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A DEMAND SYSTEM FOR SECTORAL CONSUMPTION IN CHILE*

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INDEX

ABSTRACT

This paper is concerned with the specification and estimation of a demand system for sectoral consumption in Chile. The proposed system specifies that shares of sectoral consumption (agriculture, mining, manufacturing and services) depend on prices, income and other exogenous variables, in such a way that the standard properties of homogeneity, adding up and symmetry are preserved a priori, regardless the data set. The system is estimated by FIML using data for the period 1961-1982. The empirical results show that the proposed system is theoretically plausible because they corroborate the negativity of the own price substitution effect, not imposed a priori and determined empirically. At the same time, the explanatory power of the system by the dynamic simulation was quite satisfactory.

I. INTRODUCTION

This paper is concerned with the specification and estimation of a system of demands for sectoral consumption in Chile. Although there are several econometric studies of consumption demands for developed countries, the literature devoted to the empirical analysis of demand systems in developing economies is rather scarce. Most of the empirical studies for these latter economies are concerned with the estimation of demands for individual commodities or group of commodities but not with complete demand systems. Therefore, it is interesting to know, for comparison purposes, what are the specifications more suitable for a developing country as well as the order of magnitudes of the elasticities when they are obtained from a complete demand system. These empirical results are also useful for building planning models which usually require these elasticities as some of their inputs. In fact the demand system here estimated is part of an econometric multisectoral model of growth for the Chilean economy.

The demand system developed here assumes that the determination of overall consumption of private households is independent of its allocation among sectors. By itself, the demand system will determine sectoral consumptions conditional on overall consumption and prices, which are determined in other parts of the multisectoral model of growth. This model divides consumption in four sectors of origin: agriculture and fishing, mining, manufacturing and services.

This study on sectoral consumption covers the period 1961-1982. Given the large variance of relative prices during this period, it is very interesting from the sampling view point.

Preliminar empirical analysis of the Chilean data addressed to the estimation of the standard alternative of a linear expenditure system (in static and dynamic frameworks) showed empirical results that were not consistent with the theory[1]. This failure led to propose an alternative demand system. The latter deviates somewhat from traditional demand systems (double logarithmic functions, Theil system, indirect addilog system, linear expenditure system)[2], but fulfils the classical properties of a demand system: adding up, homogeneity of degree zero in all prices and expenditure, symmetry of substitution terms and negativity of the own price (or direct) substitution effect. The first three properties are satisfied regardless the set of data and the last is achieved empirically. The proposed system specifies that shares of sectoral consumption depend on prices, income and other exogenous variables, in such a way that classical properties are preserved and, at the same time, income elasticity is not restricted a priori (as is the case, of double logarithmic functions when adding up is imposed).

The empirical results show that the proposed system is theoretically plausible because they corroborate the negativity of the own price substitution effect, not imposed a priori and determined empirically. At the same time, the explanatory power of the system is quite satisfactory.

Section 2 is devoted to the specification of the demand system and section 3 presents the empirical results.

[1]See Campero, (1). Her study used the same data base as the present research and showed that a dynamic version of the linear expenditure system produced positive own price substitution effects.

[2]See Yoshihara (2) and Phlips (3), for a description of traditional demand systems.

2. GENERAL FRAMEWORK OF THE DEMAND SYSTEM

The proposed model can be related with better known demand systems, like the linear expenditure system (L.E.S.) (Stone (4)).

For an individual consumer (or a "representative consumer") the L.E.S. can be stated as follows:

$$P_j \bullet C_j = \gamma_j P_j + \beta_j (CT - \sum_i \gamma_i P_i) \qquad (1)$$

where:

P_j	=	Price of item j
C_j	=	Real consumption of item j
CT	=	Total expenditure in consumption

It must be noted that $P_j \gamma_j$ measures the minimum expenditure to which the consumer commits himself, $\sum_i P_i \gamma_i$ measures the "subsistence income" and CT - $\Sigma P_j \gamma_j$ is the residual expenditure which the consumer allocates among the n commodities in the proportions $\beta_1 ... \beta_n$ (Samuelson (5)).

This linear expenditure system always fulfils adding up, homogeneity and symmetry. Negativity of the direct substitution effect holds if $C_j > \gamma_j$ and $0 < \beta_j < 1$, which is an empirical matter.

As was said in the introduction, preliminary empirical analysis of the L.E.S. yielded positive estimations of the direct substitution effects. This led to the alternative demand system of this study which is closely related with the naive model of Stone.

Under the assumption of $\gamma_i = 0$, the L.E.S. converges to the naive model of Stone:

$$P_j C_j = \beta_j CT$$

or

$$C_j = bj \frac{CT}{P_j} \qquad (2)$$

where β_j is both the sectoral share of total expenditure and the marginal propensity to consume commodity j.

If $\sum_i \beta_j$ is restricted to be equal to one, the model represented by equation 2) or 3) fulfils adding up, homogeneity and symmetry. Negativity is attained if $\beta_j > 0$. This model, however, is too restricted, because the absolute values of uncompensated price elasticities and income (total expenditure) elasticities are all constant and equal to one, and uncompensated cross price elasticities are zero.

The alternative proposed here differs from equation 2) since it assumes that β_j are not constant but depend on prices, total expenditure in consumption and other state variables represented by a vector z.

The dependence of β_j on the vector of prices and income implies that the corresponding elasticities are not restricted a priori. Besides, through the role of z, the system allows to consider that tastes or the utility function can change through time, as a response to exogenous or/and endogenous variables[3].

Thus, the general form of the alternative system is:

[3]The analogy between changing tastes in consumer theory and technical progress in production theory can be easily stablished. See Peston (6).

$$\beta_j = \beta_j\,(\overline{P}, CT, z) \tag{3}$$

where

$\overline{P}$ = Vector of prices

CT = Nominal consumption

Z = Vector of other exogenous variables that affect tastes (or the utility functions).

In order that the set of β_j equations can be considered a demand system, the coefficients of the equations in (3) should be restricted so that adding up, homogeneity and symmetry are attained a priori. This point will be dealt with later.

From the functional form of the demand system (3) for an individual consumer, the corresponding system for the set of all individuals can be obtained under the assumption that the β_j are equal for all of them:

$$\sum_{k} C_{jk}\, P_j = \beta_j \sum_{k} CT_k \qquad k = 1, 2, ..., m \tag{4}$$

where

C_{jk} = Real consumption of commodity j by individual consumer k.

CT_k = Overall expenditure in consumption by individual consumer k.

m = Number of individual consumers

At the aggregated level, the sectoral shares of consumption are determined by relative prices, income and the variables included in z.

Such a vector z includes population (POP), lagged shares of consumption, a proxy variable for income distribution and two dummies, one for 1972 and one for 1973. The population variable conveys two kinds of effects. The first stems from those long run changes in the pattern of consumption that can be related directly or indirectly to time and demographic variables, both being represented by population. The second stems from those changes in the pattern of consumption arising from the existence of "economies of diseconomies of scale" in the consumption of some commodities. Although the first type of effect seems to be more important, it is not possible to distinguish which is more significant.

The introduction of lagged change in consumption conveys the information about those changes in tastes that are endogenous or dependent on previous consumption. Thus, the lagged shares of consumption of all sectors should be included in each β_j equation. However, problems of degrees of freedom led to adopt a more restrictive approach including in the β_j equations only the lagged share of consumption of the j sector.

The income distribution variable is the ratio between wages and wages plus profits. This variable should not be included in the demands of an individual consumer. Aggregation of individuals with the same β_j does not require an income distribution variable in the aggregated sectoral demand functions for all consumers. In order to reduce the problems caused by aggregating consumers that actually might have differences in β_j associated with income distribution, the latter has been included in the empirical implementation of the model. Obviously the income distribution index used here is a proxy variable for personal income distribution, which is the type of income distribution more relevant for consumer analysis. For a developing economy, one expects that functional income distribution be strongly associated through time with personal income distribution. A great majority of workers in developing economies do not have capital income, except for imputed rents on their houses. Moreover, there is empirical evidence indicating that functional income distribution affects overall consumption in Chile as well as in other developing countries. This fact supports the hypothesis of an association between both kinds of income distribution.

Finally, the inclusion of dummies for 1972 and 1973 obey to severe price controls, black markets and stockpiling phenomena observed during the last two years of Allende administration. Due to these events, the corresponding observations might not correspond to demand functions.

Upon replacing the β_j by the consumption sectoral shares (HC_jN), using the same codes for the variables as in the multisectoral model of growth and omitting time subindices for the current period variables, the demand system of the set of all consumers can be written as:

$$C_jR = HC_jN \bullet \frac{CTTN}{P_jCN} \tag{5}$$

$$HC_jN = \alpha_j + \sum_i \lambda_{ji} (\ln P_j CN - \ln P_i CN) + n_j \bullet \frac{CTTNPOP}{PCC} + \Pi_j \bullet POP + \delta_j$$

$$\bullet HC_jN_{t-1} + \varepsilon_j \bullet WLWLRK + D2_j \bullet DUM72 + D3_j \bullet DUM73 + u_j \tag{6}$$

$\Sigma u_j = 0 \qquad j = 1, 2, 3, 9$

j = 1, agricultural-fishing sector; j = 2, mining sector;

j = 3, manufacturing sector; j = 9, services sector.

C_jR = Real consumption of sector j.

C_jRPOP = C_jR/POP

P_jCN = Nominal price of consumption for sector j.

CTTN = Overall nominal expenditure in consumption less government output consumed by households.

CTTNPOP = CTNN/POP

PCC = Deflator of overall consumption (excluding government output consumed by households) (The code in the mode for the deflator of consumption without this exclusion is PC).

POP = Population

WLWLRK = Ratio of total wages over income ($\frac{WLTN}{WLTN + RKTN}$)

WLTN = Total wage bill

RKTN = Total profits

DUM72 = Dummy for 1972

DUM73 = Dummy for 1973

3. RESTRICTIONS ON THE PARAMETERS AND PROPERTIES OF THE DEMAND SYSTEM

Although not all classical properties of a demand system (adding up, homogeneity, symmetry and negativity) must be fulfilled when the unit of analysis is no longer the individual consumer, it is usual to require that these properties hold for estimated aggregate systems too. The same practice is followed here. The analysis of these properties for the just described system will follow next.

3.1. Homogeneity

The system of equations (5) and (6) is homogeneous of degree zero in prices and overall nominal consumption, because when these variables are multiplied by a same constant the sectoral consumption remain the same.

3.2. Adding up

This condition demands that $\Sigma\ HC_jN = 1$; so that the following restrictions should be imposed:

a) $\delta_j = \delta_i = \delta$

b) $\Sigma\ \alpha_j = 1 - \delta$

c) $\lambda_{ji} = \lambda_{ij}$

d) $\sum_j n_j = 0$

e) $\sum_{j} \Pi_j = 0$

f) $\sum_{j} \varepsilon_j = 0$

g) $\sum_{j} D2_j = 0$

h) $\sum_{j} D3_j = 0$

3.3. Symmetry of Cross Substitution Effects

This property is satisfied when the cross substitution effect k_{ji} is equal to k_{ij}, which , in terms of Slutsky equation, implies that:

$$\frac{?G_jR}{?P_iCN} + C_iR\,\frac{?C_jR}{?CTTN} = \frac{?C_iR}{?P_jCN} + C_jR\,\frac{?C_iR}{?CTTN} \qquad (7)$$

The left hand side is k_{ji} and the right handside is k_{ij}. From equations (5) and (6):

$$\frac{?C_jR}{?P_iCN} = \frac{CTTN}{P_jCN} \bullet \frac{?HC_jN}{?P_iCN} = \frac{CTTN}{P_jCN}\left(\frac{-\lambda_{ji}}{P_iCN} + n_j\,\frac{?(CTTNPOP/PCC)}{?P_iCN}\right) \qquad (8)$$

Since,

$$PCC = \frac{CTTN}{CTTR} = \sum_{i} \frac{C_iR \bullet P_iCN}{CTTR} \qquad (9)$$

where:

CTTR = Overall consumption (excluding government item) valued at base year prices, which are all one,

$$\frac{?C_jR}{?P_iCN} = -\frac{CTTN}{P_jCN}\left(\frac{-\lambda_{ji}}{P_iCN} + n_j \bullet \frac{CTTNPOP}{PCC^2}\frac{C_iR}{CTTR}\right) \tag{10}$$

Using the definitions of PCC and CTTNPOP,

$$\frac{?C_jR}{?P_iCN} = -\frac{CTTN}{P_jCN}\left(\frac{\lambda_{ji}}{P_iCN} + n_j \bullet \frac{C_iR}{POP \bullet PCC}\right) \tag{11}$$

On the other hand,

$$\frac{?C_jR}{?CTTN} = \frac{1}{P_jCN}\left(HC_jN + n_j \frac{CTTN}{POP \bullet PCC}\right) \tag{12}$$

Therefore, applying (11) and (12), the left hand side of (7) can be written as:

$$k_{ji} = -\frac{CTTN}{P_jCN}\left(\frac{\lambda_{ji}}{P_iCN} + n_j \bullet \frac{C_iR}{POP \bullet PCC}\right) + \frac{C_iR}{P_jCN}\left(HC_jN + n_j \frac{CTTN}{POP \bullet PCC}\right)$$

$$= \frac{1}{P_jCN}\left(C_iR \bullet HC_jN - CTTN \bullet \frac{\lambda_{ji}}{P_iCN}\right)$$

$$= \frac{1}{P_jCN}\left(C_iR \frac{C_jR \bullet P_jCN}{CTTN} - CTTN \bullet \frac{\lambda_{ji}}{P_iCN}\right)$$

$$k_{ji} = \frac{C_iR \bullet C_jR}{CTTN} - \frac{CTTN \bullet \lambda_{ji}}{P_jCN \bullet P_iCN} \tag{13}$$

Similarly,

$$k_{ji} = \frac{C_iR \bullet C_jR}{CTTN} - \frac{CTTN \bullet \lambda_{ji}}{P_iCN \bullet P_jCN} \tag{14}$$

Hence symmetry demands $\lambda_{ji} = \lambda_{ij}$, which is one of the requirements for adding-up given in 3.2.

3.4. Negativity of the Direct Substitution Effect

This property is fulfilled if the direct substitution effect, k_{jj}, is negative. Thus, an increase in the price of sector j (P_jCN) should imply a decline in the consumption of sector j (C_jR), when income or total expenditures (CTTN) effect is excluded.

According to Slutsky equation,

$$k_{jj} = \frac{?C_jR}{?P_jCN} + C_jR \frac{?C_jR}{?CTTN} \qquad (15)$$

and, from (5) and (6),

$$\frac{?C_jR}{?P_jCN} = \frac{P_jCN \bullet CTTN \bullet \frac{?HC_jN}{?P_jCN} - HC_jN \bullet CTTN}{(P_jCN)^2}$$

$$= \frac{1}{P_jCN} (CTTN (\sum_i \frac{\lambda_{ji}}{P_iCN} - n_j \bullet \frac{CTTNPOP \bullet C_jR}{PCC^2 \bullet CTTR}) - C_jR)$$

$$= \frac{1}{P_jCN} (CTTN (\sum_i \frac{\lambda_{ji}}{P_iCN} - n_j \bullet \frac{C_jR}{POP \bullet PCC}) - C_jR)$$

$$= \frac{1}{P_jCN} (\frac{C_jR}{HC_jN} \sum_i \lambda_{ji} - \frac{CTTN \bullet n_j \bullet C_jR}{POP \bullet PCC}) - C_jR)$$

$$\frac{?C_jR}{?P_jCN} = \frac{C_jR}{P_jCN} (\frac{\lambda_{ji}}{HC_jN} - \frac{CTTN \bullet n_j}{POP \bullet PCC}) - 1) \qquad (16)$$

Using (12) and (16) in (15),

$$k_{jj} = \frac{C_jR}{P_jCN} (\sum_i \frac{\lambda_{ji}}{HC_jN} - \frac{CTTN \bullet n_j}{POP \bullet PCC}) - 1) + \frac{C_jR}{P_jCN} (HC_jN + n_j \frac{CTTN}{POP \bullet PCC})$$

$$= \frac{C_j R}{P_j CN} \left(\sum_i \frac{\lambda_{ji}}{HC_j N} + HC_j N - 1 \right) \qquad (17)$$

Since $C_j R$, $P_j CN$, $HC_j N$ are positive, equation (17) implies that negativity will be attained if,

$$\left(\sum_i \frac{\lambda_{ji}}{HC_j N} + HC_j N - 1 \right) < 0$$

The negativity property will not be imposed a priori, but will be verified empirically.

4. ELASTICITIES OF THE DEMAND SYSTEM

The description of the demand system is completed with a brief review of its elasticities,

4.1. Price Elasticity ($EPTC_j$)

This elasticity is obtained by multiplying (16) by $\frac{P_jCN}{C_jR}$:

$$EPTC_j = \sum_i \frac{\lambda_{ji}}{HC_jN} - \frac{CTTN \bullet n_j}{POP \bullet PCC} - 1$$

$$= \sum_i \frac{\lambda_{ji}}{HC_jN} - n_j\, CTTRPOP - 1$$

where: $CTTRPOP = \frac{CTTN}{POP \bullet PCC}$ = per-capita real overall consumption (excluding government item)

It should be noted that, according to equation (6), changes in the measurement unit of CTTRPOP produce compensatory variations in n_j, so that the elasticity $EPTC_j$ is independent of the units in which CTTRPOP is measured.

4.2. Compensated Price Elasticity ($EPSC_j$)

This elasticity is obtained by multiplying k_{jj}, (17) by $\frac{P_jCN}{C_jR}$:

$$EPSC_j = \sum_i \frac{\lambda_{ji}}{HC_jN} + HC_jN - 1$$

4.3. Income Elasticity (EIC_j)

This elasticity is obtained by multiplying (12) by $\frac{CTTN}{C_jR}$:

$$EIC_j = \frac{CTTN}{C_jR \cdot P_jCN}\ (HCjN + n_j\ \frac{CTTN}{POP \cdot PCC})$$

$$= \frac{1}{HC_jN} + (HC_jN + n_j\ CTTRPOP)$$

$$= 1 + \frac{n_j \cdot CTTRPOP}{HC_jN}$$

4.4. Cross Price Elasticity ($EPCT_{ji}$)

This elasticity is obtained by multiplying (11) by $\frac{P_iCN}{C_jR}$:

$$EPCT_{ji} = -\frac{P_iCN \cdot CTTN}{C_jR \cdot P_jCN}\ (\frac{\lambda_{ji}}{P_iCN} + n_j \cdot \frac{C_iR}{POP \cdot PCC})$$

$$= -\ \frac{1}{HC_jN}\ (\lambda_{ji} + n_j \cdot HC_iN \cdot CTTRPOP)$$

4.5. Compensated Cross Price Elasticity ($EPCS_{ji}$)

This elasticity is obtained by multiplying k_{ji}, 13), by $\frac{P_iCN}{C_jR}$:

$$EPCS_{ji} = -\frac{P_iCN}{C_jR}\ (\frac{C_iR \cdot C_jR}{CTTN} - \frac{CTTN \cdot \lambda_{ji}}{P_jCN \cdot P_iCN})$$

$$= HC_iN - \frac{\lambda_{ji}}{HC_jN}$$

5. ESTIMATION AND RESULTS

The demand system is constituted by the four stochastic equations of sectoral shares of consumption (equations (6)) and four identities (equations (5)). Since the relation between (5) and (6) is not simultaneous but recursive, the set (6) can be estimated independently of (5).

Due to the restrictions on the coefficients of (6), the share equations should be estimated jointly.

The structure of the error term causes a problem in estimating the all four share equations together. Since $\sum_j HC_jN = 1$, and the deterministic part of the share equations are restricted to add up to one, $\sum_j u_{jt}$ is equal to zero when error terms ujt are introduced into (6). Although it can be assumed that the errors are independent through time ($E(u_{jt}\ u_{jt+h}) = 0\ \forall\ h\ ?\ 0$), it can be shown that $\sum_j u_{jt} = 0$ implies that the variance covariance matrix of the complete system will be singular.

The singularity problem is solved by eliminating one equation before estimating the system. Still, the across -equation covariances of the error terms of the three remaining equations are not necessarily zero[4]. The seemingly unrelated equations approach of Zellner or Full Information Maximum Likelihood (FIML) estimation techniques can be used. The second alternative of FIML is used here.

[4] Due to adding up and the assumption that the composition of overall consumption does not affect its level, null accross equation covariances of the error terms of the three remaining equations require that an stochastic shock on the sectoral consumption share of any of the three included sectors be compensated by a change in the share of the excluded sector. If this shock is compensated, totally or partially, by changes in the shares of the other two included sectors, the aforementioned covariances will not be zero.

It may be shown that the choice of the sector to be eliminated does not affect the estimation results. Here, sector 9 is eliminated from the estimation.

Once the coefficients of the first three sectors are estimated, the estimation of share equation for sector 9 can be derived using the adding up property.

Sector 9 share equation will then be equal to:

$$HC9N = A9 + \lambda_{91} (\ln P9CN = \ln P1CN) + \lambda_{92} (\ln P9CN - \ln P2CN)$$

$$+ \lambda_{93} (\ln P9CN - \ln P3CN) + n_9 \bullet \frac{CTTNPOP}{PCC} + \Pi_9 \bullet POP$$

$$+ \delta \bullet HC9N_{t-1} + \varepsilon_9 \bullet WLWLRK + D29 \bullet DUM72$$

$$+ DUM39 \bullet DUM73$$

The coefficients of sector 9 equation are related to those of the other three sectors:

$$\lambda_9 = 1 - \alpha_1 - \alpha_2 - \alpha_3 - \delta$$

$$\lambda_{91} = \lambda_{19}$$

$$\lambda_{92} = \lambda_{29}$$

$$\lambda_{93} = \lambda_{39}$$

$$\eta_9 = -(\eta_1 + \eta_2 + \eta_3)$$

$$\Pi_9 = -(\Pi_1 + \Pi_2 + \Pi_3)$$

$$\varepsilon_9 = -(\varepsilon_1 + \varepsilon_2 + \varepsilon_3)$$

$D_{29} = -(D_{21} + D_{22} + D_{23})$

$D_{39} = -(D_{31} + D_{32} + D_{33})$

Finally it should be mentioned that FIML was used under assumption of normality of the errors. Although the standard properties of the coefficients are not at stake for this assumption, the t ratios statistics should be taken with care[5]. The normality assumption will be less plausible if the residuals of the equations are too large, signifying that some estimated sectoral consumption shares lie outside the bounds of zero and one. Fortunately, the equations fits are very close to the observed values of the dependent variables and none of the estimated shares fall out of the interval between zero and one.

A brief summary of the results will be offered next.

The estimated coefficients and their corresponding t ratios appear in Table 1.

[5]A test about normality has not been implemented yet. Also, if the residuals show important non normality, the t tests should be corrected. We leave this point for future work.

TABLE 1
ESTIMATED COEFFICIENTS

Parameter	Estimate	T-Statistic
α_1	0.0776	4.7044
λ_{12}	-0.0013	-2.0352
λ_{13}	0.0163	1.3591
λ_{19}	0.0348	4.2616
ε_1	0.0054	0.2262
δ	0.2459	5.6190
n_1	-0.1E-5	-2.4005
D_{21}	0.0373	6.1893
D_{31}	0.0030	0.5076
Π_1	0.0010	1.2800
α_2	-0.0015	-0.3308
λ_{23}	0.0013	1.7524
λ_{29}	0.4E-4	0.0424
ε_2	0.0009	0.6047
η_2	-0.6E-7	-1.7191
D_{22}	-0.0002	-0.5980
D_{32}	-0.4E-4	-0.1164
Π_2	0.0003	0.6820
α_3	0.4514	12.0842
λ_{39}	0.0709	4.3121
ε_3	-0.1930	-4.0462
η_3	0.7E-5	6.1973
D_{23}	-0.0139	-1.3176
D_{33}	0.0276	2.4674
Π_3	-0.0096	-6.4404

As was pointed out above, the different elasticities of sectoral consumption, with respect to prices and income, are not constant throughout the sample.

Table 2 shows price elasticities with respect to own prices ($EPTC_j$). The means of these elasticities are all negative, being manufacturing the most elastic sector. Although the mean elasticity for Mining is not the lowest, its value has a large variance across observations. Disregarding two years in which mining has a positive price elasticity, all the rest of price elasticities have negative values.

In Table 3, the compensated own price elasticities ($EPSC_j$) are presented. The mean elasticities for the four sectors are negative. The compensated own price elasticities for agriculture, manufacturing and services are negative for all observations and fairly stable throughout the sample period. The elasticity for mining is negative for most of the observations and positive values appear in only two years. Two comments deserve attention here. First, the high variance of mining elasticity can be interpreted as if the mining elasticity is not different from zero. Measurement errors of the mining consumption may be the source of this large variance. Second, most of mining consumption corresponds to coal, used as home energy supplier. Its importance is negligible when compared with the consumption of any of the other three sectors. Notice that gasoline, paraffin, and gas, whose consumption is much higher than coal, are processed commodities and are classified in the manufacturing sector. The fact that only two observations of the least important sector do not exhibit negativity, indicates that negativity of the own price substitution effect is fulfilled by the overall system.

Table 4 shows income elasticities (EIC_j). Manufacturing has the highest income elasticity (above one) while mining has the lowest, being this latter sector an "inferior good". The income elasticities of the three more important sectors are very stable throughout the sample. Mining income elasticity shows a great instability and the above discussion about the mining sector compensated own price elasticity applies here.

Table 5 shows the means of cross price elasticities ($EPCT_{ji}$) and Table 6 presents compensated cross price elasticities ($EPCS_{ji}$). In Table 6, it can be appreciated that both, complementarity and substitution relationships are present. However, most of $EPCS_{ji}$ are positive, reflecting that substitution relationships are more important.

Finally, Table 7 provides a summary evaluation of the explanatory power of the system. This Table shows the results of the simple regressions between observed sectoral consumption (C_jR) and dynamically simulated values of the same variables. The t ratios appear between parenthesis. The values of the R^2 indicate a high explanatory power of the system. The absence of any dynamic drift in the simulations is verified by the non significance of all the constants and by the statistically close approximation of the estimated slopes to one. These simulations, along with the values obtained for the elasticities, show that the estimated demand system is capturing adequately the main features of sectoral consumptions within the standard theoretical constraints.

TABLE 2
OWN PRICE ELASTICITIES

	EPTC1	EPTC2	EPTC3	EPTC9
1961	-0.32338	0.28572	-0.99705	-0.57782
1962	-0.32834	-0.31618	-0.99817	-0.57919
1963	-0.27011	-6.24578	-1.00423	-0.57247
1964	-0.29168	0.33991	-0.99953	-0.57581
1965	-0.33867	-0.67467	-0.99255	-0.58585
1966	-0.33310	-0.73969	-1.00661	-0.57458
1967	-0.28028	-0.62940	-1.01037	-0.57257
1968	-0.21247	-0.19703	-1.01513	-0.57067
1969	-0.23438	-0.41036	-1.02279	-0.55799
1970	-0.22452	-0.40104	-1.01773	-0.56575
1971	-0.22446	-0.71165	-1.03230	-0.56300
1972	-0.53724	-0.78602	-1.03994	-0.52229
1973	-0.47616	-0.79220	-1.04544	-0.45784
1974	-0.41280	-0.80890	-0.99969	-0.55446
1975	-0.39930	-0.86656	-0.96830	-0.61087
1976	-0.37379	-0.86348	-0.96411	-0.62041
1977	-0.37964	-0.88675	-0.98086	-0.60627
1978	-0.32428	-0.88361	-0.98871	-0.60450
1979	-0.31873	-0.87902	-1.00176	-0.58567
1980	-0.29017	-0.88241	-1.00943	-0.58135
1981	-0.17845	-0.87310	-1.02212	-0.58053
1982	-0.11104	-0.86955	-0.99458	-0.61453
Mean	-0.31195	-0.86781	-1.00504	-0.57429

TABLE 3
COMPENSATED OWN PRICE ELASTICITIES

	EPSC1	EPSC2	EPSC3	EPSC9
1961	-0.27486	0.28456	-0.27502	-0.34721
1962	-0.27962	-0.31728	-0.27842	-0.34657
1963	-0.22831	-6.24709	-1.26979	-0.34741
1964	-0.24694	0.33874	-0.27151	-0.34740
1965	-0.28802	-0.67556	-0.28235	-0.34582
1966	-0.28530	-0.74060	-0.28165	-0.34594
1967	-0.23892	-0.63046	-0.27732	-0.34593
1968	-0.17813	-0.19827	-0.27311	-0.34578
1969	-0.19901	-0.41160	-0.26746	-0.34745
1970	-0.18940	-0.40225	-0.27082	-0.34656
1971	-0.19259	-0.71281	-0.28279	-0.34323
1972	-0.45758	-0.78714	-0.29162	-0.34914
1973	-0.40895	-0.79317	-0.23131	-0.33820
1974	-0.35182	-0.80955	-0.26501	-0.34948
1975	-0.33752	-0.86680	-0.29794	-0.34277
1976	-0.31537	-0.86372	-0.30289	-0.33981
1977	-0.32312	-0.88696	-0.30344	-0.33999
1978	-0.27618	-0.88391	-0.30289	-0.33812
1979	-0.27251	-0.87942	-0.29017	-0.34308
1980	-0.24840	-0.88284	-0.28959	-0.34252
1981	-0.14947	-0.87372	-0.29258	-0.33844
1982	-0.08342	-0.87002	-0.30717	-0.32914
Mean	-0.26479	-0.86863	-0.28204	-0.34364

TABLE 4
INCOME ON TOTAL EXPENDITURE ELASTICITIES

	EIC1	EIC2	EIC3	EIC9
1961	0.63111	-13.29683	1.26804	0.65211
1962	0.62839	-6.71761	1.27456	0.65052
1963	0.58763	61.41267	1.27383	0.63880
1964	0.61020	-14.01526	1.26786	0.64818
1965	0.64359	-2.56779	1.26991	0.66362
1966	0.61027	-2.10217	1.29320	0.63328
1967	0.57163	-3.49207	1.29462	0.62763
1968	0.52087	-8.93748	1.29719	0.62139
1969	0.52011	-6.53251	1.30289	0.59800
1970	0.52387	-6.48437	1.29860	0.61291
1971	0.47333	-2.99218	1.34168	0.58823
1972	0.67956	-2.12990	1.37008	0.51521
1973	0.65966	-1.80730	1.29738	0.44301
1974	0.68397	-1.09942	1.26006	0.62648
1975	0.71391	-0.28595	1.24804	0.71401
1976	0.70545	-0.29674	1.24770	0.72617
1977	0.67228	-0.21156	1.28021	0.69021
1978	0.62415	-0.30849	1.29411	0.67952
1979	0.60358	-0.42525	1.29794	0.64820
1980	0.56826	-0.44713	1.31101	0.63438
1981	0.45783	-0.68918	1.33904	0.61918
1982	0.47585	-0.54188	1.31270	0.68381
Mean	0.59843	-0.63493	1.29276	0.63249

TABLE 5
CROSS PRICES ELASTICITIES

EPCT12	0.0173
EPCT13	0.0095
EPCT19	-0.3133
EPCT21	1.6594
EPCT23	-0.7057
EPCT29	0.5490
EPCT31	-0.0519
EPCT32	-0.0026
EPCT39	-0.2331
EPCT91	-0.0678
EPCT92	0.00007
EPCT93	0.0096

TABLE 6
CROSS PRICES ELASTICITIES

EPCT12	0.0176
EPCT13	0.3442
EPCT19	-0.0970
EPCT21	1.6024
EPCT23	-1.0493
EPCT29	0.3155
EPCT31	0.0483
EPCT32	-0.0019
EPCT39	0.2356
EPCT91	-0.0191
EPCT92	0.0004
EPCT93	0.3624

TABLE 7
DYNAMIC SIMULATION

	CONSTANT	SLOPE	R^2
C1R	2.060 (0.0017)	.998 (15.57)	.923
C2R	-3.330 (-.236)	1.043 (10.95)	.827
C3R	-194.29 (-0.100)	1.001 (68.29)	.995
C9R	716.25 (.438)	.990 (47.06)	.991

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