 27698 | 11.34 | 324 | .13 | -722 | .29 |
| 7 | 38128 | 13.30 | 472 | .16 | -983 | .34 |
| 8 | 44712 | 13.20 | 555 | .16 | -1149 | .33 |
| 9 | 62097 | 14.90 | 808 | .19 | -1580 | .37 |
| 10 | 160665 | 23.34 | 2287 | .33 | -4086 | .58 |
| Retired | 32518 | 17.02 | 421 | .22 | -831 | .43 |
| 0 Children | 44210 | 15.90 | 574 | .20 | -1127 | .40 |
| 1 " | 39743 | 13.23 | 502 | .16 | -1020 | .33 |
| 2 " | 39747 | 13.25 | 509 | .17 | -1018 | .33 |
| 3 " | 53937 | 16.20 | 720 | .21 | -1375 | .41 |
| 4 " | 35061 | 10.54 | 426 | .12 | -914 | .27 |

N.B. Reform 1 changes 6% for 9% and 12% for 14%.
Reform 2 sets all rates at 9%.
Simulations carried out with rank 2 model
Decile breakdown is by expenditure.
Increment of tax column shows the increase in tax with respect to the pre reform situation.
Percentage of total is the proportion of the above increment over total expenditure.

| TABLE SIM.8.WELFARE RESULTS. | | | | | |
|---|---|---|---|---|---|
| | Initial pattern | REFORM 1 | | REFORM 2 | |
| Decile | Expenditure | E.G. | % total | E.G. | % total |
| 1 | 63413 | -2204 | 3.47 | -1966 | 3.10 |
| 2 | 110291 | -3786 | 3.47 | -3301 | 2.99 |
| 3 | 146406 | -4997 | 3.43 | -4308 | 2.94 |
| 4 | 178310 | -6051 | 3.41 | -5155 | 2.89 |
| 5 | 209101 | -7076 | 3.39 | -5998 | 2.86 |
| 6 | 244210 | -8236 | 3.38 | -6932 | 2.83 |
| 7 | 286644 | -9628 | 3.37 | -8035 | 2.80 |
| 8 | 338690 | -11320 | 3.35 | -9357 | 2.76 |
| 9 | 416672 | -13834 | 3.34 | -11259 | 2.70 |
| 10 | 688119 | -22375 | 3.32 | -17369 | 2.52 |
| Retired | 191028 | -6378 | 3.25 | -5244 | 2.74 |
| 0 Children | 277894 | -9247 | 3.33 | -7595 | 2.73 |
| 1 " | 300185 | -10046 | 3.32 | -8328 | 2.77 |
| 2 " | 299909 | -10011 | 3.34 | -8205 | 2.73 |
| 3 " | 332897 | -11115 | 3.33 | -9177 | 2.75 |
| 4 " | 332530 | -11250 | 3.38 | -9394 | 2.82 |

N.B. Reform 1 changes 6% for 9% and 12% for 14%.
Reform 2 sets all rates at 9%.
Simulations carried out with rank 2 model
Decile breakdown is by expenditure.
E.G. stands for Equivalent Gain. The percentage of total refers to equivalent gain (loss) as a proportion of total expenditure.

In the case of food, we observe how the poorest households (throughout this section, we shall use the adjective "poor" and "rich" for those households at the bottom and top of the expenditure distribution respectively) have a share nearly double of that of the richest households. The presence of children does not seem to push the share up substantially unless there are four or more. Retired households have a share similar to households within the seventh expenditure decile. This pattern of expenditures suggests that any tax on this category is likely to be regressive in the sense that poor households will end up paying a higher percentage of their total expenditure than rich households. This is confirmed by the increase in payments forecast. The latter ranges between 1039 and 6691 pts. per quarter and between 1.63% and .97% of total expenditure. Thus poor would households would pay 66% more on food tax than rich households with respect to their total expenditures. The second reform offers similar results in terms of the distribution of payments but the amount is slightly increased.

In the case of alcohol, the share increases with total expenditure across the first 50% of its distribution but the variation in percentage is very small. This leads the increase in tax to represent a nearly constant percentage of total expenditure. This increase, however, ranges from 25 to 291 pts. per quarter. The second reform implies a fall in tax payments.

The category clothing and footwear is clearly a luxury: the average share rises from 10% in the first decile to 30% in the top one. This means that the effect of the tax is progressive, as the simulation results show for both reforms. For instance, if the first reform were implemented, the top decile would be paying .4% more of its expenditure on tax than the poorest one, whereas the second reform would lead to a saving of .6% of total expenditure.

Fuel is again a case of a clear necessity with respect to total expenditure. The share falls 8 percentage points from the lowest to the highest decile. Retired households have a higher share too (equal to that of the fifth decile). This implies regressiveness in the pattern of tax payments.

Expenditure on household non-durable goods is observed to vary between 3.75% and 5% of the total, consequently, the resulting tax payments represent a nearly constant percentage for all expenditure deciles.

Public transport is similar to household non-durable goods in that the average share does not change substantially across the different groups.

The rest of non-durable goods are a luxury: their share moves from 8% to 23% as total expenditure rises. Such a pattern results in a progression in the increase of tax payments for the two simulated reforms.

Summarising, it is clear that increases in VAT will have a regressive effect on food and fuel, a progressive effect on clothing and the residual category and a roughly "neutral" effect on the rest of categories.

With respect to welfare effects, the last table of the series shows the money metric welfare change associated with the two reforms. As we can tell from the table, the equivalent gain associated with the first reform ranges between -2204 and -22375 pts per quarter but in terms of percentage out of total expenditure, it stands between 3.25% and 3.5%. Therefore the reform cannot be said to be either progressive or regressive. Concerning reform 2, the main point to comment upon is that it does not improve the welfare of any household while it generates approximately the same revenue for the Exchequer.

Finally, revenue simulation is carried out by calculating every household's tax payment before and after the reform and then grossing it up. The I.N.E. calculates a grossing-up factor with each observation. Each Autonomous Community is divided into three "zones" (except Madrid and Cataluña with four zones and Ceuta-Melilla with one zone) according to the size of township for which the actual population size is known from Census information. The factor is then computed as the ratio between population size and sample size for each "zone". There are thus 51 different grossing-up factors each quarter. It is important whether these factors have been calculated before or after sampling because an unequal rate of response is reported both across regions and socio-economic characteristics in all quarters from 1985 to 1989. The manual is not clear about such issue but judging by the introductory foreword, we would come to the conclusion that no adjustment has been done:

> "*Despite the resources applied in order to facilitate household collaboration (...), it has been impossible to avoid refusals; which, firstly, have not affected different Autonomous Communities in the same way and, secondly, have not followed an uniform pattern across socioeconomic strata, therefore the publication of results a the Autonomous Community level is impossible..*"

It would then be desirable to correct for such differential non-response. Atkinson and Micklewright (1983) suggest possible ways to do so. For instance, a re-weighing of the grossing-up factor to account for the missing households in each region would be appropriate in our case. Despite our efforts, however, Autonomous Community information is not supplied within the tapes.

In these circumstances, a range of alternatives would be possible. Firstly, since the manual provides separate information on non response by number of members in the household and education level of the head of household, the supplied factors could be re-weighted by groups of these two variables (this is done for age groups in the F.E.S. by Atkinson and Micklewright [ibid]).

Secondly, Atkinson et al. (1988) propose to obtain grossing-up factors by solving a system of linear equations linking household characteristics in the sample to their counterparts in the population. Since no unique solution is obtained from this system, a suitable minimum distance method ensures that the resulting weights are as close as possible to the existing ones.

For this research we use the supplied weights without adjustment. This is due in part to its preliminary nature but most of all to the impression that it might be worth waiting for future editions of the E.C.P.F. supplying geographical information so that adequate weighing by region jointly with other demographic characteristics can be done. Given this, we do not adjust for changes in the structure of the population from the last quarter of 1989 to the current date either. Further research will seek to solve this problem in a satisfactory manner.

Finally, a last warning should be issued in the sense that even if we had the correct grossing-up factors, the forecast figures would be still be subject to departures from other forecasts due to the so called non-sampling errors. These may arise because of wrong coding, erroneous answers and, above all, the tendency to conceal certain types of expenditures which has been detected in other budget surveys such as the F.E.S. In addition such surveys do not include institutional consumers.

With these caveats in mind, we present our aggregated figures in the following table. All figures are in millions of 1989 pesetas.

**TABLE 5. FORECASTS OF REVENUE CHANGES TO REFORMS 1 AND 2.**

| CATEGORY | PRE-REFORM | REFORM 1 | REFORM 2 |
|---|---|---|---|
| FOOD AND NON ALC. DRINKS | 80105 | 117070 | 117750 |
| ALCOHOLIC DRINKS | 9843 | 11107 | 7653.3 |
| CLOTHING AND FOOTWEAR | 67437 | 77212 | 52977 |
| FUEL FOR HOUSING | 14017 | 16717 | 11500 |
| HOUSEHOLD NON DURABLE GOODS | 13958 | 16034 | 10303 |
| PUBLIC TRANSPORT | 3554 | 5907 | 4778,2 |
| OTHER NON DURABLE GOODS | 47376 | 53100 | 36073 |
| TOTAL | 236290 | 297147 | 241034.5 |

N.B. Reform 1 sets reduced and standard rates at 9% and 14% respectively.

It is useful to recall that it is not the total of revenue that is important (for we have omitted a number of important expenditure categories which generate a lot of revenue) when interpreting the table. Rather, it is interesting to see the reaction from every single category. In this sense it is noteworthy that the increase in revenue accrued from food in the two reforms reaches 46% from an increase of three points in VAT. The case of alcohol shows that a move from 12% to 14% would increase revenue by 12%, whereas there would be a loss of 22% if a 9% rate was applied. The same pattern applies to clothing, where reform 1 would raise 14% more and reform 2 21% less. From household and other non-durable goods the Exchequer would also lose twice as much in percentage with the second reform as they would gain with the first . Public transport would generate 66% and 34% more revenue with the first and second reforms respectively.

There is a couple of facts that emerge from this results. Firstly, amongst the reduced rate goods, public transport seems capable of generating proportionally more revenue than food, but only if all taxes increase together. Thus the application of a single rate would shift the burden towards food, which is a necessity. Not surprisingly the reform does not improve the welfare of households, as mentioned before. Secondly, amongst the standard rate goods, the one with the highest capacity for generating revenue in proportion to the initial level is fuel for housing, which not surprisingly is a necessity and has a low own price elasticity too. This is followed by clothing and household non-durable goods, which are classed as luxuries and accordingly could be used as a revenue generating instrument with a presumably lower impact on welfare.

**SUMMARY AND CONCLUSION.**

We have estimated a complete flexible demand system on microdata and then used it to carry out indirect tax simulations. In our opinion the **system** could still be improved in terms of price parameters significance only if we had counted with more years of microdata and thus more relative price variation. More experiments with rank three specifications could also improve the information about the nature of some categories of consumption. Another field in which further research will yield improvements for the modelling exercise is the inclusion of tobacco and petrol, which bear special taxes and, given suitable modelling, durable goods.

However, the current system results are the first of their kind for Spain and provide a good starting point on which to build up progressively more sophisticated versions.
Concerning the performance of the current model, the results seem to confirm the a priori ideas we had in terms of sign and size of own-price and expenditure elasticities for the majority of categories and therefore serve as a good simulation basis too. Thus we are able to obtain predictions of the increment in tax that households would have to pay and moreover, this is done at the individual level. The implications for the assessment of different tax policies on welfare grounds is that a detailed monitoring of who are the losers and the winners in a particular fiscal measure can be done.

The two tax reforms we have simulated do not show a clear bias towards either regressiveness or progressiveness in terms of percentage of tax payments out of total expenditure; however, with respect to individual categories, such patterns have been identified unambiguously. The exercise also produces a good picture of the capacity that each commodity has as a revenue generating instrument and, again, this takes into account the behaviour of households.

Our view, thus, is that this exercise increases its usefulness when its results are compared with other predictions, be it from time series or any other forecast instrument. Consequently it may turn out to be an interesting aid in policy-making even in its current state.

**APPENDIX 1. Data Sources.**

The data we use for the estimation of the demand system is a pool of two microdata surveys, the "Encuesta de Presupuestos Familiares" (EPF) and the "Encuesta Continua de Presupuestos Familiares" (ECPF) both organised by the Instituto Nacional de Estadistica (see I.N.E. 1985).

The first of these surveys is run every 10 years and we use the 1980 edition. Its contribution to the estimating sample is 2000 households. The ECPF has been carried out quarterly since January 1985. Its sample of 3200 households is renewed in a 12% every quarter so in order to preserve independence, the set of new households entering the survey for the first time each quarter are the contribution to our estimating sample.

Next we describe the sampling structure and nature of collected information, which is common to both surveys. The sample has been obtained through a two-stage process of stratification, which leads to an independent sample for each Autonomous Community thereby representing the whole nation. At a first stage, the total of 32,000 electoral constituencies into which Spain is divided are classified into different strata according to size of township. These strata are further sub-divided according to the proportion of active population that falls within three different groups of activity. Subsequently, 584 constituencies are chosen from such classification in a manner proportional to the concentration of population but containing a minimum of 85 households from each Autonomous Community. From each of those constituencies contributes with a fixed number of households is drawn randomly.

With respect to the collection of information, there are 4 basic questionnaires (the two surveys are identical in this sense):

1. Household Accounts. This is filled by the person in charge of running the house (generally the housewife). It contains all expenditure (on goods and services to be consumed by either the housewife or the household in general) made by the housewife during the sample week (day by day).

2. Individual Expenditures. One of these is filled separately by each member of the household over fourteen years of age except the housewife. It collects all expenditure (on goods and services to be consumed by either this member or the household as a whole) made during the sample week (day by day).

3. Expenditure of Monthly or Quarterly Reference. This is filled by the I.N.E. agent during an interview with members of the household. It collects expenditure on goods whose reference period is either a month or a quarter.

4. Household General Data. This is filled by the I.N.E. agent during an interview with members of the household. It collects all demographic information and the (net) income of each member according to its source.

The households used for both welfare and revenue simulation are those which make up the last quarter of 1989. Every household has a grossing up factor which indica( the number of households which it theoretically represents in the whole of the nation and this is used to obtain aggregate predictions of tax revenue.

**Appendix 2. Data on prices.**

A problem commonly faced when estimating a demand system with flexible price responses from microdata is that of insufficient variation in relative prices. This is crucial, because if there is a high degree of multi-collinearity in price series, we cannot expect to identify separately own- and cross-price effects and the resulting parameters will generally display large standard errors. Our previous experience was that an A.I.M. cannot be estimated out of the E.C.P.F. data for the period 1985-89, hence our study for a Linear Expenditure System (Labeaga and López, 1992).

In these circumstances, we have examined the nature of the variation in prices in Spain during the period 1980-89 with a view to assessing the convenience of adding extra price variation by means of pooling the E.C.P.F. data with E.P.F. data for 1980. We find that a substantial increase in relative price variation is obtained this way with respect to the period 1985-89. However, a high degree of collinearity is still present in the series so the results for our system in terms of significance of price parameters are not very surprising.

The analysis is carried out for twenty price series rather that just the seven series used in estimation. Our intention when doing so was to obtain evidence on which categories could be either aggregated or kept apart in order to avoid close correlations and exploit independent variation. As we will see our results do not suggest any of these.

All prices (quarterly series) have been obtained from the official publications of the I.N.E. "Indice de precios al consumo". Since it is relative price variation that matters when estimating a demand system (the effects of nominal general increases are collected by the real income terms), we express all series relative to one common category and we perform a principal component analysis.

**APP2.1. Principal component analysis.**

The use of principal components analysis in the context of multivariate regression is justified when there is a high degree of collinearity amongst variables in order to detect which of these can be ignored without loss of information or which linear combination(s) can provide a good summary of the variability in the data.

Principal components are derived from either the correlation or the covariance matrix of a set of variables. Formally, let C be the correlation matrix of a data matrix X containing n variables, the $i^{th}$ principal component of C is defined as the following linear combination

$$z_i = \vec{\lambda}_i X; \quad i = 1 \ldots n;$$

where $\vec{\lambda}_i$ is the eigen vector of each of the n eigen values of C (see e.g. Manly, 1986).

By construction, principal components are orthogonal to each other and are defined in a way such that the variance of each of the principal components corresponds to its eigen value which in turn add up to the trace of C, therefore principal components can be said to account for all the variation in the original data.

The practical implication is that by examining which principal components are important in explaining total variance, we know what variable or (linear combination of variables) offers independent information simply by looking at its contribution to the principal component. In technical terms this is known as the loading of the $k^{th}$ variable on the $i^{th}$ component and from the definition above it is easy to see that this is given by the $k^{th}$ element of $\vec{\lambda}_i$. By the same token, the variables loading high on irrelevant principal components are revealed to contribute little to total variance. The threshold above which principal components are considered important is 6% of total variance, which can be shown to be equivalent to displaying an eigenvalue above the unit. It should be clear thus that if our twenty price variables are all orthogonal then we should get twenty important principal components and, at the other extreme, if only one variable is independent then only one component will be so.

We have examined two different time spans, that of the E.C.P.F. (1985-89) and the whole decade of the eighties (1980-89). The results for the first span show three important components (on the criterion that their eigenvalue should be greater than one). We report here the results for the second span, where four principal components can be considered important in explaining total variance. The following chart summarises the results.

**TABLE APP2.1. Principal component analysis. Variance explained by each of the four significant components and corresponding individual loadings.**

| | # 1 | #2 | #3 | #4 |
|---|---|---|---|---|
| Eigen value | | | | |
| Variance | 12.008 | 4.36 | 1.32 | 1.07 |
| Cumulative | 60% | 21.8% | 6.6% | 5.3% |
| Loadings | 60% | 81.8% | 88.4% | 93.8% |
| Food | .74 | .17 | -.40 | .36 |
| Alcohol | .92 | -.12 | -.22 | .17 |
| Tobacco | .45 | .10 | -.17 | .30 |
| Clothing | .90 | -.30 | .16 | .002 |
| Housing | .72 | .45 | -.29 | .15 |
| Fuel | -.84 | .04 | .39 | -.05 |
| N.W. durable | .86 | .43 | -.03 | .01 |
| W. durable | .76 | .48 | -.27 | .22 |
| Medicines | .19 | -.08 | -.13 | .95 |
| Hshld n.d. | .74 | .18 | -.40 | .30 |
| Vehicles | .59 | .67 | -.17 | .12 |
| Petrol | .08 | .94 | -.11 | .09 |
| P. transport | -.48 | -.79 | .30 | -.013 |
| Telecomm. | -.10 | .61 | .13 | -.08 |
| Leisure d. | .62 | .64 | -.27 | .24 |
| Leisure n.d. | .84 | .16 | -.23 | .13 |
| Education | .72 | .56 | -.28 | .17 |
| P. care | -.35 | -.23 | .86 | -.17 |
| Holidays | .24 | -.35 | -.29 | .20 |
| Meals out | -.02 | -.25 | .19 | .07 |

N.B. The following abbreviations are used:
N.W./ W. Durables= Non-white/ White durable goods.
Hshld n. d. = Household non-durable goods.
P. transport= Public transport.
Telecomm.=Telecommunications.
Leisure d./ n.d.= Leisure durable and non-durable goods.
P. care= Personal care.

As we can see, the first factor loads mainly from alcohol, clothing, fuel, non-white durable goods, leisure non-durable goods and then food, housing, white durable and so on. The second component is driven by petrol, and marginally by public transport. The third draws from personal care and the fourth from medicines.

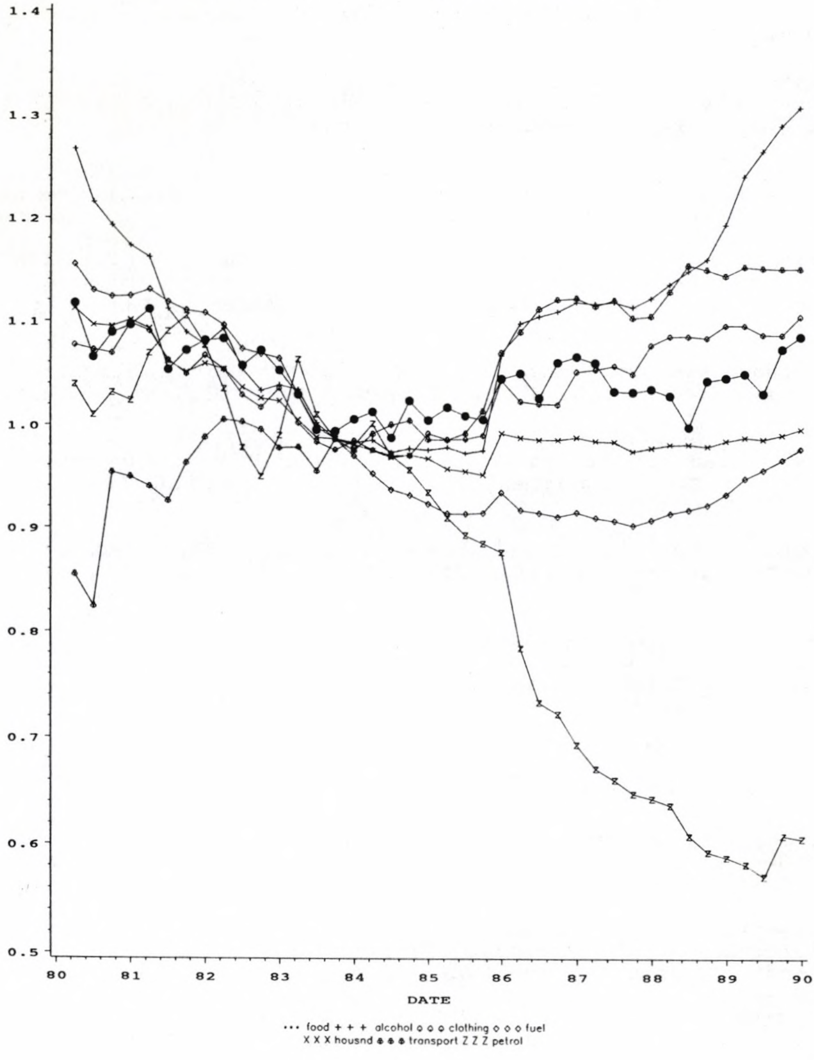
This results are interesting in that they highlight the impossibility of choosing aggregate categories with independent variation in a manner corresponding to any a priori ideas we might have on consumer behaviour. That is, these principal components results would guarantee that if we lump all the goods contributing to the first component into one single equation and do likewise with the rest of components (obtaining thus four estimating equations), then the corresponding price regressors (constructed by means of some index) would not be very correlated. However, this procedure is of little use to our exercise since we are not modelling any of the durable categories, or petrol, which seems to be the responsible for the variance explained by the second component. Likewise, the last two components are driven by categories of little interest for this exercise or at least, in the case of medicines, they would deserve separate treatment in terms of modelling. But more importantly, it turns out that our main goods of interest: food, alcohol, clothing and fuel all contribute to the same principal component and this procedure would not yield separate price estimates for each one.

This is confirmed by graphic AP2.1. We have plotted the relative prices of the estimating categories food, alcohol, clothing, fuel, household non-durable goods and public transport and also petrol. All prices appear to move closely together, except for petrol, which loads on the second factor. This is reassuring for future work in the sense that there is a minimum guarantee that once included in a demand system, we may obtain estimates of cross-elasticities with public transport and other goods of policy interest.

In conclusion our results do not offer any clear-cut way to group categories and such grouping has to be done in conformance with other criteria. They suggest that some gain can be obtained from pooling the E.C.P.F. data with data from its twin survey from 1980. However, the main conclusion we might draw from this analysis is that price parameters in our demand system are likely to lack statistical significance and that this is due to a great degree of multi-collinearity amongst the series.

GRAPH AP2.1

MOVEMENTS IN RELATIVE PRICES DURING 1980-89



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