Título do capítulo	CAPÍTULO 10 - ESTIMATION OF THE BRAZILIAN CONSUMER DEMAND SYSTEM
Autores (as)	Seki Asano Eduardo P. S. Fiúza
DOI	

Título do livro	GASTO E CONSUMO DAS FAMÍLIAS BRASILEIRAS CONTEMPORÂNEAS
Organizadores (as)	Fernando Gaiger Silveira Luciana Mendes Santos Servo Tatiane Menezes Sérgio Francisco Piola
Volume	1
Série	-
Cidade	Brasília
Editora	Instituto de Pesquisa Econômica Aplicada (Ipea)
Ano	2006
Edição	
ISBN	978-85-86170-85-0
DOI	-

CAPÍTULO 10

ESTIMATION OF THE BRAZILIAN CONSUMER DEMAND SYSTEM*

Seki Asano
Eduardo P. S. Fiúza

1 INTRODUCTION

This study estimates the Brazilian consumer demand system based on household expenditure data, for all the consumption categories, and their corresponding price indexes. The data sources for expenditures are the national expenditure surveys conducted in 1987/88 and 1995/96 (named Household Expenditure Surveys, also known by its Portuguese acronym POF) by the Brazilian Institute of Geography and Statistics (IBGE). The source for price indexes is the monthly national survey of consumer prices.

The next section reviews previous estimations of consumer demand systems in Brazil. Section 3 introduces our model, an extension of the Almost Ideal Demand System. Section 4 describes the data utilized. Section 5 displays the results and Section 6 concludes.

2 PREVIOUS STUDIES

Few studies exist on the estimation of consumer demand in Brazil. Only one of them estimated price elasticities for all expenditure groups, because of the difficulty in obtaining price data for the non-food groups. Moreover, except for two recent studies that used POF, all of them were based on older surveys. The methodology adopted varied widely.

The first study of which we are aware was carried out by Medeiros (1978), who estimated Engel elasticities for food and education in the City of São Paulo using a local Household Expenditure Survey conducted by the University of

* Este artigo foi originalmente publicado na revista *Brazilian Review of Econometrics*, 23(2), p. 255-294, novembro de 2003, tendo sido autorizado pelos autores e pelo editor da revista, Naércio Aquino Menezes Filho, a sua republicação neste livro.

São Paulo in 1971-72 (the survey will be henceforth referred to as POF-USP). Medeiros modeled demand with a Box-Cox transformation for both dependent variable (expenditure on food or on education) and explanatory variable (total expenditure), allowing for more flexibility of the functional specification. He restricted the Box-Cox parameter to be equal for both sides (estimated l's were – 0.85 for food and ranged from 0.03 to 0.14 for education, depending on whether or not additional explanatory variables were included).

The National Household Expenditure Inquiry (Estudo Nacional de Despesas Familiares – ENDEF), a comprehensive survey undertaken from August 1974 to August 1975 in all metropolitan and urban areas, as well as in rural areas in the Southern, Southeastern and Northeastern regions of Brazil, was the data source for a large number of studies. Rossi (1982) modeled demand using a Lorenz curve for concentration, following Kakwani (1977*a*, 1977*b*, 1978), and applied it to ENDEF data from the City of Rio de Janeiro. He also compared the results with estimates obtained by a Box-Cox transformation, and found them to be very similar, except for the tails of the income distribution, where Kakwani's method, albeit coming out in the end with unreasonable patterns, allows for more flexibility (including non-monotonic paths). Rossi (1983*b*) retrieved these estimates and compared them with the ones obtained for São Paulo using POF-USP and with the ones obtained for all metropolitan areas using ENDEF. Box-Cox estimates are also reported for São Paulo. The sum of residuals was lower for Kakwani's method, but it is worth remarking that this superiority is mostly due to three expenditure groups: clothing, recreation and health care.

Hoffmann (1983 and 1988) proposed an alternative framework, a piecewise linear regression, and obtained estimates for Rio de Janeiro not far from Rossi's. Although his fit was better — an elementary result, since he only added more variables, as Rossi (1983*a*) points out —, it is worth noting that it came at the expenses of finding different break points for each commodity run. Another caveat is the omission of the standard error. Both Rossi's and Hoffmann's sets of elasticities add up to one approximately, but neither author makes use of demographic variables. Hoffmann (2000) replicated his exercise to POF 1995/96 data. It is worth noting that in both runs the author only used IBGE's published tabulations as data source. Although he did not report tests for the elasticities, three expenditure groups seem to have income elasticities close to one: Education, Recreation and Miscellaneous. Food items were also estimated separately, and four subitems were found to have negative mean income elasticities: cassava meal, beans, milk powder and sugar. An odd finding was that many staple food items (such as rice, beans, pasta and milk powder) displayed negative elasticities only in intermediate income strata.

Another approach was undertaken by Rossi and Neves (1987). By transforming a logit into a linear specification and using the same explanatory variables, he was able to estimate each equation by OLS. The explanatory variables were income (total expenditure), prices and demographic variables (age of household head, family size). As opposed to previous articles, the estimation makes use of all regions covered by ENDEF. Elasticities with respect to income and family size are reported for nine income classes. Fit is reasonably good, but the standard errors are not reported. They found income-inelastic demands for Food and elastic demands for Transportation and Education and Reading. Elasticities with respect to family size suggest that economies of scale are only present in Food, Transportation and Education, indicating that these expenditures on these items increase at the expenses of the Housing and Other Expenses category. Price elasticities are missing.

The same approach of logit transformation to OLS had been chosen by Cipriano and Brandt (1983) for agricultural products (Food and Tobacco), but the authors added some original variables, such as: state population, regional dummies and an income inequality index. Income elasticity estimates are, however, suspiciously too low – probably due to omission of other goods – and standard errors were also not reported.

Simes and Brandt (1981) ran an expanded linear expenditures system (ELES) using all expenditure categories, but reported both price and income elasticities only for Food and Tobacco. Parameter estimates attained a 10 percent significance. Unfortunately, additional explanatory variables were simply not listed. The adding-up criterion was met.

Thomas, Strauss and Barbosa (1989) ran a generalized version of the Almost Ideal Demand System (AIDS) on ENDEF data, also on all regions covered. Because of the concern on agricultural policymaking, the system is very disaggregated, and contains some detailed food commodity items as dependent variables. However, disaggregation is limited, mainly due to the difficulty in handling non-zero expenditures, i.e., commodities that are never purchased or whose purchase was not recalled by the household during the survey. Prices are estimated indirectly by the expenditure/quantity ratio (ENDEF collected quantities of all commodities). However, in order to prevent endogeneity and minimize the effect of outliers, caused by measurement errors, the regional median prices are used. The system they eventually ran is the following:

$$w_{ih} = \beta_{0i} + \beta_{1i}\ln(x_h) + \beta_{2i}[\ln(x_h)]^2 + \sum_j \gamma_{ij} \cdot \ln(p_j) + \delta_i \cdot \ln(n_h) +$$

$$+\sum_d \delta_{id} \cdot (n_{ihd} / n_h) + \phi_i \cdot z_h + \varepsilon_{ih} \qquad (1)$$

where:

- x_h is total expenditure of household *h*;
- w_{ih} is the share of item *i* in total expenditure of household *h*;
- p_j is price of good *j;*
- n_h is the household size;
- n_{ihd}, *d=1,…8,* is the number of household members in each of eight age groups; and
- z_h is a vector of household characteristics: education of the household head and that of the spouse, and dummies for household head's gender, and for the presence of spouse.

They reported both expenditure[1] and price elasticity estimates.

Alves, Dicsch and Evenson (1982) estimated demand for food by running share equations in logarithmic prices (and including income and squared income) within a SUR model. Prices also came from ENDEF, and were also averaged on a regional basis. Both price and income elasticities were reported, and they appear to be sensible. The authors note that results were better for a subset of nine geographical regions. Estimates for non-food goods and services were hampered by lack of independent price data, and a consequent untested assumption of separability from food.

Menezes *et al*. (2002) estimated a quadratic expansion of the Almost Ideal Demand System (AIDS) – based on Blundell, Pashardes and Weber (1993) – on microdata from POF 1995/96. They ran a system of equations for 39 food items, where the typical equation was:

$$w_{ih} = \beta_{0i} + \beta_{1i}\ln(x_h) + \beta_{2i}[\ln(x_h)]^2 + \sum_j \gamma_{ij} \cdot \ln(p_{jh}) \qquad (2)$$

where x_h here refers to total non-food expenditure – a two-stage budgeting underlies the model. The authors measured prices indirectly from quantity

1. The authors instrumented total expenditure with non-labor income.

2. Referring to total consumption expenditure, a proxy for income.

data instead of importing them from outside sources, so their inputs were actual prices faced by consumers. However, no instrumental variable for prices was used in the regression – though the aggregation into thirty income strata may have attenuated endogeneity concerns. Similarly to Hoffmann's findings, they encountered negative elasticities for cassava meal and milk powder, while figures for beans and sugar were close to zero. Unfortunately, price elasticities were not reported by the authors.

3 THE MODEL

3.1 AI Demand System

The model used in the estimation is based on the Almost Ideal Demand System (AIDS), as proposed by Deaton and Muellbauer (1980), which allows a flexible approximation to the general preference structure. AIDS specifies the log expenditure function as:

$$\ln e(p,v) = \alpha_0 + \sum_i \alpha_i \ln p_i + \frac{1}{2}\sum_i \sum_j \gamma_{ij} \ln p_i \ln p_j + v\beta_0 \prod_i p_i^{\beta_i} \qquad (3)$$

where p is the price vector, p_i is the ith price, and v is utility. α_i, β_i, γ_{ij} are the parameters. This specification is close to quadratic in log prices, thus allowing a second order approximation to general expenditure functions. In order for the expenditure to be increasing in utility (v), β_0 must be positive. Note that one can assign arbitrary values to utility v. As a useful normalization, Deaton and Muellbauer suggested assigning zero to utility at subsistence. Then we can interpret α_0 as the log expenditure at subsistence level when all the prices are normalized at one ($ln(p_i)$'s are zero).

The linear homogeneity of the expenditure function with respect to the price vector requires the following constraints:

$$\sum_i \alpha_i = 1, \ \sum_i \beta_i = 0, \ \sum_i \gamma_{ij} = \sum_j \gamma_{ij} = 0 \qquad (4)$$

We denote the number of commodity groups by M. So the summation in (4) runs through one to M. The share of the ith expenditure group, w_i, is obtained by applying Shephard's lemma on equation (3), that is, by differentiating the expenditure function with respect to prices, multiplying it by p_i and replacing v with the indirect utility:

$$\ln P = \alpha_0 + \sum_i \alpha_i \ln p_i + \frac{1}{2}\sum_i \sum_j \gamma_{ij} \ln p_i \ln p_j, \quad i = 1,.., M \qquad (5)$$

where Y is total consumption expenditure, and P is the cost of living index given by:

$$\ln P = \alpha_0 + \sum_i \alpha_i \ln p_i + \frac{1}{2}\sum_i \sum_j \gamma_{ij} \ln p_i \ln p_j \tag{6}$$

which is a nonlinear function of prices (p_j's). From (3) we can see that ln P is the log of the income required to attain the subsistence utility. Moreover, a quick glance at the share equation (5) reveals that both the adding up constraint and zero degree homogeneity of the demand function are assured by the conditions in (4).

By differentiating the demand system with respect to the price vector, one obtains the Hicks substitution matrix, i.e., the Jacobian matrix given by the formula:

$$w_{ih} = \beta_{0i} + \beta_{1i} \ln(x_h) + \beta_{2i}[\ln(x_h)]^2 + \sum_j \gamma_{ij} \cdot \ln(p_{jh}) \tag{7}$$

where δ_{ij} is Kronecker's delta ($\delta_{ij} = 1$ if $i = j$, $\delta_{ij} = 0$ if not). Note that the symmetry of the substitution matrix implies symmetry of γ_{ij} ($\gamma_{ij} = \gamma_{ji}$). The negative semi-definiteness of the substitution matrix can be examined by calculating the eigenvalues of (7). Also, the expenditure elasticities[2] are given by:

$$\eta_i = 1/+\beta_i \quad w_i \tag{8}$$

It follows that if β_i is negative the ith group is a necessity, and if β_i is positive it is a luxury.

3.2 Estimation procedure

The model allows for taste variation due to demographic factors, such as age of the household head, family size, education, etc. We denote these factors by Z. Then, in the context of our data structure, the model is written as:

$$w_{imlt} = \alpha_i + \sum_j \gamma_{ij} \ln p_{jlt} + \beta_i \ln(Y_{lmt} / P_{lt}) + \sum_k \omega_{ik} Z_{klmt} + \varepsilon_{ilmt} \tag{9}$$

where additional subscripts l, m, and t represent, l: region (l = 1,...,11); m: individual or stratum in each region; t : time period; and ε_{ilmt} is the disturbance term. Note that prices are common within the same region l and time period t, and total consumption expenditure (ln$Y$) and control variables Z (may) vary across l, m, and t.

The disturbance term has a variance component structure. Namely we write ε_{ilmt} as:

$$\varepsilon_{ilmt} = \lambda_{it} + \upsilon_{ilmt} \tag{10}$$

where λ_{it} is the time specific factor which uniformly affects all the regions in a given year but changes over time, and υ_{ilmt}'s are other white noise random factors.

It is well known that when time effects are correlated with the explanatory variables, usual OLS and GLS estimators will be biased. If that is the case, we should correct for the bias by introducing time specific dummies, which is the so-called fixed effect specification. We employ this specification, so that the covariance matrix of disturbance terms will have the following structure:

$$\begin{aligned} &\mathrm{Cov}(\varepsilon_{ilmt}, \varepsilon_{i'l'm't'}) = \sigma_{ii'}, \text{ if } l = l', \; m = m', \; t = t' \\ &\mathrm{Cov}(\varepsilon_{ilmt}, \varepsilon_{i'l'm't'}) = 0, \text{ if not.} \end{aligned} \tag{11}$$

The resulting system in (9) and (10) is nonlinear in parameters, with fixed time effects. Unlike the conventional practice of estimating AIDS system by its linear approximation (LAIDS), we estimate the system as the fully nonlinear system by maximum likelihood.

3.3 Linear approximation vs. fully nonlinear AIDS

The most common practice to estimate AIDS in the past had been to estimate the system by replacing ln P with the Stone index, ln $P^* = \Sigma_i w_i \ln p_i$, thus getting a system of linear equations and running a SUR. This linearized system is called LAIDS. In fact, Buse (1994) reported that in the Social Sciences Citation Index, from 1980 to 1991, 68 out of 89 empirical AIDS applications used the LAIDS.[3]

Deaton and Muellbauer, who suggested the approximation, warned that this procedure might not always be accurate. Indeed, Green and Alston (1990) and Buse's (1994) findings point out that it will generate inconsistent estimators.[4] Simply plugging the Stone index into (5) and using the estimated parameters to calculate the elasticities will produce inconsistent elasticity estimates as well. Moschini (1995) remarks that the Stone index is not invariate to changes in the units of price measurement.[5] This problem fortunately "does not plague the non-linear AI model." (p. 64)

3. Asano (1997) is one of the few studies that estimated an AI demand System as a nonlinear system by maximum likelihood.

4. Green and Alston (1990) claim that "researchers should employ the AIDS price elasticity formula only when they have estimated the AIDS" (p.444) and recommend another formula they derive for the linear approximation. This claim is purely theoretical though, as the estimates by Blanciforti, Green and King (1986) that they refer to do not support it.

5. "It is clear that estimation of the behavioral parameters in LA-AIDS will generally be biased." (p.64).

Pashardes (1993), Buse (1994) and Moschini (1995) compared results of LAIDS and the fully nonlinear AIDS and found substantial biases. Pashardes used a specific data set and encountered more pronounced effects on biases than Buse's Monte Carlo result. Buse (1998) took a step further to look at the effects of the linearization on the tests of homogeneity. In his Monte Carlo experiment, he found significant and substantial size distortions under some data sets. No significant distortion in test size, however, appeared if very strong positive correlation exists among prices. According to Buse (1998), however, such high correlations are rare.

Curiously, Alston, Foster and Green (1994) also performed Monte Carlo experiments and though they also found that LAIDS yields very poor elasticity estimates, they noticed that the performance is **worse** when price correlation is high. Moschini also used Monte Carlo – but only to check the income elasticities – and found that the Tornqvist index, the "corrected" Stone index and the use of fixed weights vastly improve the LAIDS estimates, producing virtually the same results as the true nonlinear AI model. He conjectures that the bias in income elasticities attributable to the use of the standard Stone index must spill over to price elasticities as well.

4 DATA

The data sources for expenditures are the POF surveys run in 1987/88 and 1995/96, which collected expenditure data for households on consumption goods and services from eleven metropolitan areas.[6] These surveys were undertaken after the implementation of two major stabilization plans in Brazil (the Cruzado Plan, in February 1986, and the Real Plan, in July 1994). The purpose of the surveys was to update the weighting structure of the National Consumer Price Index System, which dates back to ENDEF's time. They were, therefore, supposed to reflect household consumption behaviors in low inflation environments. But that was the case only with the last POF survey, for the Cruzado Plan, as well as four other stabilization plans thereafter, failed, in the sense that inflation rates continued to escalate until the successful Real Plan was launched. In fact, the average inflation rate during the collection period of the first POF survey (1987/88) was 11.70 percent a month, as opposed to 1.68 percent during the second POF survey (1995/96). The first POF survey had started in early 1987, but it was extended for six months, so

6. The metropolitan areas are: (1) Rio de Janeiro; (2) Porto Alegre; (3) Belo Horizonte; (4) Recife; (5) São Paulo; (7) Belém; (8) Fortaleza; (9) Salvador; (10) Curitiba. In addition, (6) Brasília-DF and (11) the municipality of Goiânia are also surveyed. For the sake of simplicity, all of them will be henceforth called metropolitan areas.

as not to cover periods when supply shortages and black market premiums had appeared as a consequence of price freezes. The first six months were discarded from the period that was eventually utilized.

Monthly expenditures at family level on various detailed commodity groups are available in the original POF survey. We aggregate them into seven broad categories: 1. food; 2. housing; 3. furniture and appliances; 4. clothing; 5. transportation and communication; 6. health and personal care; and 7. personal expenses, education and reading. Corresponding price indexes were constructed for the seven categories as described below. The price indexes allow for comparisons both across-time and across-region.

4.1 Subsample used for estimation

The total number of observations in the original survey, were 12,568 in 1987/88, and 14,551 in 1995/96 — after selecting families with income between one and 40 minimum wages only, because that is the price index target population (see below). Our estimation is based on a subsample of families: some of the observations are dropped from the lower and higher ends of income, total consumption expenditure, and per capita consumption expenditure distributions. Also observations with missing variables (education of the household head and sample weight) or with negative values for automobile purchases (households that sold their used cars for more than they paid for new ones, or simply did not buy new ones at all) are excluded. The resulting sample sizes are 11,344 in 1987/88, and 13,119 in 1995/96. Table 1 shows the number of samples dropped by our screening procedure. Table 2 shows the number of original samples retained for estimation for each region/year.

TABLE 1
Selection of sample households
(Exclusion criteria and number of households excluded for each of them)

Year	1987/1988	1995/1996
Total consumption expenditure lowest 1%	125	145
Total consumption expenditure highest 1%	126	146
Per capita expenditure lowest 2%	248	291
Per capita expenditure highest 5%	629	728
Transportation negative	157	188
Income lowest 1%	125	143
Income highest 1%	126	146
Missing sample weight	3	0
Missing education of household head	5	28
Survivors	11,344	13,119
Original observations	12,568	14,551

4.2 Aggregation

For expenditure data, after sorting families by their per capita consumption expenditure, we focus on a more aggregate level. Aggregation proceeds as follows: first, the original observation units (households) are sorted by per capita consumption expenditure. Then the sample weights and family size are used to replicate the distribution of the population per capita consumption expenditures in the given region/year. Then, the resulting distribution is divided into 20 equal sized strata (income quantiles) classified by magnitude of per capita consumption expenditure. The average shares, total consumption expenditures and demographic variables are calculated for each stratum. This grouping procedure kept estimation in a manageable order. The resulting sample size is 440 (two years, 11 regions, and 20 strata per region-year), which provides a sample large enough to estimate the demand system of seven expenditure categories, with high accuracy.

TABLE 2
Number of observations used to calculate income strata, by region

Region	Year	
	1987/1988	1995/1996
1. Rio de Janeiro	1,079	1,362
2. Porto Alegre	918	999
3. Belo Horizonte	916	1,238
4. Recife	1,096	1,528
5. São Paulo	1,225	1,057
6. Brasília	623	683
7. Belém	885	1,260
8. Fortaleza	1,412	1,629
9. Salvador	1,025	1,214
10. Curitiba	1,102	911
11. Goiânia	1,063	1,238

4.3 Price indexes

We needed price indexes that reflected price differences both along time and across regions. To construct such index, we ordered a set of nominal prices at product level from IBGE,[7] aggregated them to subitem level (the immediately more aggregated level, which is the least disaggregate whose average price variation is quoted by IBGE) and deflated them to POF reference dates using quoted subitem average variations. The underlying preferences (weighting structure) are given by

7. IBGE does not use to work on nominal prices, but rather on price variations only. Moreover, IBGE publishes price variations at group, subgroup, item and subitem levels, but not at product levels. For example, a cherry wood wardrobe is a product of the Bedroom Furniture subitem, which in turn belongs to the Furniture item, within the Furniture and Houseware subgroup, in the Furnishings group (the list of products may not be the same, and that is why we used only a core set for the index estimation). This was the first time IBGE released such a comprehensive and detailed set of nominal prices.

the average National reference basket of September 1996. To make subitems comparable across regions, only a core of products was selected for each subitem. In total, 129 out of 512 food and non-food subitems of the current IPCA[8] weighting structure were used, amounting to 73.07 percent of the index. The remaining subitems' weights were redistributed within each item.

5 RESULTS

We estimated the parameters of the system by maximum likelihood. Although all the parameters of the system are estimable, we found that the likelihood is very flat with respect to changes in α_0, which is the subsistence income when prices are normalized to one. To bypass this problem, we fixed the value of α_0 at 5.5, which corresponds to an annual consumption expenditure that amounts to 300 Reais per person in 1996 (at September 1996 prices). Hence the statistical inference in this section is conditional on this assumption. The effects of changes in α_0 on price and consumption expenditure elasticities, however, are of negligible order because of compensating changes in $\hat{\alpha}_i$'s.

5.1 Coefficients

We present the estimation result based on the assumption that constant terms (α_i's) change over two survey periods, but other "slope" coefficients ($\beta_i, \gamma_{ij}, \omega_{ik}$'s) do not change. The assumption of common slope coefficients is not rejected by the likelihood ratio test.[9] Table 3 displays the estimates from the restricted model in which homogeneity and symmetry constraints are imposed. We include four additional explanatory variables to capture demographic factors that shift intercepts of the share equations. They are: a dummy for the North and Northeast regions (the poorest regions), the age of the household head, the schooling years of the household head, and the family size.

The dummy variable for metropolitan areas in the North and Northeast regions[10] was introduced after the first runs, when we noticed that food shares in these areas were systematically underestimated after doing all the other controls. Indeed, the coefficients of this dummy in the demand equations for Food, Housing and Transportation proved significant. They are negative

8. IPCA is the Extended Consumer Price Index. This is the most comprehensive consumer price index available for all Metropolitan Regions in Brazil.

9. We compared the two models with homogeneity and symmetry restrictions. The restricted model assumes common slope coefficients, and the unrestricted model allows all the coefficients to change in two periods. The likelihood ratio test statistic is 313.01, with 51 degrees of freedom. It implies rejection in classical tests, but with a large sample like ours, it is recommended to use $q \times \ln(n)$ as the critical value, where q is the number of restrictions and n is the number of observations (n=440 in our sample). With these criteria, the common slope assumption is not rejected. See also Deaton (1997, p.131) and note 8.

10. Namely: 7. Belém (North); 4. Recife, 8, Fortaleza, 9. Salvador (Northeast).

for Housing and Transportation, thus capturing North and Northeast regional characteristics: available prices do not distinguish between apartment sizes and commuting distance, for example (these areas are smaller, so the expenditures on public transportation, parking, etc. are lower and the price per square meter of housing are much lower than in bigger areas). The positive coefficient for Food is more difficult to explain; several hypotheses come up to mind: measurement error in consumption versus income (poorer families might spend — or report — more on food during collection out of shame for their ordinarily low levels); measurement error on prices; other omitted variables (differences in taste, absence of leisure options, etc.).

The age of the household head did not prove significant, but the number of years of schooling did have an impact on Food, Furnishings and Personal Expenses: Food and Furnishings are negative (less educated families tend to spend more on food and durable goods, such as appliances); Personal Expenses is positive (households whose heads are more educated tend to invest more in education and reading, for example).

Last but not least, the coefficient for family size turns out to be significant and meaningful, for the per capita expenditures on Housing are lower when the family size is larger. This is evidence of scale economies in housing production functions. The positive signs for Transportation and Personal Expenses would be a consequence of shifting expenses from Housing due to those scale economies. The effect on food consumption is not significantly different from zero.

TABLE 3

Estimated coefficients – restricted model

	Food	Hous	Furn	Clth	Tran	Hlth	Pers Exp
Cnst	0.6117	0.3004	0.0959	0.1313	–0.1632	0.0732	–0.0491
(t-val)	(11.24)	(7.97)	(3.51)	(4.39)	(–3.08)	(2.98)	(–1.25)
Hous	–0.0177						
(t-val)	(–1.28)						
Furn	–0.0180	–0.0037					
(t-val)	(–1.58)	(–0.65)					
Clth	–0.0323	0.0047	0.0035				
(t-val)	(–1.59)	(0.51)	(0.52)				
Tran	0.0256	0.0090	–0.0061	0.0085			
(t-val)	(1.28)	(0.84)	(–0.71)	(0.74)			
Hlth	–0.0287	0.0145	0.0031	–0.0184	–0.0073		
(t-val)	(–1.61)	(1.90)	(0.56)	(–0.81)	(–0.77)		
Pers Exp	–0.0108	–0.0158	0.0105	0.0109	–0.0062	0.0177	
(t-val)	(–0.72)	(–2.05)	(1.87)	(1.07)	(–0.59)	(2.00)	
lnY	–0.0556	–0.0341	0.0066	0.0032	0.0639	0.0003	0.0158
(t-val)	(–5.92)	(–5.30)	(1.41)	(0.60)	(7.09)	(0.07)	(2.37)
D_NE	0.0625	–0.0396	0.0023	0.0041	–0.0224	–0.0023	–0.0047
(t-val)	(9.39)	(–8.60)	(0.69)	(1.13)	(–3.48)	(–0.76)	(–0.97)
Age_h	–0.0003	–0.0005	0.0002	–0.0005	0.0009	0.0005	–0.0002
(t-val)	(–0.38)	(–1.00)	(0.40)	(–1.09)	(1.19)	(1.28)	(–0.35)
Edu_h	–0.0141	0.0046	–0.0051	–0.0017	–0.0003	0.0018	0.0148
(t-val)	(–4.00)	(1.89)	(–2.89)	(–0.86)	(–0.09)	(1.13)	(5.94)
F_siz	–0.0007	–0.0099	–0.0046	–0.0011	0.0117	–0.0036	0.0081
(t-val)	(–0.13)	(–2.77)	(–1.74)	(–0.37)	(2.29)	(–1.53)	(2.15)

5.2 Elasticities

It is rather hard to evaluate results based upon the original parameters. Thus, we examine results based upon the estimates of the price and total consumption expenditure elasticities. As shown in section 2, these elasticities are highly nonlinear in parameters, and depend on the values of prices and total consumption expenditure at which they are evaluated. For both 1987/88 and 1995/96 surveys, elasticities are evaluated at all of the data points. The standard errors for elasticities are obtained by applying Rao's (1973) δ-method.[11] Table 4 presents estimates of elasticities for 1987/88, and Table 5 shows those for 1995/6, evaluated at the sample means of prices and total consumption expenditures in each year. Fitted shares are plotted along with observed ones in Figures 1 and 2 for Belo Horizonte as an illustration.

The first rows of Tables 4 and 5 show the eigenvalues of the substitution matrix. All the eigenvalues are negative, as predicted by the consumer theory. Furthermore, when we examine the eigenvalues for all the 440 data points,

11. See Deaton (1997), p.128-129 for a concise description of the δ-method.

negativity is supported without exception; this is rare in demand studies. In addition, homogeneity and symmetry are supported by comfortable margin (see Table 6) by the likelihood ratio test,[12] except for Housing and Food.

Total consumption expenditure elasticities (a proxy for income elasticities) indicate that Food and Housing are the only necessities, whereas Furnishings, Clothing, Transportation, Health Care and Personal Expenses are found to be luxuries. All the own-price elasticities are significantly negative. Among them (see Table 8), those for Food, Housing and Furnishings are significantly less than one (own-price-inelastic), while we cannot reject the hypothesis that the elasticity of demand for Clothing, Transportation and Communication and Health Care equals one. The same hypothesis for Personal Expenses is rejected in 1995/96, but is not rejected in 1987/88. Toiletry items and cosmetics are products whose effects may be having an important influence on rendering elastic the demand for Health and Personal Care,[13] and private motor vehicles may be rendering elastic the demand for Transportation.

It is also worth noting that the elasticity estimates remained quite stable between 1987 and 1996, in spite of the multitude of stabilization attempts during this period. High inflation rates like those recorded in the 1980s and early 1990s should give rise to a high degree of price dispersion; consumers would lose track of “fair” relative prices and would be expected to be less price-elastic for this reason. Yet, casual comparisons of elasticities reveal that, except for Health Care and Personal Expenses, the variation in price elasticities was negligible. The latter had slight increases from 1987/1988 to 1995/1996. Movements of income elasticities are also negligible and ambiguous; no noteworthy shifts are found in all the expenditure categories.

It is interesting to examine the elasticity estimates based on nonlinear AIDS as compared to those based on popular but problematic LAIDS. Comparisons are made between restricted AIDS elasticities and those based on Buse’s four LAIDS elasticity correction formulas.[14] In our data set, we have found that both the price and total consumption expenditure elasticities are fairly close to each other when they are evaluated at the sample mean values in each year.

12. We tested the joint hypothesis of homogeneity and symmetry, for which the number of restrictions is 27. They are the sum of 6 (for homogeneity) and 21 (number of pairs of off-diagonal elements in gij’s). The log likelihood ratio test statistic is 103.00. The 5 percent critical value of the Chi-square distribution (d.f. 27) is 40.11. This implies rejection of the null hypothesis in the classical test. However, for tests in large samples as ours, it is preferable to use the critical value given by q*ln(n), where q is the number of restrictions, and n is the number of observations (Deaton, 1997, p.131). In our case the critical value is 27 x ln(440) = 164.3.

13. In fact, Andrade and Lisboa’s (2001) tabulations of a recent supplement on health expenditures run by IBGE along with PNAD’s (an annual household survey) 1998 edition suggest that expenditure shares on health care are higher for the lower-income deciles.

14. Buse (1994), pp.784-785, equations (19), (21), (22), and (23).

TABLE 4

Total consumption expenditure and price elasticities – restricted model (1987/1988)

Eigenvalues							
	–0.200	–0.141	–0.102	–0.088	–0.064	–0.062	0.000
Expd.	Food	Hous	Furn	Clth	Tran	Hlth	Pers exp
Shares	0.354	0.124	0.079	0.103	0.141	0.107	0.093
Elas'ty	0.843	0.724	1.084	1.031	1.454	1.003	1.169
(s.e.)	(0.030)	(0.064)	(0.057)	(0.050)	(0.056)	(0.040)	(0.066)
Price elasticities							
	Food	Hous	Furn	Clth	Tran	Hlth	Pers exp
Food	–0.384	0.092	0.024	0.010	0.178	0.026	0.054
(t-val)	(–3.58)	(2.45)	(0.76)	(0.19)	(3.27)	(0.57)	(1.33)
Hous	0.264	–0.770	0.043	0.138	0.152	0.224	–0.050
(t-val)	(2.22)	(–10.16)	(0.88)	(1.53)	(1.71)	(3.15)	(–0.68)
Furn	0.109	0.067	–0.784	0.149	0.082	0.147	0.231
(t-val)	(0.78)	(0.94)	(–9.10)	(1.64)	(0.80)	(2.04)	(3.53)
Clth	0.034	0.166	0.114	–0.672	0.230	–0.073	0.201
(t-val)	(0.19)	(2.14)	(1.79)	(–2.28)	(2.16)	(–0.31)	(2.54)
Tran	0.447	0.133	0.046	0.168	–0.924	0.055	0.074
(t-val)	(3.31)	(1.90)	(0.78)	(2.01)	(–6.22)	(0.82)	(1.02)
Hlth	0.085	0.258	0.108	–0.070	0.073	–0.713	0.259
(t-val)	(0.55)	(4.23)	(1.94)	(–0.34)	(0.81)	(–3.62)	(3.75)
Pers Exp	0.205	–0.066	0.195	0.222	0.112	0.297	–0.964
(t-val)	(1.35)	(–0.37)	(2.23)	(1.93)	(1.33)	(2.04)	(–7.82)

TABLE 5

Total consumption expenditure and price elasticities – restricted model (1995/1996)

Eigenvalues							
	–0.197	–0.166	–0.116	–0.092	–0.060	–0.040	0.000
Expd.	Food	Hous	Furn	Clth	Tran	Hlth	Pers exp
Shares	0.309	0.130	0.072	0.114	0.148	0.071	0.156
Elas'ty	0.820	0.738	1.091	1.028	1.433	1.004	1.101
(s.e.)	(0.029)	(0.044)	(0.069)	(0.047)	(0.081)	(0.060)	(0.045)
Price elasticities							
	Food	Hous	Furn	Clth	Tran	Hlth	Pers exp
Food	–0.389	0.095	0.009	0.007	0.189	–0.022	0.111
(t-val)	(–3.14)	(2.05)	(0.25)	(0.09)	(2.99)	(–0.34)	(2.19)
Hous	0.225	–0.768	0.037	0.147	0.156	0.182	0.020
(t-val)	(2.33)	(–11.01)	(0.95)	(2.62)	(2.18)	(3.59)	(0.40)
Furn	0.041	0.068	–0.778	0.164	0.084	0.115	0.307
(t-val)	(0.25)	(0.88)	(–8.80)	(1.74)	(0.69)	(1.39)	(3.50)
Clth	0.020	0.168	0.104	–0.683	0.228	–0.091	0.254
(t-val)	(0.10)	(1.86)	(1.63)	(–2.94)	(2.20)	(–0.47)	(2.32)
Tran	0.395	0.137	0.041	0.176	–0.910	0.022	0.139
(t-val)	(3.00)	(1.93)	(0.70)	(2.28)	(–6.20)	(0.33)	(1.94)
Hlth	–0.096	0.333	0.116	–0.146	0.046	–0.658	0.405
(t-val)	(–0.32)	(2.36)	(1.49)	(–0.40)	(0.34)	(–1.85)	(2.38)
Pers Exp	0.220	0.016	0.141	0.185	0.131	0.184	–0.878
(t-val)	(2.47)	(0.40)	(4.32)	(3.72)	(2.11)	(3.83)	(–15.24)

TABLE 6
Estimated coefficients – unrestricted model

	Food	Hous	Furn	Clth	Tran	Hlth
Cnst	0.6124	0.3099	0.0925	0.1330	–0.1639	0.0733
(t-value)	(11.50)	(8.57)	(3.41)	(4.59)	(–3.06)	(2.98)
Food	–0.0893	–0.0272	0.0065	0.0004	0.0067	0.0139
(t-value)	(–1.35)	(–1.73)	(0.57)	(0.03)	(0.29)	(1.33)
Hous	–0.0094	–0.0040	0.0095	0.0008	–0.0032	0.0011
(t-value)	(–0.42)	(–0.42)	(1.34)	(0.11)	(–0.23)	(0.17)
Furn	–0.0134	0.1540	–0.0223	0.0950	0.0667	0.0113
(t-value)	(–0.96)	(2.54)	(–0.49)	(1.97)	(0.75)	(0.27)
Clth	–0.2104	0.0199	0.0011	0.0591	0.0040	0.0058
(t-value)	(–2.36)	(0.90)	(0.06)	(3.33)	(0.12)	(0.38)
Tran	–0.0473	–0.1739	0.0585	–0.0234	–0.0580	0.0010
(t-value)	(–1.44)	(–3.53)	(1.61)	(–0.60)	(–0.80)	(0.03)
Hlth	0.0901	–0.0770	0.0305	0.0187	–0.0031	0.0158
(t-valu e)	(1.27)	(–4.28)	(2.30)	(1.32)	(–0.12)	(1.31)
Pers Exp	–0.0036	0.1304	–0.0536	0.0291	0.0721	–0.0092
(t-value)	(–0.14)	(2.97)	(–1.61)	(0.82)	(1.12)	(–0.31)
LnY	–0.0561	–0.0305	0.0053	0.0011	0.0624	0.0002
(t-value)	(–6.07)	(–4.82)	(1.13)	(0.22)	(6.71)	(0.06)
D_NE	0.0631	–0.0391	0.0019	0.0035	–0.0222	–0.0027
(t-value)	(9.65)	(–8.76)	(0.56)	(1.00)	(–3.37)	(–0.90)
Age_h	–0.0007	–0.0006	0.0002	–0.0002	0.0011	0.0005
(t-value)	(–0.96)	(–1.11)	(0.59)	(–0.45)	(1.38)	(1.49)
Edu_h	–0.0125	0.0024	–0.0044	–0.0015	–0.0003	0.0016
(t-value)	(–3.58)	(0.99)	(–2.46)	(–0.79)	(–0.07)	(1.02)
F_siz	0.0024	–0.0110	–0.0045	–0.0028	0.0103	–0.0041
(t-value)	(0.47)	(–3.16)	(–1.72)	(–1.00)	(1.98)	(–1.71)
Homogeneity	–0.2833	0.0223	0.0303	0.1797	0.0852	0.0396
(s.e.)	(0.0932)	(0.0761)	(0.1153)	(0.0766)	(0.0949)	(0.0815)

Symmetry (absolute difference of ij– ji)

	Hous	Furn	Clth	Tran	Hlth	Pers Exp
Food	0.0105					
Hous	0.1536	0.0231				
Furn	0.0132	0.0043	0.0076			
Clth	0.1878	0.0574	0.0347	0.0637		
Tran	0.0860	0.0214	0.1131	0.0394	0.0899	
Hlth	0.1398	0.0402	0.2395	0.1194	0.0993	0.0759

However, when we evaluate the elasticities of the AIDS and LAIDS estimates at all the 440 data points, there are noticeable discrepancies between the two. On the other hand, discrepancies among the four LAIDS correction formulas are very small. Table 7 shows a summary of the differences in own price and total consumption expenditure elasticities for each expenditure group. In Table 7, LAIDS elasticity estimates are based on Buse's formula (19). The first column in the subtables shows differences (LAIDS-AIDS) evaluated at sample mean values, "bias" is the mean difference in each year, "s.d." is the standard deviation of the differences, and "min.", "max." are the minimum and the maximum values.

The largest absolute bias is 0.119 for own price elasticities (Clothing in 1987/88), and 0.105 in the case of expenditure elasticities (Housing in 1995/96). Also, the maximum absolute discrepancy is 0.292 among own price elasticities (again, Clothing in 1987/88), and 0.631 (Transportation in 1995/96) within the consumption expenditure elasticities. Whether these discrepancies should be considered "substantial" or not depends on the researchers' objectives. However, it should be stressed that the discrepancies among the four sets of elasticity estimates based on Buse's (1994) LAIDS correction formulas are in the order of the second decimal point.

Investigating the causes of the discrepancies is not in the scope of this study, but it is safe to say that it is advisable to estimate the AIDS as fully nonlinear system, when it is feasible to do so, rather than to try to correct for LAIDS estimates.

TABLE 7

Differences in the elasticity estimates based on AIDS and LAIDS (restricted models) * own price elasticities

	1987/1988					1995/1996				
	At sample means	Bias	s.d	Min	Max	At sample means	Bias	s.d	Min	Max.
Food	–0.001	–0.002	0.008	–0.029	0.011	–0.002	–0.006	0.015	–0.077	0.014
Housing	0.000	0.013	0.018	–0.015	0.096	0.003	0.004	0.010	–0.051	0.022
Furnishings	–0.005	–0.004	0.001	–0.006	0.003	–0.010	–0.011	0.002	–0.020	–0.007
Clothes	–0.038	–0.013	0.002	–0.019	–0.009	0.026	0.119	0.035	0.078	0.292
Transportation	–0.025	–0.023	0.020	–0.055	0.034	0.007	0.017	0.030	–0.022	0.162
Health	0.028	0.069	0.021	0.026	0.169	–0.047	–0.017	0.005	–0.035	–0.003
Pers.exp.	0.045	0.041	0.006	0.030	0.058	–0.030	–0.036	0.009	–0.096	–0.029

Expenditure elasticities

	1987/1988					1995/1996				
	At sample means	Bias	s.d	Min.	Max.	At sample means	Bias	s.d	Min.	Max.
Food	–0.004	–0.002	0.001	–0.005	–0.001	0.002	0.000	0.001	0.000	0.005
Housing	–0.077	–0.105	0.061	–0.460	–0.041	0.022	0.011	0.007	0.001	0.062
Furnishings	0.029	0.032	0.003	0.025	0.050	0.023	0.021	0.002	0.018	0.026
Clothes	0.010	0.010	0.000	0.010	0.010	0.042	0.078	0.012	0.064	0.135
Transportation	0.040	0.074	0.083	0.009	0.631	–0.049	–0.050	0.036	–0.265	–0.015
Health	–0.016	–0.022	0.003	–0.033	–0.015	–0.015	–0.012	0.001	–0.014	–0.010
Pers. exp.	–0.026	–0.019	0.009	–0.046	–0.004	0.027	0.057	0.043	0.012	0.310

TABLE 8
Test statistics for testing H_o: own-price elasticity = –1

1987/1988			
	Estimate	S.E.	T- stat
Food	–0.384	0.107	5.75
Housing	–0.770	0.076	3.03
Furnishings	–0.784	0.086	2.51
Clothing	–0.672	0.295	1.11
Transportation	–0.924	0.148	0.52
Health	–0.713	0.197	1.45
Pers. exp.	–0.964	0.115	0.31
1995/1996			
	Estimate	S.E.	T-stat
Food	-0.389	0.124	4.93
Housing	-0.768	0.070	3.32
Furnishings	-0.778	0.088	2.51
Clothing	-0.683	0.233	1.36
Transportation	-0.910	0.147	0.61
Health	-0.658	0.356	0.96
Pers. exp.	-0.878	0.058	2.12

Comparing our estimates of expenditure elasticities with the results of previous estimations (see Table 9) is a challenging task, for, as we have already mentioned, specifications, samples and expenditure classification are very diverse. We find our estimates to be closer to those obtained by Rossi (1983b), Rossi and Neves (1987) and Hoffmann (1983, 1988) than to those obtained by Thomas, Strauss and Barbosa (1989). This suggests that sample design and categorization may have higher impacts on estimates than the functional form adopted. In particular, we should highlight the proximity of our estimates for Health and Clothing. Transportation and Personal Expenses are plausible convex combinations of the subgroups constructed from them, while Furnishings is a bit lower. As for the categories we found to be necessities, their estimated elasticities are much farther from most of the previous estimates. Our estimates for Food indicate a much more elastic demand, whereas the opposite occurs for Housing, where we find a much less elastic demand than most of the other authors (except Alves *et al*'s, whose figures are not too far from ours).

As noted in section 2, price elasticities had only been reported by Thomas, Strauss and Barbosa (1989), Alves, Disch and Evenson (1982), and Simões and Brandt (1981). However, only the estimates by Thomas, Strauss and Barbosa cover all consumption categories, and they are very different from ours[15] (see Table 10). We found that Clothing and Housing are more price-elastic; on the other hand, Food items cannot be compared,

15. It is worth noting that the order of size of the cross-price elasticities is, through a visual inspection, not too different from each other.

due to our aggregation, but Transportation figures are very close to each other. Again, differences in sampling or in commodity grouping may be blamed; otherwise either the different AIDS specification or a change along time may be what causes such differences. The other estimates were reported for agricultural products only, and at a much disaggregate level, thus rendering comparisons unfeasible.

TABLE 9
Expenditure elasticity estimates in previous studies

Author:	Medeiros (1978)	Rossi (1982)	Rossi (1983b)	Hoffmann (1983,1988)	Cipriano and Brandt (1983)
Methodology	Box-Cox	Lorenz curve	Lorenz curve	Piecewise log-linear	Logit
Data source:	POF-USP 1971/72	ENDEF 1974/75	ENDEF 1974/75	ENDEF 1974/75	ENDEF 1974/75
Sample:	Sao Paulo (city)	Rio de Janeiro (city)	Brazil (metrop. areas)	Rio de Janeiro (city)	Brazil
Elasticities estimated:	Expenditure	Expenditure (at mean point)	Expenditure (at mean point)	Expenditure (mean)	Expenditure (mean)
Food	Btw. 0.21 and 0.77	0.20	0.54	0.57	
Grains		0.16	0.19	0.25	0.068 (Cereals);
Tubercles		0.43	0.24	0.45	0.028
Vegetables		0.53	0.63	0.54	0.398 (Potherbs);
					–0.110 (Legumes)
Fruit		0.91	0.94	0.87	–0.325
Meat and fish		0.62	0.60	0.63	0.469
Eggs and dairy		0.70	0.71	0.68	0.528
Beverages		0.50	0.53 (Bev. & others)	0.52	0.271
Food away from home		0.85	0.83	0.79	
Sugar, oils, etc.		0.18	0.33 (Sugar); 0.31 (Oils)	0.31	0.074 (Sugar); 0.103 (Oils and Fats)
Other food			–0.01 (Legumes)		0.840
Clothing		1.21	1.15	1.10	
Housing		1.05	1.07	1.12	
Health		1.16	1.14	1.13	
Education	Btw. 1.54 and 1.64	1.70	1.60	1.38	
Recreation		1.46	1.49	1.22	
Tobacco		0.45	0.51	0.46	0.505
Public transport.		0.32	0.02	0.57	
Own vehicle		1.20	1.97	1.49	
Fuel and transport.			1.68 (Long Dist. Trips)		
Miscellaneous		1.46	1.40	1.44	

Author:	Rossi and Neves (1987/88)	Alves, Disch and Evenson (1982)	Simoes and Brandt (1981)	Thomas, Strauss and Barbosa (1989)
Methodology	Logit	SERP	ELES	Generalized AIDS
Data source:	ENDEF 1974/75	ENDEF 1974/75	ENDEF 1974/75	ENDEF 1974/75
Sample:	Brazil	9 regions	Brazil	Brazil
Elasticities estimated:	Expenditure (at mean point)			Expenditure (median) and prices
Food	0.55			
Grains		−0.0096 (Rice); 0.2927 (Cereals)	0.1588 (Cereals);	0.58 (Rice); 0.881 (Wheat); −0.49 (Corn); – 0.565 (Cassava); 0.282 (Beans)
Tubercles		0.3251 (Root crops)	0.100	0.705
Vegetables		0.434	0.4425 (Potherbs); 0.014 (Legumes)	0.403
Fruit		0.779	0.630	1.023
Meat and fish		0.938 (Beef); −0.023 (Pork); 0.494 (Other meats); 0.453 (Fish)	0.429	1.025 (Meat); 0.473 (Fish)
Eggs and dairy		0.3665 (Eggs); 0.755 (Dairy)	0.513	1.045 (Milk); 1.065 (Eggs & Non–milk dairy)
Beverages		0.2062 (Coffee/Tea)	0.357	
Food away from home				
Sugar, oils, etc.		0.1078 (Oils); 0.908 (Sweets)	0.202 (Sweets); 0.216 (Oils & fats)	0.266 (sugar); 0.635 (Oils & fats)
Other food		−0.0095 (Legumes)		0.570
Clothing	1.11			1.316
Housing	1.26	0.898		1.009
Health	1.18 (Hygiene)			
Education	1.71	1.09 (Education, recreation, culture)		
Recreation	1.60			
Tobacco			0.43	
Public transport.	1.60 (Transportation)	1.538 (Transportation)		
Own vehicle				
Fuel and transport.				1.339
Miscellaneous	1.31	1.054		1.426 (Furnishings); 1.644 (Other goods)

(continuing)

Author:	Hoffmann (2000)	Menezes et al. (2002)	Our estimates (1995/96)
Methodology	Piecewise log-linear	QUAIDS	AIDS
Data source:	POF 1995/96	POF 1995/96	POF 1987/88 and 1995/96
Sample:	Brazil (metrop. areas)	Brazil (metrop. areas)	Brazil (metrop. areas)
Elasticities estimated:	Expenditure (mean)	Expenditure (mean) and prices	Expenditure (at mean point).
Food	0.436		0.820
Grains	0.035 (Rice & beans); 0.158 (Pasta, flour, cassava meal); 0.213 (Bakery)	0.0466 (Rice); 0.057 (Beans); 0.2812 (Flour); –0.2107 (Cassava meal); 0.2904 (Pasta); 0.2457 (Bread); 0.3982 (Cookies); 0.2777 (Crackers)	
Tubercles	0.286	0.4647 (Potato); 0.6868 (Cassava)	
Vegetables	0.326	0.4502 (Tomato); 0.3638 (Onion); 0.4623 (Cabbage); 0.4175 (Garlic)	
Fruit	0.485	0.6193 (Banana); 0.6145 (Orange); 0.7192 (Lime)	
Meat and fish	0.345	0.672 and 0.1854 (Beef); 0.1307 (Liver); 1.2877 (Ham); 0.4468 (Bologna); 0.517 (Kielbasa); 0.344 (Sausage); 0.3288 (Fish); 0.2318 (Chicken); 0.5558 (Pork)	
Eggs and dairy	0.155 (Eggs and poultry); 0.392 (dairy)	0.4873 (Milk); –0.1005 (Milk powder); 0.9923 (Cheese); 0.514 (Butter); 0.7616 (Yogurt)	
Beverages	0.471	0.152 (Coffee);	
Food away from home	0.745		
Sugar, oils, etc.	0.370 (Sugar); 0.247 (Oils & fats)	0.0124 (Sugar); 0.1289 (Oils); 0.3075 (Margarine)	
Other food	0.341 (Salt, sauces, etc); 0.599 (Canned food); 0.791 (ready-to-eat food)	0.0993 (Salt); 0.0799 (Tomato paste); 0.8246 (Mayonnaise)	
Clothing	0.678		1.028
Housing	0.714		0.738
Health	0.734		1.004
Education	0.997		1.101 (Personal exp., education and reading)
Recreation	0.953		
Tobacco	0.251		
Public transport.	0.766 (Transportation)		1.433 (Transportation)
Own vehicle			
Fuel and transport.			
Miscellaneous			1.091 (Furnishings)

TABLE 10
Price elasticity estimates in previous studies

	Simoes and Brandt (1981)	Alves, Disch and Evenson (1982)	Thomas, Strauss and Barbosa (1989)	Our estimates (for 1995/96)
Methodology	ELES	SERP	Generalized AIDS	AIDS
Data source:	ENDEF 1974/75	ENDEF 1974/75	ENDEF 1974/75	POF 1987/88 and 1995/96
Sample:	Brazil	Nine regions	Brazil	Brazil (metrop. areas)
Food				–0.531
Grains	–0.155 (Cereals)	–0.96 (Rice); 0.66 (Root crops); +0.64 (Cereals)	–3.59 (Rice); –1.971 (Wheat); –0.114 (Corn); +0.280 (Cassava);–1.679 (Beans)	
Tubercles	–0.087		–1.954	
Vegetables	–0.007 (Legumes); –0.440 (Potherbs)	–0.49	–0.786	
Fruit	–0.624	–0.74	–0.882	
Meat and fish	–0.435	–0.74 (Pork); –1.34 (Beef);–1.25 (Other Meats); –1.11(Fish)	–0.421 (Meat); –2.561 (Fish)	
Eggs and dairy	–0.511	–0.77 (Dairy); +0.46 (Eggs)	–3.371 (Milk); –2.470 (Eggs & Non–milk dairy)	
Beverages	–0.353	–0.30 (Coffee/Tea)		
Food away from home		–0.1538		
Sugar, oils, etc.	–0.195 (Sweets);–0.211	–0.38 (sugar); 0.95 (Oils)	–0.004 (sugar); +2.732 (Oils & fats)	
Other food		–0.52 (Legumes)	–1.440	
Clothing			–0.583	–0.929
Housing			–0.445	–0.787
Health				–0.986
Education				–1.012 (Personal expenses, education and reading)
Recreation				
Tobacco	–0.442			
Public transp.				–1.121 (Transportation)
Own vehicle				
Fuel and transp.			–1.096	
Miscellaneous			0.033 (Furnishings); –0.021 (Other goods)	–0.735 (Furnishings)

Besides the relative stability of our mean elasticities, the mean shares of the categories also display negligible changes between the two dates. The most notable changes were Health, which decreased, and Personal Expenses, which increased, due to a combination of income increase[16], severe changes in relative prices (see Table 11) and differences in elasticities. In fact, the price elasticities for these two groups are quite high and prices increased severely during the elapsed time, as compared to other categories. This effect appears to have dominated the expenditure effect (real income increase and high expenditure elasticity).

TABLE 11
Accumulated variation of income and prices by expenditure group according to IPCA and RPDI (October 1987-September 1996)
(%)

Expenditure Group	RPDI	IPCA
0.General	7.2E+09	12.3E+09
1.Food	5.3E+09	9.9E+09
2.Housing	17.8E+09	21.0E+09
3.Furnishings	3.2E+09	5.6E+09
4.Clothing	4.3E+09	4.5E+09
5.Transportation and communication	8.1E+09	12.9E+09
6.Health Care	14.0E+09	21.2E+09
7.Personal expenses, education and reading	10.1E+09	21.6E+09
Real *Per Capita* Income	51.97	–11.45

6 CONCLUDING REMARKS

This study estimated a complete Brazilian consumer demand system from two waves of a family budget survey (POF/IBGE) conducted in 1987/88 and 1995/96. To the best of our knowledge, it is the first study of this breadth of scope, based on those data. IBGE's stratified sampling scheme used for the survey provides large variations in total expenditures. We look at seven broad categories of consumption goods and services, which cover all consumption expenditures. To enable the estimation of the system, regional price difference indexes are created. By exploiting intertemporal and interregional differences in prices, we estimated the parameters for the price variables. The result showed a striking conformity to the microeconomic theory. The estimated price and income (expenditure) elasticities are close to what economic common sense predicts, and their standard errors are fairly small, as opposed to earlier estimates from other studies (based on ENDEF, an earlier and more comprehensive survey). Negativity of the Hicks substitution matrix is

16. Using the national general index calculated according to our Regional Price Difference Index (RPDI) methodology, annual per capita real income (Brazilian average) increased from BRL 1,730 to BRL 2,639 at Sep 1996 prices (a 51.97 percent accumulated variation, or 4.76 percent per annum rate) in our sample.

supported. To our knowledge this is a rare result in empirical studies of demand systems that use flexible functional forms. The gains in estimating the system with a fully nonlinear Maximum Likelihood algorithm may be found reasonably small or substantial, depending on the reader's objectives. Also, we found that, despite high inflation in the sample period, Brazilian consumers' preferences, captured in terms of elasticities, showed a rather stable pattern.

The estimated system will serve as a solid microeconomic basis for evaluating various policy related issues, such as the impact of commodity taxation on different goods/services, effects of subsidy to needy families, etc., and for comparing living standards across regions, and across income classes. Versions of this estimation with possibly different levels of aggregation might also be plugged into computable general equilibrium models. We also plan to extend this model to take into account the choice between consumption and leisure by the household members in the labor force – this should render studies on taxation more realistic.

6.1 Acknowledgements

This work was undertaken under a cooperation agreement between IPEA and Japan International Cooperation Agency (JICA), whose support is gratefully acknowledged. We thank Eustaquio Reis and Octavio Tourinho for their comments, support and encouragement. We are also grateful to Rita Sbano, Fatima Louro, Eulina Nunes, Lucia Pinto, Edilson Silva, Nezio Pontes and Marcia Quintslr of IBGE for their patient assistance in providing the required data and documentation and clarifying their obscure points. Viviane Silva, Paola Dias and Marcia Pimentel's help on SAS programming is highly appreciated. Erica Novello and Adrian Heringer's assistance is gratefully acknowledged. Remaining errors are of our exclusive responsibility.

REFERENCES

ALSTON, J. M.; FOSTER K. A.; GREEN R.D. Estimating elasticities with the linear approximate almost ideal demand system: some Monte Carlo results. *Review of Economics and Statistics,* n. 76, p. 351-356, 1994.

ALVES, D. C. O.; DISCH, A.; EVENSON, R. E. *The demand for food in Brazil.* IV ENCONTRO BRASILEIRO DE ECONOMETRIA. Águas de São Pedro: Sociedade Brasileira de Econometria, 1982.

ANDRADE, M. V.; LISBOA M. B. *Gastos com saúde no Brasil.* Manuscript. Rio de Janeiro: EPGE/FGV, 2001.

ASANO, S. Joint allocation of leisure and consumption commodities: a Japanese extended consumer demand system 1979-90. *Japanese Economic Review*, n. 48, p. 65-80, 1997.

BUSE, A. Evaluating the linearized almost ideal demand system. *American Journal of Agricultural Economics,* n. 76, p. 781-793, 1994.

BUSE, A. Testing homogeneity in the linearized Almost Ideal Demand System. *American Journal of Agricultural Economics,* n. 80, p. 208-220, 1998.

CIPRIANO, J.; BRANDT, S. A. Sistema logit multinomial de demanda agrícola. ENCONTRO BRASILEIRO DE ECONOMETRIA. Belém: Sociedade Brasileira de Econometria, 1983.

DEATON, A. *The analysis of household surveys.* Baltimore: Johns Hopkins U.P, 1997.

DEATON, A.; MUELLBAUER. J. An Almost Ideal Demand System. *American Economic Review,* n. 70, p. 312-326, 1980.

GREEN, R.; J. ALSTON Elasticities in AIDS models. *American Journal of Agricultural Economics,* n. 72, p. 442-445, 1990.

HOFFMANN, R. Elasticidades de Engel para dispêndios familiares na Cidade do Rio de Janeiro: outro método de estimação. *Pesquisa e Planejamento Econômico,* n. 13, p. 267-274, 1983.

_____. Elasticidades de Engel para dispêndios familiares na cidade do Rio de Janeiro: outro método de estimação – uma correção. *Pesquisa e Planejamento Econômico,* n. 18, p. 197, 1998.

_____. Elasticidades-renda das despesas e do consumo físico de alimentos no Brasil metropolitano em 1995-96. *Agricultura em São Paulo,* n. 47, p. 111-122, 2000.

INSTITUTO BRASILEIRO DE GEOGRAFIA E ESTATÍSTICA (IBGE). *Indices de preços ao consumidor: métodos de cálculo*. Série Relatórios Metodológicos. 14 ed. Rio de Janeiro: IBGE, 1994.

KAKWANI, N. C. Application of Lorenz curves in economic analysis. *Econometrica,* n. 45, p. 719-727, 1077a.

_____. On the estimation of Engel elasticities from grouped observation with application to Indonesian data. *Journal of Econometrics,* n. 6, p. 1-19, 1977b.

_____. A new method of estimating the Lorenz curve: a reply. *Econometrica,* n. 48, p. 1063-1064, 1978.

MEDEIROS, J. A. S. Curvas de Engel e transformação de Box-Cox: uma aplicação aos dispêndios em alimentação e educação na Cidade de São Paulo. *Pesquisa e Planejamento Econômico,* n. 8, p. 795-828, 1978.

MENEZES, T. *et al*. *Gastos alimentares nas grandes regiões urbanas do Brasil*: aplicação do modelo AIDS aos microdados da POF 1995/1996 IBGE. Brasília: Ipea, 2002. (Texto para Discussão, n. 896).

MOSCHINI, G. Units of measurement and the stone index in demand system estimation. *American Journal of Agricultural Economics,* n. 77, p. 63-68, 1995.

PASHARDES, P. Bias in estimating the Almost Ideal Demand System with the stone index approximation. *Economic Journal,* n. 103, p. 908-915, 1993.

Rao, C. R. *Linear statistical inference and its applications*. 2nd ed. New York: Wiley, 1973.

ROSSI, J. W. Elasticidades de Engel para dispêndios familiares na cidade do Rio de Janeiro. *Pesquisa e Planejamento Economico,* n. 12, p. 579-606, 1982.

_____. Elasticidades de Engel para dispêndios familiares na cidade do Rio de Janeiro: outro método de estimação – comentários. *Pesquisa e Planejamento Econômico,* n. 13, p. 275-284, 1983a.

_____. Elasticidades de Engel para dispêndios familiares nas principais capitais brasileiras. *Revista Brasileira de Estatística,* n. 44, p. 381-451, 1983b.

ROSSI, J. W.; NEVES, C. Elasticidades de Engel no Brasil usando um sistema de equações com especificações *logit*. *Revista Brasileira de Economia,* n. 4, p. 425-434, 1987.

SIMÕES, R. C.; BRANDT, S. A. Sistema completo de equações de demanda para o Brasil. III ENCONTRO BRASILEIRO DE ECONOMETRIA. Olinda: Sociedade Brasileira de Econometria, 1981.

THOMAS, D.; STRAUSS, J.; BARBOSA, M. M. T. *Estimating the impact of income and price changes on consumption in Brazil*. New Haven: Yale University. Yale Economic Growth Center (Discussion Paper, n. 589). 1989.