THE EFFECT OF HOUSEHOLDS LOCATION ON THE SPANISH DEMAND FOR FOOD: A PANEL DATA APPROACH

A.M. Angulo and J. Mur
Departamento de Análisis Económico
Facultad de Ciencias Económicas y Empresariales
Gran Vía, 2, 50.005 Zaragoza (Spain)
Phone: (976) 761831- Fax: (976) 761996
E-mail:aangulo@posta.unizar.es, jmur@posta.unizar.es

B. Dhehibi and J.M. Gil
Unidad de Economía Agraria
Servicio de Investigación Agroalimentaria (DGA)
P.O. Box 727, 50.080 Zaragoza (Spain)
Phone: (976) 576361- Fax: (976) 575501
E-mail:dhehibi@aragob.es, jmgil@posta.unizar.es

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Abstract

The aim of this paper is to analyse the effect of househods location on the Spanish demand for food. The methodological approach followed in the paper is to use panel data built from the Spanish Quarterly National Expenditure Survey to estimate a demand system. The use of this type of data allows us to control for unobserved time invariant heterogeneity as well as to correct the measurement error induced by infrequent purchases. Four locations are distinguished: 1) less than 10,000 inhabitants; 2) between 10,000 and 100,000 inhabitants; 3) between 100,000 and 500,000 inhabitants; and 4) more than 500,000 inhabitants. Eight broad food categories are considered: 1) cereals and potatoes; 2) meat; 3) fish; 4) dairy products; 5) fats and oils; 6) fruits; 7) vegetables; and 8) other food. Income and price elasticities as well as the effects of the most relevant socio-economic variables are calculated. Results indicate that the size of the town where the household lives is not a main determinant of food demand.

1. Introduction

The knowledge of food consumers' reactions to income and price changes (elasticities) is relevant for several economic agents. On one hand, policy makers can anticipate changes in consumers' food consumption patterns by defining policy measures affecting food prices or income. On the other, producers or marketing managers can use food elasticities to know general trends in food consumption. Moreover, a certain knowledge of main sociodemographic characteristics of households can help them in order to implement adequate product and pricing policies to specific market segments to which address their products.

Among the different household sociodemographic characteristics, the size of the location they live has been proved to generate differences in food consumption patterns in Spain (Ramajo 1996; Gracia et al. 1998). Thus, the purpose of this paper is to analyse whether households living in locations of different size react in the same way or not to income and price changes.

The effect of household location on the Spanish demand for food has been already analysed in the literature. Gracia et al. (1998) used time series data in order to estimate a dynamic model for the demand for seven food aggregates. Results showed some differences in terms of reactions to income changes between households living in the smallest towns and the rest. Differences were higher in the case of price changes. Ramajo (1996) analysed the demand for food, beverages and tobacco using cross-section data for a Spanish region (Extremadura) using single equation censured regressions. The distinction between households living in rural and urban towns showed to be relevant in relation to cereals, meat and other food products (sugar and non-alcoholic drink). More precisely, those living in the smallest towns allocated more proportion of their total expenditure to cereals and meat while less to other food. Laajimi (1995) and Angulo (1999) also detected that some differences existed in relation to household location even using different cross-section databases and different methodologies.

Although papers mentioned before are not directly comparable, it can be appreciated important differences as regards the effect of size of the towns where the households live on food consumption. From our point of view, main differences are due to the different data set and methodology used. All the papers mentioned above only take into account the time or cross-section dimension of data. The main methodological novelty of this study is to jointly consider both dimensions by using a panel data set. According to Baltagi and Griffin (1995), among others, purely cross-section or time series studies tend to yield seriously biased elasticities estimates. When only a pure time series data set is used, it is impossible to control for unobservable taste changes occurring over time. Alternatively, cross-section data sets are unable to effectively control for individual-specific effects that can also bias elasticities estimates. The panel data set used in this paper is built from the Spanish Quarterly Household National Survey. More precisely, data set consists on food consumption records from 217 households along the 1995:1-1996:4 period. The second relevant methodological issue considered in this paper is that instead of estimating single equation models, a demand system framework will be used in order to take into account cross-equations variance components. Although using panel data complexity increases there exist a general consensus that the estimator of demand systems is more appropriate to analyse consumers behaviour as theoretical restrictions can be easily imposed. Among all flexible demand systems, the Rotterdam model has been chosen. Thus, in this paper both issues (the use of panel data and the estimation of a demand system) are considered in order to determine the effect of size towns on food demand.

The paper is structured as follows. Next section briefly describes the evolution of food expenditure structure in Spain. In section 3, a description of data used as well as some preliminary transformations are outlined. Methodology is described in section 4. Main results are presented in section 5. The paper finished with some concluding remarks.

2. The evolution of food expenditure structure in Spain

The objective of this section is to briefly describe the evolution of food expenditure structure in Spain making a distinction attending to the size of the town where households live in order to better understand results from the econometric analysis. Table 1 shows main results from the first quarter of 1995 to the fourth of 1996 (the sample period considered in this paper).

As it can be observed, the most interesting patterns are that as the size of the town where the household lives increases, cereal and potatoes and fat and oil expenditure shares decrease while the opposite takes place in the cases of fruits, vegetables and other food. On the other hand, households living in medium size towns (between 10,000 and 500,000 inhabitants) allocate the highest proportion of total food expenditure to meat and fish. Finally, dairy products expenditure share is similar in all types of households.

Although the considered time period is too short and food product categories are too aggregated, some trends can be outlined within each town size. Such small changes can be interpreted as reflecting some substitution process among the considered products that it is likely to be provoked by a continuous process of tastes change along the period. When comparing the evolution across town sizes, some differences can be observed. For instance, while households living in towns with between 10,000 and 100,000 inhabitants are increasing the proportion of total food expenditure allocated to meat, the opposite takes place in the case of households living in towns with more than 500,000 inhabitants. Thus, it may be an indicator that tastes slightly differ among households living in towns of different size. However, this point will be deeply analysed later on.

Table 1. Households food expenditure structure by town size (%).

	1995-1	1995-2	1995-3	1995-4	1996-1	1996-2	1996-3	1996-4
Cereals and potatoes								
< 10,000 inhabitants	21.10	21.58	21.20	18.54	20.83	20.98	19.67	20.52
10,000-100,000 inhabitants	16.01	17.70	12.83	13.38	13.21	12.98	18.85	12.19
100,000-500,000 inhabitants	14.69	16.40	14.76	15.34	14.95	16.82	15.57	15.86
> 500,000 inhabitants	13.21	17.49	14.45	13.28	14.31	14.32	13.96	14.01
Meat								
< 10,000 inhabitants	21.40	23.35	20.13	23.17	22.75	20.50	21.14	21.30
10,000-100,000 inhabitants	25.82	22.21	25.64	27.44	33.16	31.16	18.83	31.14
100,000-500,000 inhabitants	23.05	23.95	22.28	21.83	24.39	20.62	23.98	24.41
> 500,000 inhabitants	22.51	18.16	22.13	26.72	17.37	19.23	17.98	20.07
Fish								
< 10,000 inhabitants	8.95	9.59	5.92	8.35	7.86	10.28	10.58	9.63
10,000-100,000 inhabitants	9.84	9.16	10.83	12.73	10.34	10.01	5.42	15.46
100,000-500,000 inhabitants	14.39	12.08	12.14	10.90	13.56	11.69	11.07	12.52
> 500,000 inhabitants	10.33	9.43	11.99	10.10	9.12	9.92	14.24	14.77
Dairy products								
< 10,000 inhabitants	15.91	12.58	12.81	11.96	12.97	12.69	11.72	14.68
10,000-100,000 inhabitants	15.28	17.95	11.93	10.76	14.08	13.42	11.97	9.54
100,000-500,000 inhabitants	14.57	12.30	12.76	12.72	11.26	15.60	11.97	12.28
> 500,000 inhabitants	15.09	14.40	12.11	11.81	16.42	15.26	11.86	11.31
Fats and oils								
< 10,000 inhabitants	6.12	4.66	5.05	8.48	7.31	7.88	6.64	7.01
10,000-100,000 inhabitants	5.84	4.27	4.68	7.90	7.39	7.51	4.40	7.69
100,000-500,000 inhabitants	5.36	4.74	6.14	9.16	6.71	6.02	6.27	5.89
> 500,000 inhabitants	5.83	2.45	2.55	5.82	5.79	8.02	4.86	7.12
Fruits								
< 10,000 inhabitants	13.11	12.17	16.45	11.60	12.15	11.95	14.24	9.96
10,000-100,000 inhabitants	10.64	12.87	14.24	10.75	10.29	10.59	18.65	11.73
100,000-500,000 inhabitants	10.52	15.44	13.64	12.97	12.89	12.68	13.77	12.10
> 500,000 inhabitants	10.45	16.70	17.32	13.81	13.63	13.16	17.70	13.63
Vegetables								
< 10,000 inhabitants	7.11	9.25	9.85	8.64	7.39	6.58	7.81	6.03
10,000-100,000 inhabitants	5.99	7.29	6.07	8.97	4.70	7.88	10.22	5.74
100,000-500,000 inhabitants	5.71	8.78	8.54	7.62	7.24	9.43	9.01	7.06
> 500,000 inhabitants	7.80	12.62	7.87	6.57	6.67	10.29	8.33	8.78
Others								
< 10,000 inhabitants	6.32	6.80	8.60	9.26	8.73	9.14	8.20	10.86
10,000-100,000 inhabitants	10.58	8.55	13.78	8.07	6.82	6.45	11.67	6.50
100,000-500,000 inhabitants	11.71	6.31	9.75	9.46	9.00	7.14	8.37	9.87
> 500,000 inhabitants	14.79	8.75	11.58	11.89	16.71	9.79	11.07	10.32

Source: Own elaboration from the Spanish Quarterly Household National Survey.

3. Data and preliminary transformations

Data come from the Spanish Quarterly Household National Survey conducted by the *Instituto Nacional de Estadística* (INE). It provides information on expenditure and quantity consumed of different food products by a stratified random sample of 3,200 households from the first quarter of 1985 to the first of 1997. It also gathers information on a limited number of household characteristics including the level of education and main activity of the head of the household, household income, household size, age and sex of family members and town size, among others. For each quarter households are asked to record all information during one week. Theoretically, one household stays in the survey during eight quarters; however, there exist an important percentage of households which do not stay along the whole theoretical period (Browing and Collado 1999). In this work, a panel is built by considering all household remaining in the sample during the last eight quarters information is available (from the first quarter of 1995 to the fourth of 1996). Some households have been discarded as they did not record any expenditure (9.45% of the sample). Finally, 217 households have been considered from whom information has been recorded during 8 periods. Food products have been aggregated into eight broad categories: 1) cereals and potatoes; 2) meat; 3) fish; 4) dairy products; 5) fats and oils; 6) fruits; 7) vegetables; and 8) other food.

Finally, as prices are not recorded, unit values for each product are calculated by dividing expenditure by quantities. However, these values may reflect more than spatial variation caused by supply shocks (i.e., transportation costs, cost of information, seasonal variations, etc.). That is, such prices will also reflect variations in quality which can be attributed to brand loyalty or marketing services, among other reasons, (Cramer 1973; Cox and Wohlgenant 1986). In order to obtain proper results, calculated unit values must be adjusted before using them in demand analysis (Cowling and Raynor 1970; Deaton 1989). Following Gao et al. (1995), the quality-adjusted price can be defined as the difference between the unit price and the expected price, given its specific quality characteristics[1]. The expected price is calculated by a hedonic price function such as:

$$P_k = \vartheta_k + \sum_s \iota_s \; K_{ks} + v_k \qquad (1)$$

where P_k is the unit price; K_{ks} are variables affecting the consumer choice of qualities, such as income and household characteristics, as proxies for household preferences for unobservable quality characteristics. Regional and seasonal dummy variables are not included because they reflect systematic supply variations, but their average effects are reflected by the intercept ϑ_k. The quality-adjusted price is then defined by:

$$P_k^{'} = P_k - \sum_s \hat{\iota}_s \; K_{ks} = \hat{\vartheta}_k + \hat{v}_k \qquad (2)$$

4. Economic model and econometric specification

4.1 The Rotterdam model

The Rotterdam system was first proposed by Theil (1965) and Barten (1964) and since then it has been widely used in food demand analyses. One of the main advantages of this model is that it designates theoretical demand equations of flexible functional forms without assuming any particular form of the utility function (Barnett 1979; Mountain 1988). Nevertheless, it approximates infinitesimal changes in all variables by finite changes and, as a consequence, the Rotterdam model cannot be considered as an exact representation of preferences unless restrictive conditions are imposed (Nayga and Capps 1994). That is, this model needs the use of classical restrictions so that the estimates of demand theory parameters conform to theory. The constraints from demand theory can be directly imposed to the Rotterdam parameters.

Let w_{kit}, q_{kit} denote the budget share and the quantity of a good k (k=1,..., M) for a household i (i=1,..., N) at time t (t=1,..., T); p_{kt}, the price of a good k at time t; and Y_{it} the total food expenditure[2] for household i in period t. The Rotterdam model with constant terms[3] can be written as:

$$\overline{w_{kit}}\,\Delta\log\ q_{kit} = a_k + b_k\,\Delta\log\ Q_{it} + \sum_{k=1}^{M} c_{kh}\,\Delta\log\ p_{ht} + \xi_{kit} \qquad (3)$$

$$\xi_{kit} = \mu_{ki} + \upsilon_{kit}$$

where $\overline{w_{kit}} = \frac{1}{2}\,(w_{kit} + w_{ki,t-1})$

$$\Delta\log\ Q_{it} = \Delta\log\ Y_{it} - \sum_{k=1}^{M}\overline{w_{kit}}\,\Delta\log\ p_{kt} = \sum_{k=1}^{M}\overline{w_{kit}}\,\Delta\log\ q_{kit}$$

$$\Delta\log\ q_{kit} = \log\ q_{kit} - \log\ q_{ki,t-1}$$

$$\Delta\log\ p_{kt} = \log\ p_{kt} - \log\ p_{k,t-1}$$

a_k, b_k and c_{kh} are the intercept, income and price parameters, respectively. Finally, the disturbance term ξ_{kit} is the composite error term consisting of a household-specific effect μ_{ki} and the conventional error υ_{kit}.

Demand theory restrictions hold if parameters satisfy the following expressions:

Adding-up: $\sum_{k=1}^{M} a_k = 0, \quad \sum_{k=1}^{M} b_k = 1, \quad \sum_{k=1}^{M} c_{kh} = 0,$ (4)

Homogeneity: $\sum_{k=1}^{M} c_{kh} = 0,$ (5)

Symmetry: $c_{kh} = c_{hk}$ (6)

Finally, estimated parameters provide the following relevant information:

! From intercepts, time trend effects are obtained:

$$\frac{\partial q_{ki} / \partial t}{q_{kit}} = \frac{a_k}{w_{kit}} \qquad (7)$$

! From income parameters, the income elasticity of the k-th good for household i at period t (η_{kit}) is obtained from:

$$\eta_{kit} = \frac{b_k}{w_{kit}} \qquad (8)$$

! From price parameters, the compensated price elasticity of the k-th good with respect to the h-th good for household i at period t (e^*_{khit}) have the following expression:

$$e^*_{khit} = \frac{c_{kh}}{w_{kit}} \qquad (9)$$

! Finally, the marshallian price elasticity of the k-th good with respect to the h-th good for household i at period t (e_{khit}) is obtained using the Sluskly equation:

$$e_{khit} = e^*_{khit} - w_{hit} \ \eta_{kit} \qquad (10)$$

4.2 Econometric issues

As in this paper a full demand system (3) is specified, it is necessary to take into account when estimating it that disturbances may be correlated across equations. In these circumstances, not taking into account information from all equations would provide consistent, but inefficient, parameter estimates. If we define 3_υ and 3_μ as the (MxM) covariance matrices across equations of υ_{kit} and μ_{ki}, respectively, the complete (MNTxMNT) covariance matrix is defined as (Baltagi 1995):

$$\Omega = \Sigma_1 \otimes Q + \Sigma_2 \otimes P \qquad (11)$$

where 3_1 /3_{υ}.

3_2 / 3_{υ} + T3_{μ}.

P = I_N θ J_T/T, being J_T a TxT matrix of 1's.

Q = I_{NT} - P.

Furthermore, powers of matrix Ω are given by:

$$\Omega^r = \Sigma_1^r \otimes Q + \Sigma_2^r \otimes P$$

where r denotes any power.

For a single equation, such as the j-th equation, the relevant covariance matrix is the j-th NT x NT diagonal block of Ω, that is,

$$\Omega_{jj} = \sigma^2_{1,j} Q + \sigma^2_{2,j} P$$

where $\sigma^2_{1,j}$/$3_{1,jj}$ and $\sigma^2_{2,j}$/$3_{2,jj}$. As a consequence, relevant powers are:

$$\Omega^{-1}_{jj} = \frac{1}{\sigma^2_{1,j}} Q + \frac{1}{\sigma^2_{2,j}} P ; \qquad \Omega^{-1/2}_{jj} = \frac{1}{\sigma_{1,j}} Q + \frac{1}{\sigma_{2,j}} P$$

The Generalized Least Squares estimator of β is defined as:

$$\hat{\beta}_{GLS} = (X' \Omega^{-1} X)^{-1} X' \Omega^{-1} y \qquad (12)$$

For feasible GLS estimates, estimates of 3_1 and 3_2 are needed. Prucha (1984) shows that as long as 3_{υ} is estimated consistently and the estimate of 3_{μ} has a finite positive limit, the corresponding feasible SUR-GLS estimator is asymptotically efficient. Following Baltagi (1995), 3_1 can be estimated by U'QU / N (T-1) and 3_2 by U'PU / N where U= [u_1,...,u_G] is the NT x M matrix of OLS residuals [according to Wallace and Hussain (1969)] or Within-type residuals [according to Amemiya (1971)], for all M equations.

5. Model estimation and calculated elasticities

Once the economic and the econometric framework have been defined, the next step consists of specifying a final demand system to be estimated. The specification of system (3) has been completed by introducing some dummy variables reflecting main households sociodemographic characteristics. As the main objective of the paper is to analyse if households living in towns of different size react in the same way to changes in income and prices, town size dummy variables have been introduced. Such variables have been included both affecting the constant terms as well as price and income parameters. Among the rest of sociodemographic variables only the education level of the household head was able to remove the remaining heterogeneity in a significant way.

The estimation process starts with estimation of the Ω matrix, defined in (11) and, as a consequence, with the estimation of 3_1 and 3_2. Between the two alternatives suggested by Wallace and Hussain (1969) and Amemiya (1971) and mentioned in the previous section, the former has been used in the paper, although no significant differences between the two approaches were found. Finally, the estimated parameters are obtained using expression (12)[4].

Several tests have been carried out to check if intercepts and dummy variables were significant as these variables measure the importance of time effects on the different types of households' food demand. Results indicate that only two significant differences appear with respect to those households without education living in the smallest towns. A positive time effect has been found on the demand for meat of those households headed by a non-educated person and living in towns with a number of inhabitants between 10,000 and 100,000. On the other hand, a negative time effect has been detected on the demand for dairy products of the same type of households but living in the biggest towns (with more than 500,000 inhabitants). However, in general terms, and due to the short period considered, it is possible to conclude that only slight and non-significant changes in tastes have taken place.

Tables 2 and 3 show the most interesting results in food demand analyses: food expenditure (as weak separability has been assumed) and price elasticities, respectively[5]. In general terms, some differences have been found in relation to food expenditure elasticities and considering the different town sizes. Meat, dairy products and vegetables expenditure elasticities decrease as town size increases while the opposite takes place in the cases of fish and fruits. Expenditure elasticities for households living in towns between 100,000 and 500,000 inhabitants are different from those existing in other segments. Most of the capitals are included in this group which generates a certain amount of heterogeneity. Comparing the rest of the segments among them, results are as expected in the sense that expenditure elasticities use to decrease as town size increases as it exists some correlation between town size and income level.

Table 2. Income elasticities by size of the town where the household lives, at the mean time period [(a)].

	Less than 10,000 inhabitants	Between 10,000 and 100,000	Between 100,000 and 500,000	More than 500,000
Cereals and potatoes	0.74*	0.84*	1.12*	0.76*
Meat	1.28*	1.06*	0.95*	1.15*
Fish	0.71*	1.08*	0.70*	1.38*
Dairy product	1.09*	1.04*	0.98*	0.77*
Fat and Oils	0.81*	0.56*	1.00*	0.60*
Fruits	1.01*	1.08*	1.03*	1.21*
Vegetables	1.22*	1.09*	0.91*	0.82*
Others	1.00*	1.06*	1.41*	0.98*

[(a)] An asterisk indicates that the null hypothesis of non-significance is rejected at 5% level of significance.

As regards own-price elasticities, table 3 shows that most of them are inelastic and significant. Nevertheless, the size of the town mainly affects own-price elasticities for fish, fats and oils and other food. In such products, the null hypothesis of non-significance cannot be rejected for households living in towns higher than 10,000 inhabitants, corresponding the most elastic responses to those households living in the smallest towns. The similar trend can be found in dairy products, fruits and vegetables as, although elasticities in all segments are significant, there exist a decreasing trend as town size increases. However, the opposite takes place in the cases of meat and, to a certain extent surprisingly, cereals.

Table 3. Own-price elasticities by size of the town where the household lives, at the mean time period [(a)].

	Less than 10,000 inhabitants	Between 10,000 and 100,000	Between 100,000 and 500,000	More than 500,000
Cereals and potatoes	-0.88*	-1.03*	-1.26*	-0.99*
Meat	-0.41*	-0.53*	-0.45*	-0.59*
Fish	-0.24*	-0.11	-0.12	-0.18
Dairy product	-0.76*	-0.63*	-0.82*	-0.44*
Fat and Oils	-0.32*	-0.04	-0.05	-0.02
Fruits	-0.76*	-0.77*	-0.55*	-0.63*
Vegetables	-0.46*	-0.41	-0.30*	-0.46*
Others	-0.60*	-0.18*	-0.01	-0.04

[(a)] An asterisk indicates that the null hypothesis of non-significance is rejected at 5% level of significance.

6. Conclusions

In this paper, the effect of households location on the Spanish demand for food has been analysed. Reliable effects have been obtained from information based on a panel data set constructed from the Spanish Quarterly Household National Survey. Moreover, a complete demand system has been estimated in order to take into account all the cross-equations variance components.

Results show that the size of the town where the household lives is not an important determinant of food demand. First, only two significant differences are found in relation to time effects, allowing us to conclude that tastes have not changed along the considered period. This result is consistent with the sort sample period used in this study. Second, reactions to changes in income and prices are not either much different. However, the most significant result is that, in general terms, elasticities decrease as town size increases. This conclusion is more relevant in the case of price elasticities. Considering total food expenditure elasticities, the exception to this general trend are found in fish and fruits.

The main conclusion here is that the size of the town where the household lives is not a relevant characteristic in the determination of households' food demand. However, results obtained in this paper are conditioned to the chosen food categories and sample period. More desegregation as well as a longer time period could discriminate a bit more. Nevertheless, this issue is left for further research.

Footnotes

1. In those cases where unit values do not exist as households do not buy a specific product, they have been estimated from a regression of the observed unit values of households how actually buy the product on dummy variables reflecting household characteristics such as season or income. Estimated parameters are then used to predict unit values for a specific household.

2. Weak separability of preferences is assumed.

3. Although theoretically the Rotterdam model did not include constant terms, they have been introduced in order to test whether gradual changes in tastes are observable in the data.

4. One equation has been arbitrarily deleted before estimation (in this case, that corresponding to other food) to avoid singularity of the errors covariance matrix due to the adding-up restriction. Furthermore, homogeneity and symmetry restrictions have been imposed. Estimated parameters are not shown due to space limitations.

5. Due to space limitations, only marshallian own-price elasticities are displayed. Cross price elasticities will be provided upon request.

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