How Economic Factors Influence the Nutrient Content of Diets: an Application of Animal Products Demand System in Tunisia

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Abstract

Most of the literature on Tunisian food demand measures the influence of traditional variables such as income and prices, or some socio-demographic variables. However, nowadays other important factors determine the consumer's final choice, among which are: the nutritious quality, the nutrient content of food and the increasing concern about health. The objective of this paper is twofold. On one hand, the paper aims to analyse the effect of previous factors on meat consumer behaviour. On the other hand, to the author's knowledge, this may well be one of the first studies that use data to answer the previous questions in the case of Tunisia. The nutritious quality of meat is measured by an index that relates nutrient content of each product with the standards suggested by the National Academy of Science. To cope with the second objective a demand system has been specified and estimated and nutrient elasticities have been obtained. Results are different from traditional studies in the sense that higher prices do not indicate lower consumption but a higher quality demand.

Key words: *Animal products demand, health awareness, nutrients price/quality index, Tunisia*

Introduction

The evolution of food consumption structure in recent years shows that the pattern of food consumption has been constantly changing, due to both economic and socio-demographic factors. The origin of food is modified; with is a higher incidence of manufactured products from the agro-food industries and a lower incidence of non-manufactured products. Food expenditure shares have been modified because of changes in relative prices, income, and variations in tastes and preferences. Therefore, food demand seems to be well diversified, particularly at the quality level. At the same time, the consumption of animal products (meat, fish, milk, dairy products and eggs) has substantially increased during the last two decades.

Recently, some food demand studies have been undertaken in Tunisia providing many insights into the effects of conventional factors such as price and income as well

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as some socio-demographic variables in food demand (Laajimi et al., 2003; Laajimi and Dhehibi, 2001; and Dhehibi and Gil, 2003).

In the literature, a large body of scientific research has shown that diet plays an important role in determining the risk of chronic diseases such as coronary heart disease, cancer, diabetes, hypertension and osteoporosis. As a consequence, food consumption patterns are increasingly being driven by a much more complex set of factors than those economists have traditionally incorporated in demand studies.

Some of these studies have already incorporated certain types of health information indexes to capture the effect of the increasing consumers' concerns about the potential health effects of food diet (Brown and Schrader, 1990; and Capps and Schmits, 1991). Others studies have tended to take into account nutrient intakes. In this context, two main approaches have been used. The first one, directly measures the effect of income and socio-demographic variables on the demand for nutrients (Nayga, 1994; and Ramezani, 1995). The second develops an indirect approach based on a two-step process. First, a food demand system is estimated in order to calculate the effects of relevant variables. Second, nutrient intake effects are obtained by applying nutrient conversion factors to the resulting food effects (Xiao and Taylor, 1995; Ramezani et al., 1995; and Huang, 1999a).

Following Huang (1999a), given the demand structure for foods and the bundle of nutrient attributes in each food product, one can derive the implied relationship between the overall availability of nutrients and changes in food prices and income. Taking into account both approaches, the objective of the paper is to improve our understanding about how economic factors affect Tunisians animal food choices with a consequence to the nutrient content of diets.

In order to meet the purpose of this paper, the rest of the article is organized as follows. After the introduction, the second section gives a brief description of animal food demand structure in Tunisia is offered. Section 3 is devoted to a description of theoretical foundation and the functional form of the model as well as the description of data. Results and discussion are presented in section 4. Finally, some concluding remarks and policy implications are outlined.

The Evolution of animal food consumption in Tunisia

A simple diagnosis of the food consumption evolution in Tunisia shows that eating habits of Tunisians have changed significantly in the last two decades. The main characteristics of this change are well known and can be summarised as an important increase in the demand for products of animal origin during this period. Animal origin calorie intake has continuously grown to represent nearly 12% of the total calorie intake in 1998 (INS, 2000). In terms of macro-nutrients, this change means a small increase in the quantity of proteins due to the substitution of vegetal origin proteins consumed with those from animal origin.

Animal origin products are now an important part of the Tunisian diet. According to the statistics of the Tunisian Ministry of Agriculture, Environment and Hydraulic Resources in 1973 the average intake of meat products was 12.85 kilos per person and year. In 1998 this figure had risen to 19.53 kilos per person and year being higher than in the other Maghrebian countries. Nevertheless, le level of meat consumption in Tunisia is still lower than in northern Mediterranean countries.

Table 1 shows Tunisian's annual per capita consumption of beef (including veal), lamb (including mutton), poultry, fish and eggs. It appears that has been a significant increase in poultry and beef in the last three decades. These products have been the most important sources of animal food. It can be also noticed that lamb consumption have fluctuated considerably. Per capita consumption of lamb decreased from about 5.25 to 4.95 kg/capita/year during the period 1973-1990, while in the period 1990-1998 his relative importance was increased (5.80 kg/capita in 1998). Fish consumption has decreased during this period but this decrease has been compensated by a growth in poultry consumption. Regarding animal food products, also noticeable is the stabilization of egg consumption, especially in the 90's.

Table 1. Animal Food Consumption in Tunisia along the Period 1973-1998 (kg/capita/year)

Animal Food Products	1973	1975	1980	1985	1990	1995	1998
Meat Products	12.85	15.08	16.78	17.01	16.44	18.14	19.53
Beef	5.10	6.08	5.11	5.94	5.81	6.40	6.79
Lamb	5.25	5.75	5.19	5.34	4.95	5.33	5.80
Poultry	2.50	3.25	6.48	5.73	5.68	6.41	6.94
Eggs	2.27	2.53	4.87	6.30	5.13	5.34	5.30
Fish	5.56	7.69	8.76	11.24	9.05	8.58	8.31

Source: Data from Tunisian Ministry of Agricultural (several years).

Animal food consumption in Tunisia has experienced many changes, not only in terms of quantities, but also in terms of expenditure shares. Table 2 shows the expenditure structure for the different types of animal food products. It can be observed that it has been stable for the last twenty years even though cyclical oscillations can be observed, especially for beef and fish, which can be explained by the lack of developed distribution channels. Lamb (including mouton) expenditure is quite stable due to the existing cultural and religious traditions in Tunisia. Finally, the share of eggs shows a slow tendency to decreasing since 1990, which can be explained by an important increase of price in absolute terms.

Table 2. Budget Shares of Animal Food Consumed in Tunisia along the Period 1973-1998 (%)

Animal Food Products	1973	1975	1980	1985	1990	1995	1998
Meat Products	71	63	65	63	63	66	67
Beef	33	28	22	26	25	29	30
Lamb	28	23	32	27	29	28	28
Poultry	10	12	11	10	9	9	9
Eggs	7	6	7	7	6	6	6
Fish	22	31	28	30	31	28	27

Source: Data from Tunisia National Statistics Institute and Tunisian Ministry of Agricultural (several years).

Regarding the relative participation of different animal products in the total nutrient intake (Table 3), it can be observed that these products participated, simultaneously, in the availability of 9.98% of total energy intake; 10% of total protein intake; 9.54% of total fat intake; and an important percentage in the rest of nutrients (vitamins and minerals).

To understand consumers' animal food demand behaviour, the second step of our descriptive analysis is to define nutritional quality index taking into account that food quality can be measured by nutritional content. In this context Hansen et al. (1979) developed an index of nutritional quality (INQ). The index expresses the nutritional quality of a food by comparing the nutrients in the food to the calories it contains. In order to compute the INQ, nutrients standards must be determined first. According to Hansen et al. (1979), a nutrient standard is the amount of nutrient needed to meat a human's daily need in order to maintain good health. The Recommended Dietary Allowances (RDA) can serve as the standards[1].

Table 3. Nutrient Share Structure (% With Respect to Total Food Consumption Average Period)

	Energy	Protein	Carbo-hydrate	Total fats	Vitamins	Calcium	Others minerals
Meat Products	7.09	5.70	-	7.80	1.94	2.20	2.64
Beef	3.07	2.29	-	3.60	0.85	0.70	0.90
Lamb	2.67	1.55	-	3.12	0.69	0.61	0.81
Poultry	1.35	1.85	-	1.12	0.35	0.87	0.58
Eggs	1.40	1.35	-	1.48	1.49	3.90	1.13
Fish	1.49	2.95	0.10	0.65	0.72	3.80	1.17

Source: Own elaboration.

Based on the nutrient standard, the percentage of the standard of nutrient j in animal food product i, W_{ij}, is calculated from each animal food product by:

$$W_{ij} = \frac{N_{ij}}{S_j} * 100\,\%$$

Where N_{ij} is the amount of nutrient j contained per unit of animal food product i, and S_j is the standard for nutrient j.

The INQ of nutrient j in animal food product i is expressed as the ratio of its percentage standard of nutrient j, W_{ij}, relative to its percentage standard of energy (calories), W_{ie}. It is expressed as:

$$INQ_{ij} = \frac{W_{ij}}{W_{ie}}$$

For each nutrient in an animal food, an INQ can be computed. Noting that each animal food product contained the same nutrients, there will be exact multicollinearity among nutrients. In such case, the INQ for energy in any animal food product mat be unity. The INQ's for other nutrients may be smaller or larger than unity. For a desirable nutrient, an animal food product having an INQ of 1.0 or greater will be of high quality. Otherwise, the animal food product is of low nutritional quality. Results from such INQ's are given in table 4.

Table 4. Means of Nutritional Quality Indexes of Animal Food Products

Nutrients	Meat Products			Eggs	Fish
	Beef	Lamb	Poultry		
Energy	1.00	1.00	1.00	1.00	1.00
Protein	3.26	2.54	6.00	4.18	8.60
Total fats	2.46	2.45	1.74	2.22	091
Calcium	0.11	0.10	0.29	1.31	1.16
Iron	1.36	1.31	1.21	2.70	1.60
Magnesium	0.48	0.61	0.96	0.59	1.83
Zinc	2.20	1.63	1.02	1.71	0.55
Thiamin	0.45	3.56	1.38	1.54	2.00
Riboflavin	1.12	0.89	1.29	3.17	1.25
Niacin	3.97	2.53	8.81	3.21	9.22
Folate	0.54	0.18	0.83	2.30	1.95
Vitamin B12	4.50	5.70	-	13.06	56.1
Vitamin A	-	-	-	3.60	1.12
Vitamin D	-	-	-	10.76	59.7

Source: own elaboration.

As showed in table 4, all the considered animal food products are high quality in protein, iron, zinc, riboflavin, niacin and vitamin B12. Among the meat products, poultry is of good nutritional quality. Beef and lamb have greater INQ for total fats, and hence are lower quality. For a desirable nutrient as vitamins, eggs are considered of good quality. The INQ's vitamins are greater compared to other animal food products. On the other hand, this product is of low nutritional quality with respect to total fats (saturated fat in this case). Finally, fish product is of high nutritional quality in total fats, calcium, magnesium, vitamin B12 and vitamin D.

Methodology

Theoretical framework

As mentioned in the introduction, the main objective of the paper is to improve our understanding about how economic factors affect food choices with a consequence to the nutrient content of diet. The estimated price and income effects on nutrients are relevant for several economic agents. On one hand, policy makers can anticipate change in consumer's animal food consumption patterns by defining policy measures affecting food prices and income. On the other, producers and marketing managers can use animal food elasticities to know general trends in food consumption. Moreover, this type of research is needed to improve our understanding of how diet affects health as well as how consumer behaviour affects food prices.

According to Huang (1999a), a basic property of demand systems with factors such as nutrients is that any demand increase(s) of product(s) as a result of a change in the factor must be offset by demand decreases for other products, as total consumer expenditures are constant. For practical analysis, however, the information from a complete food demand system is needed to translate changes in food prices and consumer income into changes in the levels of nutrients available.

A discussion of the procedure used in this study for measuring how economic factors affect animal food choices with a consequence to the nutrient content of diets follows. Let a marshallian demand function be defined as:

$$q_i = f_i\,(p,m) \tag{1}$$

Where q_i denote the demanded quantity of *ith* good i; p represent the corresponding prices vector; and m is the total income or expenditure. In differential form, the demand system of q commodities can be expressed as:

$$dq_i = \sum_{j=1}^{n}\left(\partial q_i / \partial p_j\right) dp_j + \left(\partial q_i / \partial m\right) dm \tag{2}$$

From (2), we obtain the following demand system:

$$dq_i / q_i = \sum_{j=1}^{n} e_{ij}\left(dp_j / p_j\right) + \eta_i\left(dm / m\right) \tag{3}$$

Where; $e_{ij} = \left(\partial q_i / \partial p_j\right)\left(p_j / q_i\right)$ is the price elasticity of the *ith* commodity with respect to a price change of the *jth* commodity and $\eta_i = \left(\partial q_i / \partial m\right)\left(m / q_i\right)$ is an expenditure elasticity showing the effect of the *ith* quantity in response to a change in per capita expenditure.

The model exposed in (3) is a demand system in which quantities demanded is a function of prices (p) and per capita income or expenditure (m). On one hand, this demand model is a general approximation of conceptual demand relationships relating to some small changes from any given point on the *n*-commodity demand surface. On the other, does not impose any rigid functional form. Moreover, is linear in parameters for easy computation, and the variables in the model are easily quantified by using available time series usually expressed as index numbers.

In view of classical demand theory, the differential form demand model can be estimated by incorporating the following parametric constraints of homogeneity ($\sum_{j=1}^{n} e_{ij} = -\eta_i$), symmetry ($e_{ji}/w_i + \eta_j = e_{ij}/w_j + \eta_i$), and Engel aggregation ($\sum_{i=1}^{n} w_i \eta_i = 1$), where ($w_i = {p_i q_i}/{m}$) is the expenditure weight of the *ith* commodity taken at the sample mean. The effort by incorporating the theoretical restrictions has narrowed the gap between demand theory and empirical application and has provided greater statistical efficiency to the estimated demand parameters.

To explore the linkage of the demand model to nutrient availability, the quantity of *kth* nutrient available, say ϕ_k (as developed by Lancaster (1971) be expressed as:

$$\varphi_k = \sum_{i=1}^{n} a_{ki}\, q_i \qquad (k = 1,...,K) \qquad (4)$$

Where a_{ki} is the quantity of the *kth* nutrient in a total of K nutrients obtained from a unit of the *ith* food.

Incorporating, the expression mentioned above in (4), we get:

$$d\varphi_k = \sum_{i=1}^{n} a_{ki}\left[\sum_{j=1}^{n}\left({\partial q_i}/{\partial p_j}\right)dp_j + \left({\partial q_i}/{\partial m}\right)dm\right] \qquad (5)$$

Accordingly, the relative change in nutrient availability can be expressed as a function of the relative changes in food prices and per capita income as follows:

$$ {d\varphi_k}/{\varphi_k} = \sum_{j=1}^{n}\left(\sum_{j=1}^{n} e_{ij}\, a_{ki}\, {q_i}/{\varphi_k}\right)\left({dp_j}/{p_j}\right) + \left(\sum_{i=1}^{n}\eta_i\, a_{ki}\, {q_i}/{\varphi_k}\right)\left({dm}/{m}\right) \qquad (6)$$

$$= \sum_{j=1}^{n}\pi_{kj}\left({dp_j}/{p_j}\right) + \rho_k\left({dm}/{m}\right)$$

Where π_{kj} is a price elasticity measure relating the effect of a change in the *jth* food price on the availability of the *kth* nutrient, and ρ_k is an income elasticity measure relating the effect of a change in income on of the availability of that nutrient.

From expression (6), we conclude that the unique feature of this model is that it incorporates the information of a food demand system including own and cross price elasticities (e_{ij}) and income elasticities (η_i) into the measurement of aggregate nutrient responses.

Given the nutrient shares of individual food categories (CN) and food demand elasticities (EP) including a complete set of own and cross price elasticities, the matrix of nutrient demand elasticities (EN) is calculated as:

$$EN = CN \times EP \qquad (7)$$

Where: EN, is a nutrient demand elasticities matrix of [K x (n + 1)] dimension ; CN is the nutrient shares of individual food categories matrix of [K x n] dimension and EP is the food demand elasticities including a complete set of own and cross price elasticities matrix of [n x (n + 1)] dimension.

Data sources

According to the procedure for estimating nutrient demand elasticities, two sets of input information are required: one is the matrix of food demand elasticities and the other is the matrix of nutrient shares of each food category.

The information on food demand elasticities is obtained from the analysis of a complete demand system (3). This demand system was estimated by using different data sources. Per capita consumption expenditures are obtained from a study conducted by the Ministry of Agriculture. Data on quantities have been estimated using the "Food Balance Sheet" approach, with requires the existence of statistical data on production, imports and exports, and changes in stocks in order to determine the quantity available for human consumption. Annual price series for each commodity are found in the *Bulletin Mensual de Statistique* (Monthly Statistical Bulletin) published by the *Institut National de la Statistique* (National Statistics Institute, or INS) and are deflated by the consumer price index taken from the same source. The following animal food products have been considered: 1) beef; 2) lamb;3) poultry; 4) eggs and 5) fish. The sample period covers yearly data from 1973-1998.

Secondly, to calculate the nutrient shares of each food category, average per capita food consumption data and information on nutrient value of food per kilograms are needed. Food consumption data has been explained. Information on nutrient values is compiled from USDA's Agricultural Handbook available online in the Internet containing data on the nutrient content of the majority of food items. The nutrient used in the analysis are: 1) energy; 2) protein; 3) saturated fat; 4) calcium; 5) iron; 6) magnesium; 7) zinc; 8) thiamine; 9) riboflavin; 10) niacin; and 11) folate.

Results and discussions

The empirical demand system specified in equation (3) has been estimated using Constrained Maximum Likelihood (CML) procedure. Economic theory restrictions of homogeneity, symmetry and Engel aggregation were imposed at sample mean in order to obtain parameters consistent with demand theory.

Breush-Godfrey (1981) multivariate test was used for testing the possible existing of autocorrelation. The obtained result showed that statistical value (1.34) was inferior to the χ^2_{16} critical values (26.3 at the 5% level of significance). Thus, autocorrelation is not a problem. Since the results of null hypotheses testing of autocorrelation were satisfied, the models appeared to be acceptable.

The most interesting economic parameters for policy analysis are the elasticities. The estimated income and own and cross-price elasticities coefficients were mostly statistically significant at the 5 percent significance level. Table 5 summarizes the estimated expenditure and own and cross-price animal food demand elasticities computed at sample mean.

When examining the expenditure elasticities in Table 5, it seems that beef and fish can be considered as luxury goods from the food expenditure point of view. Expenditure increases for such products are more than proportional when total animal food products expenditure increase. On the other hand, expenditure elasticities of lamb, poultry and eggs suggest that they are necessities in the Tunisian diet. So an increase in total animal food products expenditure induces more than proportional increases in beef and fish, but less than proportional increases for lamb, poultry and eggs.

Table 5. Expenditure, Own- and Cross-Price Animal Food Products Demand Elasticities in Tunisia

Animal Food Products	Budget Share	Expenditure Elasticity	Own-price Elasticity	Cross-price Elasticity				
				Beef	Lamb	Poultry	Eggs	Fish
Beef	0.275	1.27*	-0.51*	**-0,86***	-0,10	0,04	-0,14	-0,21*
Lamb	0.281	0.84*	-0.30*	0,02	**-0,54***	-0,11**	0,022	-0,23*
Poultry	0.102	0.63**	-0.59*	0,28	-0,25**	**-0,65***	0,067	-0,08
Eggs	0.069	0.08	-0.33	-0,23	0,30	0,15	**-0,006**	0,024
Fish	0.272	1.24*	-0.18*	-0,20*	-0,35*	-0,09	-0,07	**-0,53***

*: Indicates significance at 5% level; **: Indicates significance at 10% level.

The expenditure elasticity exhibited by lamb seems to be implausible, but not if it is beard in mind that this is a product where demand is higher in rural areas, and where a high proportion is self consumed.

All the uncompensated own-price elasticities are expected negative sign; that is, changes in own prices have inverse impacts on quantities demanded. The resulting demand for all products is inelastic. All of the estimated own-price elasticities are less than unity, while beef and poultry are the most elastic.

Most of the compensated cross-price elasticities are not significantly different from zero. The most important complementary relationships are between beef and fish, lamb and poultry, and between lamb and fish. Eggs are a net substitute for most products, and poultry product is a substitute for beef.

Finally, using previous elasticities and weights matrix, expenditure and own-price nutrient elasticities have been calculated. These elasticities show how the availability of 11 nutrients would change in response to change in five animal food prices (beef, lamb, poultry, eggs and fish) and income. Expenditure nutrient elasticities represent the percentage change in the corresponding nutrient for a 1% change in total expenditure[2]. Own price nutrient elasticities measure the percentage change in the corresponding nutrient as a result of 1 % change in prices.

Table 6 show the estimated expenditure nutrient elasticities evaluated at the mean of the sample. An increase in total expenditure produces an increase in the consumption of all nutrients under study. These results are plausible since all elasticities are positive and, except eggs, significantly different from zero, as expected. For example, the net effect of 1% increase in the total expenditure would increase protein by 0.290% and total fats by 0.455, for beef. In terms of potential public concern about health effects, some significant estimates in the table 6 show that an increase in daily per capita animal food energy (0.389 and 0.221 percent) would occur with a 1% increase budget share of beef or lamb.

Likewise, the net effects of changes in food consumption caused by 1% change (increase or decrease) in prices are listed in table 7. Regarding all own price nutrient elasticities, table 7 shows that, except eggs, are significant at 5% level. According to the estimates, a 1% increase in the price of beef or lamb would decrease energy by 0.156 and 0.08 percent, respectively. The same price decrease for poultry or fish would increase the availability of calcium by 0.049 and 0.125 %, respectively. A 1% decline in prices of beef and poultry would increase the availability of protein by 0.116 and 0.108, respectively.

Under the results that income changes affect all nutrients in the same direction, those insufficient intakes of nutrients (calcium, iron and vitamins) could be improved with increased income. On the contrary, for those already high intakes of nutrients (energy, total fats), the situation would be worsened with increased incomes. However, the situation would be worsened for high income levels in the case of beef, or lamb in rural areas, due to negative impact that may be caused by high cholesterol intake. Hence the net nutritional effect of increased consumer income is mixed.

Lower consumption of certain nutrients is also a concern. Lack of minerals (calcium, iron, magnesium, zinc) or vitamins, for instance, hinders bone development. At the same time, concern of overbalanced diets stems from the health risks associated with excessive intake of saturated fat and cholesterol, with leads to heart attack. Hence, the new definition of food security must emphasise balanced diets rather than simply meeting energy protein requirements. In this context, calculated demand elasticities in the case of Tunisian consumer, can help predict effect of policy as it relates to different animal food products.

Table 6. Expenditure Nutrients Elasticities

	Beef	Lamb	Poultry	Eggs	Fish
Energy	0,389*	0,221*	0,082**	0,012	0,184*
Protein	0,290*	0,127*	0,116**	0,011	0,362*
Total fats	0,455*	0,262*	0,071**	0,012	0,077*
Calcium	0,089*	0,049*	0,053**	0,035	0,469*
Iron	0,342*	0,188*	0,064**	0,021	0,190*
Magnesium	0,236*	0,171*	0,101**	0,008	0,423*
Zinc	0,544*	0,231*	0,053**	0,013	0,063*
Thiamin	0,096*	0,443*	0,064**	0,010	0,204*
Riboflavin	0,314*	0,140*	0,078**	0,028	0,164*
Niacin	0,314*	0,114*	0,150**	0,007	0,345*
Folate	0,222*	0,040*	0,075**	0,030	0,383*

*: Indicates significance at 5% level; **: Indicates significance at 10% level.

Table 7. Own-Price Nutrients Elasticities

	Beef	Lamb	Poultry	Eggs	Fish
Energy	-0,156*	-0,079*	-0,077*	-0,026	-0,049*
Protein	-0,116*	-0,045*	-0,108*	-0,024	-0,096*
Total fats	-0,183*	-0,093*	-0,067*	-0,026	-0,020*
Calcium	-0,035*	-0,017*	-0,049*	-0,074	-0,125*
Iron	-0,137*	-0,067*	-0,060*	-0,046	-0,050*
Magnesium	-0,095*	-0,061*	-0,095*	-0,018	-0,112*
Zinc	-0,218*	-0,082*	-0,049*	-0,028	-0,016*
Thiamin	-0,038*	-0,158*	-0,060*	-0,022	-0,054*
Riboflavin	-0,126*	-0,050*	-0,073*	-0,061	-0,043*
Niacin	-0,123*	-0,041*	-0,140*	-0,016	-0,092*
Folate	-0,089*	-0,014*	-0,070*	-0,064	-0,102*

*: Indicates significance at 5% level; **: Indicates significance at 10% level.

Conclusions and policy implications

The objective for this paper was to investigate and measure how economic factors affect animal food choices with a consequence to the nutrient content and nutrient availability of Tunisian population diets. For this purpose a new research model, developed by Huang (1999a), was employed. The advantage of this model is that it incorporates information of a food demand system including own, cross price elasticities, and income elasticities into the measurement of nutrient responses. This allows seeing how changes in the availability of all nutrients vary depending on how food price and income changes manifest themselves through the animal food demand relationships.

The findings of this study indicated a clear move towards high value and superior foods. Most evident is the calculated demand elasticities that indicate that beef and fish have the highest income elasticity. These products are considered luxury goods, and in the foreseeable future the demand for these food items would most likely increase. As regards price elasticities, for all animal food products the demand is inelastic. Besides the complementarity and substitution relations, demand is revealed to be more sensitive to total animal food expenditure than prices.

In addition, the empirical results show that changes in the availability of all nutrients vary depending on how food price and income changes manifest themselves through the animal food demand relationship. These results are an attempt in evaluating possible effects of changes in prices and income on dietary quality in the case of animal food products. First, the nutrient response estimate can offer important information for the knowledge of food demand structure which is a necessary step to the formulation of strategies and intervention policies in the food sector. This may be undertaken through studying food policy scenarios and examining the effects of possible changes and nutrients that are available for consumption. Similarly, a decrease in prices of animal products is likely to have a positive influence on nutritional status of Tunisian consumers, but not at the same extend as increasing income. Further collaboration between economists and nutritionists is useful for a better comprehension when studying food demand and nutrition.

However, results obtained in this paper are conditioned to the chosen food categories and sample period. Such analysis can be also improved by enlarging the spectrum of food products under study, and by incorporating household socio-demographic characteristics and analysing their influence on the availability of food nutrients. In this context, more desegregation conducted on all foods consumed as well as a longer time period could discriminate a bit more. Nevertheless, this issue is left for further research.

Notes

1 Recommended Dietary Allowances come from National Academy of Sciences (1989) and are: energy, 2305 kcal; protein, 46 gr; total fats, 76.8 gr; calcium, 0.6 mgr; iron, 12.5 mgr; magnesium, 314 mgr; zinc, 13.5 mgr; thiamine, 1 mg; riboflavin, 1.6 mg; niacin, 16.3 mg; folate, 167 μg; vitamin B12, 2 mg; vitamin A, 683 μg; vitamin D, 2.5 μg; and, vitamin B6, 2 mg.

2 Total expenditure corresponds to expenditure for the food group products under study (beef, lamb, poultry, eggs and fish).

References

Breusch, T.S. and L.G. Godfrey (1981). A review of recent work on testing for autocorrelation in dynamic simultaneous models, in Macroeconomic Analysis: Essays in Macroeconomics and Econometrics, eds D. Currie, R. Nobay, and D. Peel, Croom Helm, London.

Brown, D.J. and L.E. Schrader (1990). Cholesterol information and shell egg consumption. American Journal of Agricultural Economics, 72: 548-555.

Capps, O. Jr. and J.D. Schmits (1991). A recognition of health and nutrition factors in food demand analysis. Western Journal of Agricultural Economics, 16: 21-35.

Dhehibi, B. and J.M. Gil (2003). Forecasting food demand in Tunisia under alternative pricing policies. Food Policy, 28(2): 167-186.

Hansen, G.R., Wyse, B.W. and A.W. Sorenson (1979). Nutritional Quality Index of Food. Westport, CT: The AVI Publishing Company, Inc.

Huang, K.S. (1999a). Effects of food prices and consumer income on nutrient availability. Applied Economics, 31: 367-380.

Institut National de la Statistique. (Several Years). Bulletin Mensuel de Statistique. Ministère du Développement et de la Coopération Internationale, Tunisia.

Institut National de la Statistique. (Several Years). Enquête Nationale sur le Budget et la Consommation des Ménages. Ministère du Développement et de la Coopération Internationale, Tunisia.

Laajimi, A. and B. Dhehibi (2001). The structure of food demand in Tunisia. Communication presented at " 71th EAAE Seminar". Zaragoza, (Spain), April, 2001.

Laajimi, A., Dhehibi, B. and J.M. Gil (2003). The structure of food demand in Tunisia: a differential system approach. Cahiers d'Economie et Sociologie Rurales, 66: 55-77.

Lancaster, K. (1971). Consumer demand: A new approach. Columbia University Press, New York.

Ministère de l'Agriculture, (1998). Production, exportation et importation des produits agricoles: cas des viandes. Ministère de l'Agriculture, de l'Environnement et des Ressources Hydrauliques, Tunisia.

National Academy of Sciences, National Research Council (1989). Recommended dietary allowances, 10th ed. Washington, D.C.: National Academy Press.

Nayga, R.M. (1994). Effects of socioeconomic and demographic factors on consumption of selected food nutrients. Agricultural and Resource Economics Review, October: 171-182.

Ramezani, C.A. (1995). Determinants of nutrient demand: a nonparametric analysis. Journal of Agricultural and Resource Economics, 20(1): 165-177.

Ramezani, C.A., Rose, D. and S. Murphy (1995). Aggregation, flexible forms, and estimation of food consumption parameters. American Journal of Agricultural Economics, 77(3): 525-532.

U.S. Department of Agriculture (1996). Agricultural Research Service, Washington DC: USDA's Nutrient Data Base for Standard Reference Release 11 (SR11). The Online Version of Agricultural Handbook Nº8 . (http://www.nal.usda.gov/fnic/foodcomp).

Xiao, Y. and J.E. Taylor (1995). The impact of income growth on farm household nutrient intake: a case study of a prosperous rural area in Northern China. Economic Development and Cultural Change 43(4): 805-819.