The demand for meat in Egypt: An almost ideal estimation

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Abstract

This paper analyzes the demand for meat in Egypt for the period 1990–2005 using the linearized Almost Ideal Demand System to estimate own-price, cross-price and expenditure elasticities. It found that the Marshallian own-price elasticity was the highest for fish, followed by chicken, beef and duck. On the other hand, the cross-price elasticity of beef showed a complementary relationship with the other meat types, except for fish, which is substitutive. Chicken and fish showed a substitutive relationship with all other meat types. Duck showed a substitutive relationship with all meats except rabbit. Mutton and rabbit showed a versatile relationship with the other meat types. The highest substitutive relationship was between mutton and beef. Compensated own-price elasticity estimates showed similar trends but smaller values than uncompensated ones, which is theoretically consistent.

Keywords: meat; Almost Ideal Demand System; seemingly unrelated regressions; Egypt

Cet article analyse la demande en viande, en Egypte pour la période 1990–2005 à l'aide du système A.I.D.S. linéarisé, afin d'évaluer les élasticités en matière de dépense, de prix croisé et de prix de l'offre. L'étude a montré que l'élasticité marshallienne du prix de l'offre était la plus élevée pour le poisson, suivie du poulet, du bœuf et du canard. D'autre part, l'élasticité du prix croisé pour le bœuf a révélé une relation complémentaire avec les autres types de viande, excepté pour le poisson, qui est substitutive. Le poulet et le poisson ont montré une relation substitutive avec tous les autres types de viande. Le canard a montré une relation substitutive avec toutes les viandes excepté le lapin. Le mouton et le lapin ont montré une relation versatile avec les autres types de viande. La relation substitutive la plus importante est celle entre le mouton et le bœuf. Les estimations de l'élasticité du prix de l'offre compensé ont révélé des tendances similaires avec cependant des valeurs moindres que celles non compensées, ce qui en théorie demeure cohérent.

Mots-clés : *viande ; Système A.I.D.S. (Almost Ideal Demand System) ; régressions apparemment sans lien ; Egypte*

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1. Introduction

A wide range of factors, notably globalization and economic growth, have changed the lifestyle of developing countries in general, and Egypt in particular, in the direction of western or developed countries' lifestyles and diets. Such factors have not only increased meat consumption but also changed meat consumption patterns.

The way consumers allocate consumption expenditure among goods and services is of particular interest to economists. In developed countries, meat demand has been studied extensively. In developing countries, however, studies of this topic are often restricted by the data insufficiency of the past decades.

In reviewing studies of meat demand in Egypt we noted two points. Firstly, these studies divided meat into three major categories, red meat, white meat and fish, ignoring the estimation of demand parameters of each category's components (e.g. Mohamed, 2000; Ragab, 2005). As such classification gives only general estimates, it does not produce an accurate or detailed specification of meat demand in Egypt. Secondly, the adopted methodology concentrated only on the estimation of a single demand equation even though there are doubts about the reliability of the results obtained by this method.

The main aim of this paper is to produce more reliable demand parameter estimates of meat in Egypt. The reliability may be achieved by addressing the two points of weakness mentioned above. We therefore adopted the Linear Approximated Almost Ideal Demand System (LA/AIDS) methodology to estimate the demand for all meat types in Egypt. This methodology is concerned mainly with estimating own-price, cross-price and expenditure elasticities. The AIDS specification proposed by Deaton and Muellbauer (1980) is commonly used to estimate the price and income elasticities of the demand for goods when expenditure share data are available.

2. Data

Seven main types of meat are consumed in Egypt: beef, mutton, rabbit, chicken, duck, turkey and fish. The study excludes turkey as consumption of this meat is very low and there is insufficient data, and pork is not included because most Egyptian people are Muslims.

The data used for the econometric estimation are annual and were constructed by the authors on the basis of FAO statistics (FAO, undated) and publications of the Egyptian Ministry of Agriculture (MoA, various dates). The study covers the period 1990 to 2005.

3. Characteristics of meat consumption in Egypt

The FAO statistics show that in 2005 the daily per capita protein consumption in Egypt in 2005 was 107 gm/capita/day. Only 15.1 gm were of animal origin, distributed as 4.73 gm from red meat, 5.77 gm from poultry, 0.7 gm from milk and 3.91 gm from fish.

Figure 1 shows that for the past two decades, with few exceptions, the annual per capita consumption of meat has been increasing gradually. Consumption of red meat increased with some fluctuations from 10.13 kg/capita/year in 1990 to 14.6 kg/capita/year in 2000. There was a noticeable decrease between 2001 and 2005, down to 12.14 kg/capita/year in 2001, with a further decrease to 11.38 kg/capita/year by 2005.One of the main reasons for this was Bovine Spongiform Encephalopathy (BSE, widely known as 'mad cow disease'). Although the first BSE case was detected in 1986 in the UK, the disease caused fear among consumers in Egypt in 2001 and significantly decreased the demand for beef, and there were governmental polices restricting the import of beef from the infected markets.

White meat showed a gradual increase in per capita consumption through the period 1990–2005, from 4.64 kg/capita/year in 1990 to 12.12 kg/capita/year in 2005 – an increase of 0.5 kg/capita/year on average. The highest values reached in 2001 and 2002, 13.2 kg/capita/year and 13.3 kg/capita/year respectively, were probably due to the dramatic reduction in beef demand caused by BSE. The annual per capita consumption of fish showed significant increase, almost doubling from 7.98 kg/capita/year in 1990 and to 15.55 kg/capita/year in 2005 – an increase of 0.51 kg/capita/year on average. The steep increase in 2001 was probably also due to the drop in demand for beef because of BSE.

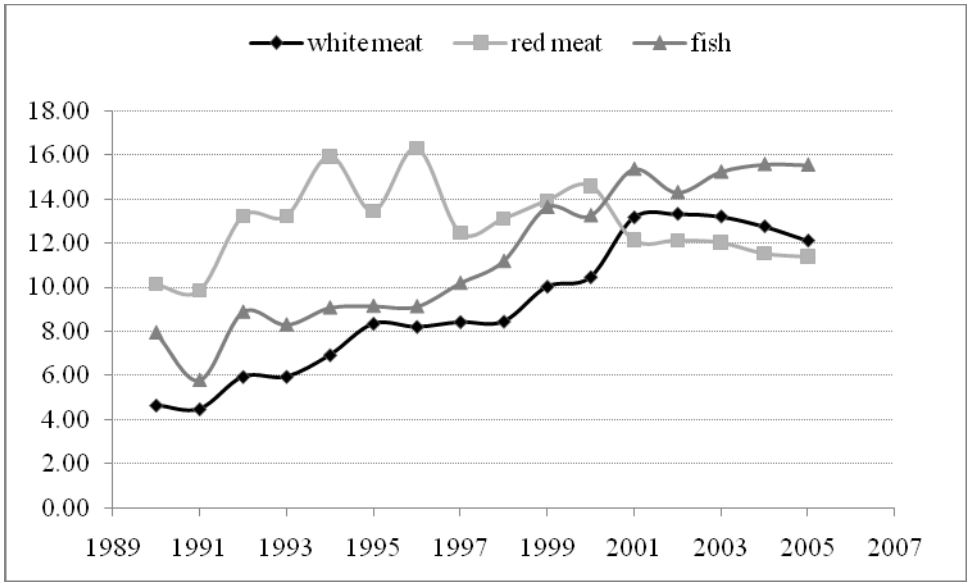

Figure 1: Per capita meat consumption in Egypt (1990–2005)

Table 1 shows the expenditure shares for each type of meat. The highest expenditure share is for beef (0.388), followed by fish (0.34), which implies that beef and fish represent about 73% of the total expenditure on all types of meat in Egypt.

Table 1: Summary statistics of expenditure shares for meat consumption (1990-2005)

Meat	Mean	Minimum	Maximum	SD
Beef	0.388	0.286	0.468	0.042
Chicken	0.135	0.065	0.168	0.034
Mutton	0.062	0.031	0.085	0.019
Duck	0.041	0.031	0.050	0.006
Fish	0.341	0.291	0.430	0.036
Rabbit	0.033	0.026	0.041	0.004

4. Methodology

Alston and Chalfant (1993) state that two demand systems have gained prominence in demand analysis, especially in the field of agricultural economics: the Almost Ideal Demand System (AIDS) and the Rotterdam model. Deaton and Muellbauer (1980) convert the nonlinear AIDS into a simplified linear AIDS (LA/AIDS) model by using the Stone's price index to replace the nonlinear price index. Because of its simplicity and lighter computational burden, this model is very popular for empirical demand analysis (Green & Alston, 1990).

This study therefore adopted the LA/AIDS model. We estimate the system of equations using the Restricted Seemingly Unrelated Regression (RSUR) method with the homogeneity and symmetry conditions imposed. The procedures for the model estimation are as follows.

Assume the AI expenditure share equation

$$\omega_i = \alpha_i + \sum_j \gamma_{ij} \ln P_j + \beta_i \ln\left(\frac{X}{P^\circ}\right) + \mu_{ij} \qquad (1)$$

where ω_i represents the share allotted to i^{th} good out of group expenditure $(i = 1,2,...,n)$, P_j is the nominal price of the j^{th} good, X is the total expenditure, α_i, γ_{ij} and β_i are RSUR parameter estimates for the LA/AIDS model, μ_i is the random or error term., and P° is the translog price index defined by

$$\ln(P^\circ) = \alpha + \sum \alpha_j \ln P_j + \frac{1}{2}\sum_i^n \sum_j^n \gamma_{ij} \ln P_i \ln P_j \qquad (2)$$

It is clear that the translog price index complicates the model. Deaton and Muellbauer (1980) suggested the Stone's price index, which can be used instead of the translog price index that is defined as follows:

$$\ln P^{\circ} = \sum_{i=1}^{n} \omega_i \ln P_i \qquad (3)$$

If we substitute the Stone's price index (equation 3) for the translog price index in equation 1, we then have

$$\omega_i = \alpha_i + \sum_j \gamma_{ij} \ln P_j + \beta_i (\ln X - \sum_{i=1}^{n} \omega_i \ln P_i) + \mu_i \qquad (4)$$

As can be seen in equation 4, this substitution causes a simultaneity problem, because the dependent variable (ω_i) also appears on the right-hand side of the LA/AIDS. Eales & Unnevehr (1988, 1994) suggested using the lagged share ($\omega_{i,t-1}$) for equation 4. Replacing equation 3 with the lagged shares in equation 1 yields the LA/AIDS, given by

$$\omega_i = \alpha_i + \sum_j \gamma_{ij} \ln P_j + \beta_i (\ln X - \sum_{i=1}^{n} \omega_{i,t-1} \ln P_i) + \mu_i \qquad (5)$$

Since budget shares sum to one, we impose the following set of restrictions on the parameter of the AIDS model:

1) Adding up implies: $\sum_{i=1}^{n} \alpha_i = 1 \qquad \sum_{i=1}^{n} \beta_i = 0 \qquad \sum_{i=1}^{n} \gamma_{ij} = 0$

   Then it follows that $\sum_{i=1}^{n} \omega_i = 1$, which is obvious from equation 1.

2) Homogeneity requires that $\sum_{j=1}^{n} \gamma_{ij} = 0$.

3) Symmetry is satisfied if $\gamma_{ij} = \gamma_{ji}$ for any two goods *i* and *j*.

As the present study focuses on the response of the demand for different meat types to changes in price and expenditure, the elasticities have been calculated at the sample mean of expenditure shares. The uncompensated (Marshallian) own-price elasticities

(ε_{ii}) and cross-price elasticities (ε_{ij}) can be derived respectively as (see Alston et al., 1994):

$$\varepsilon_{ii} = -1 + \frac{\gamma_{ii}}{\omega_i} - \beta_i \quad (6)$$

$$\varepsilon_{ij} = \frac{\gamma_{ij}}{\omega_i} - \beta_i \frac{\omega_j}{\omega_i}, i \neq j \quad (7)$$

The formula used to calculate the expenditure elasticities can be written as:

$$\eta_i = 1 + \frac{\beta_i}{\omega_i} \quad (8)$$

A positive value suggests that good i is normal. The income compensated or net (Hicksian) own-price elasticities (ℓ_{ii}) and cross-price elasticities (ℓ_{ij}) respectively are obtained by applying the Slutsky decomposition to (8) and using the price index in (3). These can be written as

$$(\ell_{ii} = -1 + \frac{\gamma_{ii}}{\omega_i} + \omega_i \quad (9)$$

$$\ell_{ij} = \frac{\gamma_{ij}}{\omega_i} + \omega_j, i \neq j \quad (10)$$

Consumer theory suggests that compensated own-price elasticities are negative for normal goods. Moreover, if (7) and (10) are positive the two goods are cross substitutes, otherwise they are complements.

Using the Slutsky equation again, it is possible to derive a relationship between the compensated cross-price elasticities and the expenditure elasticities as follows:

$$\varepsilon_{ij} = \omega_j \sigma_{ij} - \omega_j \eta_i \quad (11)$$

where σ_{ij} are the partial elasticities of substitution, also known as the Allen elasticities of substitution.

$$\sigma_{ij} = 1 + \frac{\gamma_{ij}}{\omega_i \omega_j} \quad i \neq j \tag{12}$$

The sign of σ_{ij} determines whether the goods i and j are complements or substitutes. If σ_{ij} is positive the two goods are substitutes, whereas if it is negative the two goods are complements.

5. Empirical results

This section describes the results of two tests: the time series properties, derived from the well-known Augmented Dickey-Fuller (ADF) test (Dickey & Fuller, 1979) that establishes whether the time series of all variables are stationary or not, and the empirical results from the structural breaks test.

5.1 Time series properties

Each time series variable included in a model should be tested for its time series properties. We used two tests to investigate the time series properties of the dataset: the unit root test, to examine the stationarity of the dependent variables, and the structural breaks test to examine the expenditure share variables (dependent variables) over the time series.

Unit root test

This tests whether a time series variable is non-stationary, using an autoregressive model. The Augmented Dickey-Fuller test constructs a parametric correction for higher-order correlation by assuming that the series follows an AR(k) process and adding the lagged difference terms of the dependent variable to the right-hand side of the test regression:

$$\Delta y_t = c + \alpha y_{t-1} + \sum_{j=1}^{k} d_j \Delta y_{t-1} + \varepsilon_t \tag{13}$$

Equation 13 tests for the null of a unit root against a mean-stationary alternative in y_t where y refers to the time series examined. The test results are presented in Table 2. The results confirmed that the null hypotheses are rejected for all variables. Consequently, all the variables used in the LA/AIDS model are integrated to the order one I(1), which means the time series of all variables are stationary at the difference one.

Table 2: Unit root test results for meat expenditure shares in Egypt (1990–2005)

Variable	Budget shares		Prices	
	Lags	Test statistics	Lags	Test statistics
Beef	5	-1.38	5	-1.95
Chicken	5	-2.17	5	-2.21
Mutton	5	-1.07	4	-2.01
Ducks	4	-1.64	4	-1.88
Fish	5	-1.25	5	-2.30
Rabbits	5	-2.51	3	-3.95
Expenditure	5	-0.83		

Note: 95% critical value for the augmented Dickey-Fuller statistic = -3.9949. The order is selected by the Akaike Information Criterion (AIC).

Structural breaks test

Jha and Sharma (2001) state that structural breaks are a result of some event significantly affecting the variables being studied. Such breaks can lead to a permanent shift in the level or slope (or both) of the series but the basic nature of the series remains unchanged.

To detect periods in which structural breaks occur, we examined a set of residuals from the fitted LA/AIDS share equations (equation 5), and the structural breaks are then the period(s) where the residuals exceeded two standard deviations.

Table 3: Structural breaks of the expenditure share for meat in Egypt (1990–2005)

Year	Beef	Chicken	Mutton	Duck	Fish
1990	-	-	-	-	-
1991	-0.155	-0.305	-0.036	-0.140	0.457
1992	0.602	0.309	-0.361	0.133	-0.946
1993	0.371	0.025	0.407	0.137	-0.514
1994	-0.660	0.441	0.109	0.389	0.192
1995	-0.527	-0.010	-0.290	0.065	0.573
1996	-0.085	-0.079	-0.397	-0.556	0.378
1997	-0.277	-0.552	-0.360	-0.225	0.896
1998	-0.452	-0.070	-0.379	-0.250	0.717
1999	-0.095	0.324	-0.500	0.212	-0.297
2000	-0.813	0.050	-0.115	0.311	0.725
2001	1.718	-0.194	0.269	0.129	-1.882
2002	0.597	-0.019	-0.169	-0.095	-0.518
2003	0.333	0.014	-0.562	0.155	-0.396
2004	0.264	0.147	-0.583	-0.117	-0.383
2005	-0.856	-0.088	0.296	-0.144	1.023

The results presented in Table 3 show that there are no structural breaks within any period of the expenditure share variables (dependent variables). The maximum break in beef occurred in 2001, as expected, by 1.718. Consequently, the maximum breaks occurred in the same year for fish, by -1.882. Moreover, all other expenditure share variables did not even reach 1 or -1.

Table 4: Parameter estimates for the restricted linear approximate AIDS model for meat demand in Egypt during the period 1990-2005

Explanatory variables	Dependent variables					
	Beef	Chicken	Mutton	Duck	Fish	Rabbit
Beef	0.187					
	*(3.639**)*					
Chicken	-0.054	0.052				
	*(-3.981**)*	*(3.427**)*				
Mutton	-0.069	0.014	0.112			
	*(-7.384**)*	*(1.754)*	*(7.109**)*			
Duck	-0.014	-0.001	-0.009	0.036		
	*(-3.763**)*	*(-0.287)*	*(-2.016)*	*(14.526**)*		
Fish	-0.033	-0.007	-0.048	-0.013	0.112	
	(-0.6251)	*(-0.273)*	*(-4.898**)*	*(-2.134*)*	*(1.604)*	
Rabbit	-0.016	-0.003	0.001	0.001	-0.010	0.029
	*(-5.474**)*	*(-1.104)*	*(0.366)*	*(0.691)*	*(-1.931)*	
Expenditures	-0.099	0.087	-0.078	-0.018	0.119	-0.011
	(-2.581)*	*(5.3201**)*	*(-12.751**)*	*(-5.111**)*	*(2.562*)*	
CONSTANT	1.769	-1.090	1.163	0.310	-1.350	0.198
	(3.242)*	*(-4.560**)*	*(12.858**)*	*(5.929**)*	*(-2.027)*	
R^2	0.54	0.94	0.98	0.94	0.36	
DW	1.81	1.93	1.54	1.38	1.77	
EL	32.39	52.71	68.76	76.33	32.01	
SL	337.28					
AIC	312.28					

Note: t-ratio are in parentheses where *, and ** denote significant at 0.05 and 0.01 respectively.
The t-ratio do not appear for coefficients which have been obtained using relevant restrictions.
EL refers to equation log-likelihood, SL is the system log-likelihood, and AIC is the Akaike Information Criterion.

5.2. Empirical results of the model

The model was estimated using the iterative Restricted Seemingly Unrelated Regression (RSUR) procedures (Zellner, 1962) with Microfit version 4. The set of restrictions led to a singular variance/covariance matrix. Therefore, to avoid the singularity problem, one of the share equations was dropped from the system, the rabbit share equation, which represents the lowest expenditure share on average.

The results of the RSUR system are shown in Table 4. The majority of the estimated equations contain a number of statistically significant coefficients, and overall the model fits the data well. The determination coefficients R^2s are 0.54, 0.94, 0.98, 0.94 and 0.36 for beef, chicken, mutton, duck and fish respectively. The impacts of consumer expenditure on the demand share of chicken and fish meat are positive, but negative for all other meats. In addition, the expenditure impact is significant at level 0.01, except for beef and fish which are significant at 0.05. We can therefore reasonably conclude that the parameter of expenditure reflects the impact of expenditure on budget share rather than quantity demanded. The detailed expenditure elasticities are presented in Table 5.

The estimates of Marshallian own-price elasticities and expenditure elasticities are given in Table 5. The own-price elasticities are found to be negative, as expected, except for mutton. The reason for this unexpected sign may be religious practices, as most Muslims butcher sheep or goats for the Adha feast, i.e. the reason is a cultural rather than an economic one that would suppose the consumer is responding rationally to price changes. Regarding the other elasticities, fish showed the highest own-price elasticity, followed by chicken, beef and duck.

Regarding the cross-price elasticities, beef showed a complementary relationship with the other meat types except with fish as the relation is substitutive. Chicken and fish showed a substitutive relationship with all other meat types. Duck showed a substitutive relationship with all meats except with rabbits. Mutton and rabbit showed a versatile relationship with the other meat types. The highest substitutive relationship was between mutton and beef.

The calculated expenditure elasticities using equation 8 are positive except for mutton. This positive sign implies that meat of different types can be considered normal goods. The expenditure elasticities for chicken (1.65) and fish (1.35) are greater than one, which implies that they can be considered luxury goods. On the other hand, beef, duck and rabbit are less than one, which implies that they are necessary goods. It is important to mention that a high percentage of ducks and rabbits are home produced and consumed, especially in rural areas. Consequently, their response to the income changes is somewhat weak.

Table 5: Uncompensated (Marshallian) price and expenditure elasticities of Egyptian Meat, LA/AIDS Model (1990 -2005)

	Beef	Chicken	Mutton	Ducks	Fish	Rabbits
Beef	**-0.420**	-0.432	-1.108	-0.335	-0.202	-0.189
Chicken	0.142	**-0.704**	0.258	-0.020	-0.320	0.118
Mutton	0.037	-0.089	**0.886**	-0.213	-0.797	0.045
Duck	0.116	-0.299	-0.028	**-0.104**	-1.038	0.052
Fish	-0.074	-0.086	-0.768	-0.319	**-0.792**	-0.089
Rabbit	0.975	-0.380	0.165	0.052	-1.253	**-0.127**
Expenditure	0.745	1.645	-0.254	0.547	1.348	0.660

Note: The bold values are the own-price elasticities, the others are the cross-price elasticities.

The compensated own-price elasticity estimates in Table 6 show similar trends but smaller values than uncompensated ones, which is theoretically consistent. This result indicates that the income effect on the own quantities demanded of beef, chicken, mutton, duck, rabbit and fish is very significant for the purchaser.

Table 6: Compensated (Hicksian) elasticities of Egyptian meat, LA/AIDS model (1990–2005)

	Beef	Chicken	Mutton	Ducks	Fish	Rabbits
Beef	**-0.131**	-0.014	-0.733	0.051	0.290	-1.568
Chicken	-0.005	**-0.482**	0.358	0.110	0.115	1.320
Mutton	-0.117	0.164	**0.870**	-0.163	-0.080	0.459
Duck	0.005	0.033	-0.107	**-0.082**	0.002	0.484
Fish	0.256	0.290	-0.441	0.021	**-0.332**	-0.590
Rabbit	-0.008	0.009	0.053	0.063	0.004	**-0.105**

6. Conclusions

The results show that the Marshallian own-price elasticity was the highest for fish, followed by chicken, beef, and duck. On the other hand, the cross-price elasticities of beef showed a complementary relationship with the other meat types, except with fish as the relationship is substitutive. Chicken and fish showed a substitutive relationship with all other meat types. Duck showed a substitutive relationship with all meat types except rabbit. Mutton and rabbit showed a versatile relationship with the other meat types. The highest substitutive relationship is between mutton and beef. Compensated own-price elasticity estimates show similar trends but smaller values than uncompensated ones, which is theoretically consistent.

The calculated expenditure elasticities are positive except for mutton, which implies that meat of different types can be considered normal goods. The expenditure elasticities for chicken and fish show they are luxury goods. On the other hand, beef, duck and rabbit are necessary goods.

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