

Demand for fisheries products in Brazil

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Introduction

The world fishery production decreased steadily from the early 1960s to the 1990s, when it stabilized at about 80 million tonnes per year. Since the 1970s, aquaculture has increased its share in the total fish production and since the mid-1980s was the only source of growth in the total global production (FAO, 2005). In Brazil, fishery production increased until 1985 reaching one million ton per year. The national production fell abruptly in 1986 with the end of governmental incentives to the industry and then remained constant at around 0.7 million ton until the end of the 1990s (Abdallah and Bacha, 1999).

Since the 1970s, technological advances in traditional substitutes for fishery products in the food market, namely beef, pork and poultry industries, resulted in a continuous price reduction of those products in Brazil, whereas the price of fishery products did not decrease in the same period (Sonoda et al., 2002). As

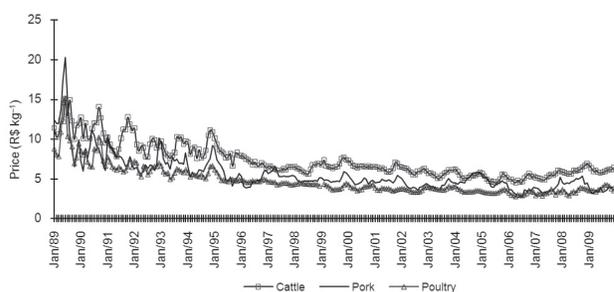


Figure 1 – Brazil: Prices of wholesale cattle, pork and poultry meat of Dec./09. 1989–2009.

ABSTRACT: Fish consumption *per capita* in Brazil is relatively modest when compared to other animal proteins. This study analyses the influence of protein prices, other food prices and population income on the fish demand in Brazil. First, the problem of fish supply in Brazil is characterized. It is followed by reviews of the relevant economic theory and methods of Almost Ideal Demand System - AIDS and their elasticity calculations. A descriptive analysis of fish demand in Brazil using the microdata called “Pesquisa de Orçamento Familiar” (Familiar Budget Research) - POF 2002-2003 is presented. Finally, demand functions and their elasticities are calculated for two different cases: one considering five groups of animal proteins (Chicken; Milk and Eggs; Fish; Processed Proteins and Red Meat) and other with seven groups of food categories (Cereals; Vegetables and Fruits; Milky and Eggs; Oils and Condiments; Fish; Other processed foods; and Meats). The main results are: *per capita* consumption of fish (4.6 kg per inhabitant per year) is low in Brazil because few households consume fish. When only households with fish consumption are considered, the *per capita* consumption would be higher: 27.2 kg per inhabitant per year. The fish consumption in the North-East Region is concentrated in the low-income class. In the Center-South Region, the fish consumption is lower and concentrated in the intermediate income classes. The main substitutes for fish are the processed proteins and not the traditional types of meat, such as chicken and red meat.

Keywords: AIDS, fish, supply, elasticity, market

a consequence, fish lost its price competitiveness with other meats (Figure 1).

The impact of these developments on the fish market was quite significant: while *per capita* consumption of fish decreased from 8 to 5 kg per year between 1978 and 2003, poultry consumption increased sharply from 7 to 34 kg per year in the same period (Figure 2) (ABEF, 2005). This trend could be changed by increasing the supply of fishery products which would benefit producers and promote healthier food for the population. However, when the demand for fish increases, it is necessary to understand the relative demand for this product regarding other groups. These answers are important to guide public and private national fishery development processes and plan the growth of its production, industrial and distribution sectors.

This study aims to estimate demand functions for fishery products in Brazil and to calculate compensated and uncompensated price elasticity for animal protein being fish, red meats, poultry, milk and eggs, and pro-

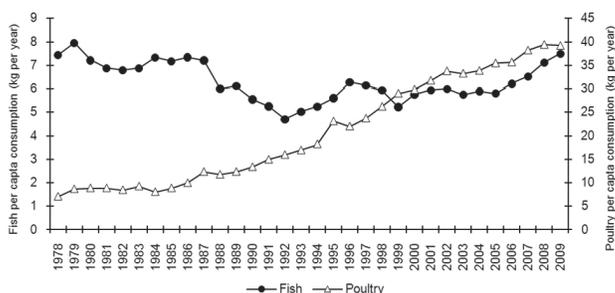


Figure 2 – Brazil: Development of *per capita* fish and poultry consumption 1978–2009.

cessed proteins; other foods such as cereals, fruit and vegetables, milk and eggs, oils and condiments, fish, other processed foods, and meats.

Materials and Methods

Almost Ideal Demand System-AIDS is a system of equations that belongs to a class denominated piglog functions. It defines the minimum cost (or expenditure) required to attain a certain utility level, known the prices. The piglog was, originally, represented by a cost function $c(u, p)$, where u represents utility and p the vector of prices (Deaton and Muellbauer, 1980):

$$\ln c(u, p) = (1 - u)\ln[a(p)] + u\ln[b(p)] \tag{1}$$

The utility level is delimited between zero and one ($0 \leq u \leq 1$), where 0 (zero) represents the subsistence level and 1 (one) represents the limit of satisfaction for the consumption. These functions are linearly homogeneous and positive in $a(p)$ and $b(p)$. The functional forms of $a(p)$ and $b(p)$ are usually expressed by:

$$\ln a(p) = \alpha_0 + \sum_k \alpha_k \ln p_k + \frac{1}{2} \sum_k \sum_j \gamma_{kj}^* \ln p_k \ln p_j \tag{2}$$

$$\ln b(p) = \ln a(p) + \beta_0 \prod_k p_k^{\beta_k} \tag{3}$$

The AIDS cost function becomes:

$$\ln c(u, p) = \alpha_0 + \sum_k \alpha_k \ln p_k + \frac{1}{2} \sum_k \sum_j \gamma_{kj}^* \ln p_k \ln p_j + u\beta_0 \prod_k p_k^{\beta_k} \tag{4}$$

where, α_i , β_i and γ_{ij}^* are parameters.

The expenditure share of good I (w_i) derive from $\ln c(u, p)$ in terms of $\ln p_i$ is given by (Griliches and Intriligator, 1990):

$$w_i = \alpha_i + \frac{1}{2} \sum_k \gamma_{kj} \ln p_k + \frac{1}{2} \sum_j \gamma_{ij} \ln p_j + u\beta_i \beta_0 \prod_k p_k^{\beta_k} \tag{5}$$

$$\gamma_{ij} = \frac{1}{2}(\gamma_{ij}^* + \gamma_{ji}^*) \tag{6}$$

Expressing w_i in terms of expenditure of good i (adapted from Silberberg, 1990):

$$w_i = \alpha_i + \sum_j \gamma_{ij} \ln p_j + \beta_i \ln \left[\frac{x}{P} \right] \tag{7}$$

where P is a price index:

$$\ln P = \alpha_0 + \sum_k \alpha_k \ln p_k + \frac{1}{2} \sum_k \sum_j \gamma_{kj} \ln p_k \ln p_j \tag{8}$$

Taking restrictions (9), (10) and (11) into account, and assuming that (7) represents a system of equations where $\sum w_i = 1$ (additive condition), the demand model is homogeneous of degree 0 (zero) for prices and income, and satisfies the Slutsky symmetry. In absence of variation in the relative prices (p) and the real income (x/P), the expenditure share (w_i) remains constant. Changes in the real income modify β_i and its sum in i is 0 (zero). The positive values of β_i represents luxury goods and the negative ones, subsistence goods.

$$\sum_{i=1}^n \alpha_i = 1 \quad \sum_{i=1}^n \gamma_{ij} = 0 \quad \sum_{i=1}^n \beta_i = 0 \tag{9}$$

$$\sum_j \gamma_{ij} = 0 \text{ (homogeneity)} \tag{10}$$

$$\gamma_{ij} = \gamma_{ji} \text{ (symmetry)} \tag{11}$$

A better approximation of w_i could be achieved generalizing (7) for a individual household, h :

$$w_{ih} = \alpha_i + \sum_j \gamma_{ij} \ln p_j + \beta_i \ln \left[\frac{x_h}{k_h P} \right] \tag{12}$$

Parameter k_h is interpreted as a measure of household size and reflects an adjustment for an "adult coefficient" of food consumption that takes into account the age and gender of its members. This parameter is used to correct or to weight the *per capita* income x_h (Deaton and Muellbauer, 1980). If the household members were homogeneous in terms of food consumption, the parameter k_h could be represented by the number of resident people in household h . However, household components are generally heterogeneous in terms of age and gender, for instance. Thus, k_h makes an adjustment for this factor that affect food consumption, to a relative value of "adult equivalent". For example, a child or adolescent is considered a fraction of an adult male. The Amsterdam Scale (Stone, 1954 *apud* Deaton and Muellbauer, 1986), based on the nutritional requirement of people, is an empirical application of this method (Table 1). A household represented by one man, one woman and a couple of children (< 14 years), has the "adult equivalent" of 2.94 instead of 4.0 if this *per capita* index was considered.

There are two alternative methods of estimation. First, a nonlinear system using maximum likelihood, which follows by substituting (8) in (7):

$$w_i = (\alpha_i - \beta_i \alpha_0) + \sum_j \gamma_{ij} \ln p_j + \beta_i \left[\ln x - \sum_k \alpha_k \ln p_k - \frac{1}{2} \sum_k \sum_j \gamma_{kj} \ln p_k \ln p_j \right] \tag{13}$$

Table 1 – Amsterdam Scale, adapted from Deaton e Muellbauer (1986).

Age	Male	Female
< 14 years	0.52	0.52
from 14 to 17 years	0.98	0.90
> 18 years	1.00	0.90

The main problem with this approach is the identification of parameter α_0 (Deaton and Muellbauer, 1980). Alternatively, such as in this study, these equations could be estimated by Seemingly Unrelated Regressions (SUR) using ordinary least square (OLS) if P in (7) were linear in terms of parameters α , β and γ .

In a situation where prices are closely collinear, P could be known as an index price P^* (Stone, 1954 *apud* Deaton and Muelbauer, 1980):

$$\ln P^* = \sum w_k \ln p_k \quad (14)$$

The same index was used to calculate the prices p_j in (7) and (8). If $P \equiv \varphi P^*$, then equation (7) can be written as:

$$w_i = (\alpha_i - \beta_i \log \varphi) + \sum_j \gamma_{ij} \ln p_j + \beta_i \ln \left[\frac{x}{P^*} \right] \quad (15)$$

considering $\alpha_i^* = \alpha_i - \beta_i \log \varphi$ and $\sum \alpha_k^* = 0$, if $\sum \beta_k = 0$.

In eq. (15) if high income households consume the same amount of food as the low income households, but their expenditures are higher as a result of prices differences, results could be understood as a proxy to the quality associated to the food products consumed. Therefore, x/P^* represents the amount weighed for the quality of food product per household. Uncompensated price elasticities in AIDS functions are calculated from eq. (8) as follows (Alston et al., 1994):

$$\begin{aligned} \varepsilon_{ij} &= \frac{\partial \ln q_i}{\partial \ln p_j} = -\delta_{ij} + \frac{\partial \ln w_i}{\partial \ln p_j} = -\delta_{ij} + \frac{\partial w_i / w_i}{\partial p_j / p_j} = -\delta_{ij} + \frac{\partial w_i}{\partial p_j} \cdot \frac{p_j}{w_i} \\ \varepsilon_{ij} &= -\delta_{ij} + \frac{\partial (\alpha_i + \sum_j \gamma_{ij} \ln p_j + \beta_i \ln x - \beta_i \ln P)}{\partial p_j} \cdot \frac{p_j}{w_i} \\ \varepsilon_{ij} &= -\delta_{ij} + \left[\frac{\gamma_{ij}}{p_j} - \beta_i \frac{\partial (\alpha_0 + \sum_k \alpha_k \ln p_k + 1/2 \sum_k \sum_j \gamma_{kj} \ln p_k \ln p_j)}{\partial p_j} \right] \cdot \frac{p_j}{w_i} \\ \varepsilon_{ij} &= -\delta_{ij} + \left[\frac{\gamma_{ij}}{p_j} - \beta_i \cdot \left(\frac{\alpha_j}{p_j} + \frac{1}{2} \sum_k \gamma_{kj} \frac{\ln p_k}{p_j} + \frac{1}{2} \sum_j \gamma_{kj} \frac{\ln p_k}{p_j} \right) \right] \cdot \frac{p_j}{w_i} \\ \varepsilon_{ij} &= -\delta_{ij} + \frac{\gamma_{ij}}{w_i} - \frac{\beta_i}{w_i} \cdot \left(\alpha_j + \sum_{k=1}^n \gamma_{kj} \ln p_k \right) \end{aligned} \quad (16)$$

where, δ_{ij} is Kronecker delta ($\delta_{ij} = 1$ if $i = j$ and $\delta_{ij} = 0$ if $i \neq j$).

Compensated price elasticities (ε_{ij}^*) are calculated using Slutsky equation:

$$\varepsilon_{ij}^* = \varepsilon_{ij} + w_j \varepsilon_{i,x} \quad (17)$$

where: $\varepsilon_{i,x}$ is expenditure elasticity for good i .

$$\varepsilon_{i,x} = 1 + \frac{\beta_i}{w_i} \quad (18)$$

Therefore, compensated price elasticity for AIDS function is given by:

$$\varepsilon_{ij}^* = -\delta_{ij} + \frac{\gamma_{ij}}{w_i} + w_j - \frac{\beta_i}{w_i} \left(\alpha_j + \sum_{k=1}^n \gamma_{kj} \ln p_k - w_j \right) \quad (19)$$

The elasticities can be calculated by a linear approximation (Chalfant, 1987 *apud* Alston, 1994). Considering a special case of derivation of P^* from (14):

$$\frac{\partial P^*}{\partial p_j} = w_j \quad (20)$$

The linear approximation of $\varepsilon_{ij}(AL)$ and $\varepsilon_{ij}^*(AL)$:

$$\varepsilon_{ij}(AL) = -\delta_{ij} + \frac{\gamma_{ij}}{w_i} - \frac{\beta_i}{w_i} \cdot w_j \quad (21)$$

$$\varepsilon_{ij}^*(AL) = -\delta_{ij} + \frac{\gamma_{ij}}{w_i} + w_j \quad (22)$$

The study uses data from "Pesquisa de Orçamento Familiar" [POF] (Household Budget Research) from 2002-2003 (IBGE, 2004) which contains information about the expenditure of a sample of 48,471 Brazilian households. Data was collected from July 2002 to June 2003 and is the most recent data available. All the expenses were registered for one week in each household in the sample. The data set covers all geographic regions and economic stratum with prices adjusted to 01 Mar., 2003.

In order to understand the demand function better, data was grouped and analyzed in two alternative forms. First, non-processed fish consumption was compared with the consumption of other animal protein. "Protein" demand was divided into five categories: fish, red meats, chicken, milk and eggs, and processed proteins. The first four categories represent purchases of proteins of low level processing (chilled, frozen or salted meat (whole or in cuts) or live animals) and the last includes these four proteins purchased by households but with higher degrees of processing.

The second analysis considers wider consumption categories ignoring the degree of processing. Foods were separated into seven groups namely cereals, fruit and vegetables, milk and eggs; oils and condiments; fish, other processed foods, and other meats. Here though, processed proteins were placed in their respective fish, milk and egg, and total meat categories.

"Outside goods" were not included due to the hypothesis that there is no substitution of food with other goods. The estimate implicitly assumes that the custom-

er defines what fraction of their income will be allocated to the purchase of animal protein and subsequently chooses products based on relative prices. It is worth noting that in the estimation of compensated price elasticity of demand, the omission of the outside alternative in conjunction with the usual restrictions (symmetry of the Slutsky matrix, the sum of shares equal to 1, etc. ...), tends to exaggerate the income effect and this tendency is proportional to the expenditure share of the good in the total expenditure.

The data line was considered in the model only when the budget share of all categories (five for Proteins and seven for Food) was more than zero, otherwise it was deleted.

Results and Discussion

Figure 3 shows the income distribution in Brazil, in total and by regions. In the North-Northeast Region, the population is concentrated in lower income levels whereas in the Central-South the concentration is intermediate levels of income. Interesting enough, fish consumption has a similar distribution (Figure 4).

Overall, the *per capita* consumption of 4.59 kg per year of fish is quite low in comparison with other countries. However it is clear that this results from the fact that few individuals (only 29.6 million people out of 175

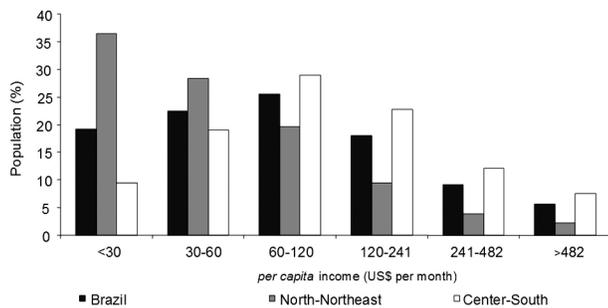


Figure 3 – Brazil: North-Northeast and Center-South Regions: distribution of population according to *per capita* income. 2003 (source IBGE. 2004).

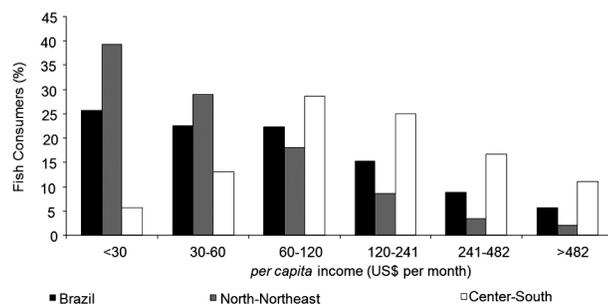


Figure 4 – Brazil: North-Northeast and Center-South Regions: percentage of fish consumers according to its *per capita* income. 2003 (source IBGE. 2004).

million report fish consumption) eat a good quantity of fish. This number needs increasing and not just among current consumers. The *per capita* consumption rises up to 27.22 kg per year when one considers only fish consumers. The consumption pattern also varies between regions. In the North and Northeast Regions, 28 % of the population eats fish while in the Central-South that ratio drops to 11 %. As a consequence, 60 % of fish consumers are in the North-Northeast Region and 40 % are located in the Central-South.

The third fact worth mentioning is the proportion of households reporting fish consumption: 11,296 out of 48,471 in the sample, and only 1,324 households reporting simultaneous consumption of all five animal protein categories. This scenario could be explained by the facts that: (i) the household consumes all animal proteins but some (or all) of these were not consumed in the survey week; (ii) the household does not have the habit of consuming either a little (or any) animal protein; and, (iii) for some reason (unknown), the information regarding this amount (kg) consumed is absent.

In the first model, AIDS function was applied to the five animal protein categories, represented by: a - chicken; l - milk and eggs; p - fish; t - processed proteins; and, v - red meats. Another three important abbreviations for the understanding of these functions are: w_i - expenditure share of protein, i (out of x - total expenditure in animal protein); lp_i - Neperian logarithms of i -th animal protein price; and x/kP - Neperian logarithms of expenditure with animal proteins divided by the adult index equivalent in the household (k) times the price index (P). The percentage of expenditure on animal protein per category (wt_i) of POF was compared with the same percentage of expenditure to the group of 5 protein categories consumed simultaneously (w_i). The main difference was that (w_i) consumers had spent three times more on fish than the national average. The ready protein consumption was practically the same; however, (w_i) consumers had a larger consumption of chicken and a lesser consumption of red meats, milk and eggs than the national average for meat (Figure 5).

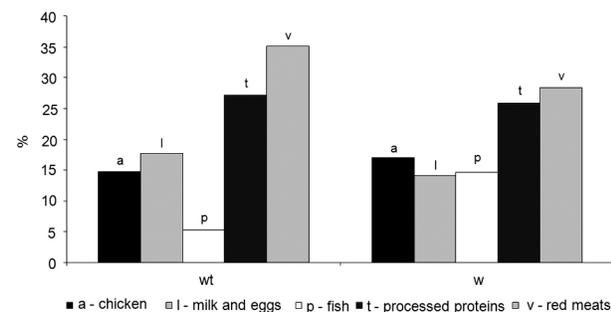


Figure 5 – Brazil: distribution of animal protein consumption by categories expenditure in “Pesquisa de Orçamento Familiar” (Familiar Budget Research) - POF (wt) and the group of 5 protein categories simultaneously consumed (w). 2003. Original research data.

Table 2 – Brazil: parameters and statistic tests estimates for partial restricted and restricted almost ideal demand system - AIDS functions for five animal proteins categories. Original research data; parameters estimated by Neperian logarithm transformation.

	Chicken	Milk and Eggs	Fish	Processed Proteins	Red Meat	x/kP	intercept	Teste F	R ²	R ² Adj.
Chicken	0.052* (7.25)	0.007 ^{ns} (1.63)	-0.022* (-4.68)	-0.008 ^{ns} (-1.43)	-0.028* (-3.86)	-0.038* (-9.05)	0.267* (36.94)	47.44*	0.152	0.149
Milk and Eggs	0.032* (4.67)	-0.039* (-9.51)	0.004 ^{ns} (0.97)	-0.007 ^{ns} (-1.35)	0.010 ^{ns} (1.44)	0.003 ^{ns} (0.65)	0.106* (15.25)	25.94*	0.089	0.086
Fish	-0.028* (-4.06)	0.017* (3.90)	0.037* (7.72)	-0.002 ^{ns} (-0.34)	-0.023* (-3.10)	-0.030* (-7.22)	0.211* (29.13)	25.51*	0.088	0.085
Processed Proteins	-0.017 ^{ns} (-1.70)	0.003 ^{ns} (0.45)	0.032* (4.83)	0.007 ^{ns} (0.85)	-0.025** (-2.39)	0.069* (11.66)	0.132* (12.79)	42.79*	0.139	0.136
Red Meat	-0.037* (-3.74)	0.013** (2.09)	-0.051* (-7.70)	0.010 ^{ns} (1.32)	0.066* (6.39)	-0.004 ^{ns} (-0.67)	0.284* (27.93)	18.98*	0.067	0.064
Chicken ¹	0.050* (7.13)	0.014* (3.88)	-0.021* (-5.43)	-0.012** (-2.31)	-0.031* (-5.07)	-0.036* (-8.75)	0.273* (39.46)			
Milk and Eggs ¹	0.014* (3.88)	-0.036* (-9.10)	0.011* (3.48)	-0.003 ^{ns} (-0.82)	0.015* (3.31)	0.001 ^{ns} (0.36)	0.104* (15.95)			
Fish ¹	-0.021* (-5.43)	0.011* (3.48)	0.039* (8.48)	0.010** (2.36)	-0.038* (-7.64)	-0.031* (-7.52)	0.206* (31.09)			
Processed Proteins ¹	-0.012** (-2.31)	-0.003 ^{ns} (-0.82)	0.010** (2.36)	0.006 ^{ns} (0.79)	-0.001 ^{ns} (-0.22)	0.071* (12.50)	0.122* (12.70)			
Red Meat ¹	-0.031* (-5.07)	0.015* (3.31)	-0.038* (-7.64)	-0.001 ^{ns} (-0.22)	0.056* (5.81)	-0.006 ^{ns} (-1.05)	0.295* (31.63)			

Note:¹ refers to restricted functions; * $p < 0.01$; ** $p < 0.05$; *** $p < 0.1$; ns – non significant.

The estimative results of the model, test t , F and the low value for R^2 were already expected since cross-section data (Griffiths et al., 1993) (Table 2). The t test using the restricted model parameters (equations 10, 11 and 12) is better than the partially restricted model (equation 11).

Uncompensated and compensated price elasticity (both sample and cross price data) and income elasticity were estimated from w_i and parameter functions. The signs of most of the price itself and income elasticity were consistent with the microeconomic theory. In some cases, the signs for the uncompensated and compensated cross price elasticity are the contrary to those expected. This analysis was based on the compensated elasticity and is hence coherent with the microeconomic theory (Table 3). All elasticity in compensated cross price analysis was positive. Curiously, the highest cross price elasticity was for processed proteins (ϵ^{*p}_{pi}) milk and eggs (ϵ^{*p}_{pa}) and not for chicken (ϵ^{*p}_{pa}) or red meat (ϵ^{*p}_{pv}) which were expected to be the main fish competitors.

Price of fishery products and income elasticity estimated in this study are similar to those found for Japan (Hayes et al., 1990; Chalfant et al., 1991). Although these studies do not compare the same animal protein groups, all cross elasticity, (USA data excluded), is lower than their prices and income elasticity. Income elasticity estimated for Brazil, Japan and Canada have a stronger influence on fish demand than the surrogate goods (Table 4).

The other model, with seven food categories (c - cereals; h - fruit and vegetables; m - milk and eggs; o - oils and condiments; d - fish; r - other processed foods;

Table 3 – Brazil: uncompensated (ϵ^p) e compensated (ϵ^{*p}) elasticities for five animal proteins categories. Original research data.

	Chicken	Milk and eggs	Fish	Processed proteins	Red meat	X
ϵ^p	-0.11*	0.10*	-0.70*	0.12**	-0.20*	
ϵ^{*p}	0.02*	0.21*	-0.59*	0.32**	0.02*	0.79*

* $p < 0.01$; ** $p < 0.05$.

Table 4 – Brazil/Japan/USA/Canada: uncompensated price and income elasticities for fish.

	Brazil	Japan*	USA*	Canada**
Chicken	-0.11	0.01	-0.12	0.19
Cattle	-	-0.04	0.19	0.09
Imported Cattle	-	-0.04		
Pork	-	-0.02	0.16	0.09
Red Meat	-0.20	-	-	-
Milk and Eggs	0.10	-	-	-
Processed Proteins	0.12	-	-	-
Fish	-0.70	-0.70	-0.23	-0.37
Income	0.79	0.78	0.15	0.89

*from Hayes et al. (1990); **from Chalfant et al. (1991).

and, n - meats) was estimated using 3,430 households reporting simultaneous consumption of these foods. The percentage of expenditure per food category (w_t) of POF was compared with the same percentage of expenditure to the group of seven food categories consumed simultaneously (w_i). Similar to the situation previously considered, the main difference was that the consumers

Table 5 – Brazil: almost ideal demand system - AIDS parameters for partial restricted and restricted functions to 7 food categories. Original research data; parameters estimated by Neperian logarithm transformation.

	cereals	vegetables and fruits	milky and eggs	oils and condiments	fish	other processed foods	meats	x/kP	Inter.	F	R ²	R ² adj.
cereals	0.076* (20.16)	0.018* (5.43)	0.006* (2.69)	-0.003 ^{ns} (-0.99)	-0.007*** (-2.57)	-0.076* (-18.74)	-0.013** (-2.53)	0.015* (4.58)	0.164* (19.65)	138.05*	0.220	0.219
vegetables and fruits	-0.0222* (-9.21)	-0.012* (-5.42)	-0.005* (-3.44)	-0.004** (-2.35)	0.004*** (1.95)	0.030* (11.36)	0.010* (2.95)	-0.001 ^{ns} (-0.23)	0.093* (17.31)	50.42*	0.093	0.091
milky and eggs	-0.023* (-8.41)	-0.003 ^{ns} (-1.06)	-0.002 ^{ns} (-1.28)	0.000 ^{ns} (0.10)	0.022* (10.08)	0.021* (7.06)	-0.015* (-4.05)	0.008* (3.30)	0.107* (17.34)	63.00*	0.114	0.112
oils and condiments	0.005** (2.48)	0.007* (4.12)	-0.005* (-4.72)	0.008* (5.67)	0.012* (8.13)	-0.013* (-6.20)	-0.013* (-5.17)	0.018* (10.42)	0.040* (9.30)	53.10*	0.098	0.096
fish	-0.022* (-9.06)	-0.001 ^{ns} (-0.44)	0.014* (10.08)	0.001 ^{ns} (0.72)	-0.010* (-5.35)	0.005*** (1.78)	0.013* (4.00)	-0.031* (-14.56)	0.153* (28.81)	59.09*	0.108	0.106
other processed foods	-0.009* (-3.09)	-0.001 ^{ns} (-0.35)	-0.009* (-5.01)	-0.002 ^{ns} (-0.84)	0.009* (3.66)	0.029* (8.69)	-0.017* (-3.99)	-0.000 ^{ns} (-0.17)	0.184* (26.89)	22.51*	0.044	0.042
meats	-0.004 ^{ns} (-1.00)	-0.008** (-2.33)	0.001 ^{ns} (0.52)	-0.001 ^{ns} (-0.22)	-0.029* (-9.11)	0.005 ^{ns} (1.11)	0.035* (6.46)	-0.009* (-2.60)	0.260* (28.75)	18.45*	0.036	0.034
cereals ¹	0.045* (20.35)	-0.010* (-5.19)	-0.006* (-3.69)	0.000 ^{ns} (0.32)	-0.018* (10.10)	-0.033* (-13.32)	-0.008** (-2.44)	0.011* (3.53)	0.156* (19.89)			
vegetables and fruits ¹	-0.010* (-5.19)	-0.009* (-4.57)	-0.003* (-2.91)	0.000 ^{ns} (0.74)	0.004* (2.72)	0.015* (7.91)	0.004 ^{ns} (1.64)	0.007* (3.30)	0.079* (15.42)			
milky and eggs ¹	-0.006* (-3.69)	-0.003* (-2.91)	-0.002 ^{ns} (-1.14)	-0.004* (-4.64)	0.016* (14.49)	-0.000 ^{ns} (-0.38)	0.000 ^{ns} (0.01)	0.019* (9.18)	0.075* (14.98)			
oils and condiments ¹	0.000 ^{ns} (0.32)	0.000 ^{ns} (0.74)	-0.004* (-4.64)	0.008* (5.88)	0.007* (5.98)	-0.005* (-3.64)	-0.006* (-3.10)	0.016* (10.28)	0.040* (10.56)			
fish ¹	-0.018* (-10.10)	0.004* (2.72)	0.016* (14.49)	0.007* (5.98)	-0.007* (-4.13)	0.007* (4.08)	-0.008* (-3.57)	-0.029* (-14.97)	0.158* (34.13)			
other processed foods ¹	-0.032* (-13.32)	0.015* (7.92)	-0.000 ^{ns} (-0.38)	-0.005* (-3.64)	0.007* (4.08)	0.023* (7.32)	-0.007** (-2.29)	-0.010* (-3.81)	0.218* (35.55)			
meats ¹	-0.008** (-2.44)	0.004 ^{ns} (1.64)	0.000 ^{ns} (0.01)	-0.006* (-3.10)	-0.008* (-3.57)	-0.007** (-2.29)	0.025* (4.76)	-0.015* (-4.45)	0.273* (34.41)			

Note:¹ refers to restricted functions; * $p < 0.01$; ** $p < 0.05$; *** $p < 0.1$; ns – non significant.

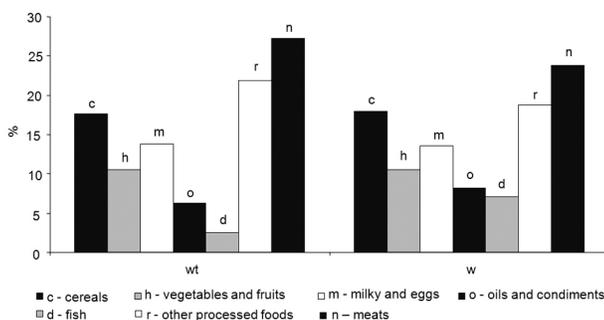


Figure 6 – Brazil: Percentage of food categories expenditure in “Pesquisa de Orçamento Familiar” (Familiar Budget Research) - POF (wt) and the group of 7 foods simultaneously consumed (w). 2003. Original research data.

sampled (w_i) had spent three times more on fish than the national average. The other food consumption was similar to the national average (Figure 6).

The statistical results were similar to the previous model (Table 5). The signs of uncompensated and

compensated price elasticity itself for fishery products and income elasticity were coherent with the micro-economic theory. The price elasticity itself was higher while income elasticity was lower than the earlier model, but the signs remained the same. All elasticity in compensated cross price analysis was positive except for cereal, indicating they are complements. Consistent to the first model, highest cross price elasticity was found for other processed food, milk and eggs (but not for meat) which were expected to be the main competitors for fish (Table 6).

In conclusion, the main substitute products for fishery products are neither red meats nor chicken, and the main markets for these products are in the lowest income stratum in North-Northeast Regions and in the intermediate stratum for the Central-South. The low *per capita* fish consumption in Brazil results, not from a low individual consumption rate but the fact that few households have the habit of consuming fish. Therefore, the challenge of raising the demand for fish is one of attracting new consumers and not increasing the expenditure of current consumers.

Table 6 – Brazil: uncompensated (ϵ^a) e compensated (ϵ^{*a}) elasticities for seven food categories.

	Cereals	Vegetables and fruits	Milky and eggs	Oils and condiments	Fish	Other processed	meats	x
ϵ^a_d	-0.184*	0.095*	0.286*	0.126*	-1.076*	0.177*	-0.016*	
ϵ^{*a}_d	-0.078*	0.158*	0.367*	0.175*	-1.034*	0.288*	0.125*	0.591*

* $p < 0.01$.

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