DEMAND FOR MEAT IN THE MIDDLE EAST

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Previous research on the meat markets of the Middle East has focused on sheep meat, especially the live sheep trade. However, there have been some changes in the nature of the demand for meat in the region following the increase in oil wealth and the growth of the expatriate population. Of particular note is an apparent shift away from sheep meat toward poultry in some Middle Eastern countries.

This paper contains an econometric analysis of the demand for sheep meat, beef and poultry in the Middle East, using the Almost Ideal Demand System (AIDS) with a partial adjustment component. Despite some problems with data collection and reliability, the main objective of the paper, to provide some representative estimates of price elasticities of demand, is achieved.

This research was partly funded by a grant from the Australian Meat and Live-Stock Research and Development Corporation.
Meat consumption patterns in the Middle East vary greatly between countries and between local and expatriate populations. The variability is associated with the large income differences between countries, the population composition of individual countries and local customs.

During the past two decades meat consumption patterns have changed markedly with the advent of oil wealth and high population growth rates by world standards. Increase in the demand for meat by the region has been met largely by carcass and live imports, and it is likely that the Middle East will remain heavily reliant upon overseas supplies of sheep meat, beef and, to a lesser extent, poultry. Over the 1980s the Middle East has accounted for an annual average of 16 per cent of Australia's mutton exports, 55 per cent of our lamb exports and almost all of our live sheep trade (ABARE 1988). Although Australia is not a major supplier of beef to the Middle East, any significant shifts in demand for beef in the Middle East will still be of interest to Australia if they affect trade flows and prices in parts of the world where Australia is a major supplier of beef.

Previous research on the Middle East meat market has concentrated on sheep, particularly sheep meat production and consumption trends and Australia's export trade in live sheep and sheep meat to this region (Blyth 1981; Department of Primary Industries 1982; Bureau of Agricultural Economics (BAE) 1983). Recognising the changes which have taken place in meat consumption, this study is an econometric analysis of the demand for beef and poultry as well as sheep. The objective is to derive representative price elasticities of demand for beef, sheep meat and poultry for the Middle East region.

Background

The increase in demand for meat in the Middle East over the past two decades has not been matched by the increase in domestic production. Opportunities for livestock production are limited due to the harsh environmental and climatic conditions. In some countries the government is encouraging domestic production by subsidising inputs and by financing schemes to encourage better livestock management than the traditional nomadic sheep and goat herding (BAE 1983). Despite some significant increases in domestic meat production, notably intensive poultry production, total meat imports have steadily increased.

Imports of beef, sheep meat and poultry have not grown uniformly. From Figure 1, which shows total estimated meat imports by six Middle Eastern states (Saudi Arabia, Kuwait, Egypt, the United Arab Emirates, Israel and Turkey), it is clear that poultry imports peaked in 1981, at a level three times that of 1977. Poultry imports have since stabilised at around 400 kt a year. Beef imports increased threefold between 1977 and 1987. By comparison, growth in sheep meat imports for the same group of countries was modest.

Growth in per person meat consumption has been fairly stable across the region, with the exception of Saudi Arabia. Where it has increased from 10-20 kg per annum in the early 1970s to 60-76 kg per annum in the mid-1980s (Figure 2). In the oil-rich Gulf states (Saudi Arabia, Kuwait and the United Arab Emirates) apparent meat consumption per person is now in the range of 50-80 kg a year (Figure 2). This is in strong contrast to the less affluent countries, for example Egypt and Turkey, where per person consumption is 10-20 kg per annum (Figure 3). By way of comparison, Australians consume around 100 kg per person of meat each year (ABARE 1988).
The oil producing countries have experienced the greatest changes in the types of meat consumed. While the indigenous populations of these countries are heavily influenced by custom, there has been a large influx of expatriates with diverse ethnic backgrounds and differing preferences for meat. The Arabs have a strong preference for fresh sheep meat from local herds (fat tailed sheep), though there is growing acceptance of chilled meat as a substitute for fresh. Imported frozen meat is the least preferred form of meat among the indigenous populations and is mostly consumed by a different market segment, namely, the catering sector (BAE 1983). In the non-oil-producing Middle Eastern countries the changes in meat consumption patterns have been less significant. Fresh sheep meat still accounts for a high proportion of total meat consumption, as has traditionally been the case.
FIGURE 3 - Apparent Annual Consumption per person

FIGURE 4 - Apparent Meat Consumption 1977 and 1986
Figure 4 shows the percentage market shares held by beef, sheep meat, poultry and pig meat for eight Middle Eastern countries, and Australia as a point of reference, in 1977 and 1986. Sheep meat is not the dominant meat type consumed in all of these countries. In Israel and Egypt, sheep meat's share is far less than that of beef or poultry. In the Arab countries (Saudi Arabia, Kuwait and the United Arab Emirates), the market share held by beef has stayed at around 10 per cent, with the remainder of the market divided fairly equally between sheep meat and poultry. In the non-Arab countries there appears to have been a trend away from sheep meat in favour of poultry, a comparatively new item in local diets.

Methodology

Data sources and compilation

Obtaining consistent and reliable data for Middle Eastern countries is difficult. For this reason it was necessary to select eight countries to represent the Middle East: Saudi Arabia, United Arab Emirates, Kuwait, Israel, Iran, Iraq, Egypt and Turkey. These eight countries accounted for 86 per cent of the region's population during the period 1970 to 1987.

Three meat types were considered in this study: beef, sheep meat and poultry. Pig meat was not included because negligible amounts are consumed in the Middle East region as a whole. For each meat type, data on domestic production (volume), live imports (volume and landed value) and carcass imports (volume and landed value) were compiled. Unit values were then computed for live and carcass imports. (It was worthwhile making the distinction between the price of carcass and live imports because the latter are preferred by indigenous consumers.) These unit values were used as proxies for the import prices of sheep meat, beef and poultry. The unit values of live sheep and beef imports were used as proxies for the local prices of these products as well as for the prices of live imports, because reliable local price data were not available. Since there are no live poultry imports, the unit values of carcass poultry imports were used as proxies for local poultry prices.

Because it was not possible to distinguish between the price of live imports and the price of local fresh produce, each meat type was aggregated across origin (domestic or imported) and 'state' (live or dead). A weighted average price was then calculated. Unfortunately, the use of a weighted average price meant that separate price elasticities of demand for each meat type categorised by origin and state could not be derived. It is also possible that the above aggregations may introduce some unavoidable imprecision because governments typically subsidise or impose price ceilings on live imports, while there are no price controls on local fresh product. (The type of meat subsidised and the level of subsidy varies from country to country: BAE 1983.) Furthermore, the final elasticities may mask the apparently strong preference for domestically grown meat by some indigenous populations, particularly those with a relatively small component of expatriates.

Import, export and production data were obtained from the Food and Agriculture Organisation (1987a,b), and the exchange rates, consumer price index and gross national product figures used were those compiled by the International Monetary Fund (1988). Livestock imports were converted into their carcass weight equivalents using uniform conversion factors (0.67 for beef and 0.52 for sheep).
The model

The demand for meat in the Middle East was estimated as a separable two-stage system using an extension of the Almost Ideal Demand System (AIDS) developed by Deaton and Muellbauer (1980). The assumption of separability reduced the number of model parameters by restricting the substitution relationships between meat and other commodities. In the first stage, aggregate income was allocated between expenditures on meat and all other commodities. In the second stage, expenditure on meat was allocated between beef, chicken and sheep meats.

The AIDS is a flexible functional form derived from the expenditure function for the price independent generalised log (PIGL) class of preferences. The key feature of the AIDS model is that the theoretical restrictions of homogeneity and symmetry may be imposed to further reduce the number of model parameters to be estimated. The potential gains in estimation efficiency achieved through the structural reduction of the model are at the expense of estimation bias if the assumptions are not valid.

The AIDS model may be generalised to incorporate partial adjustment dynamics. The derivation is similar to that for the translog cost function developed by Ball, Beare and Harris (1989). The dynamic specification may be derived from a consumer's cost or expenditure function. An expenditure function $E(u,p)$ is defined as the minimum expenditure necessary to attain a level of utility $u$ at a given price vector $p$. A partial adjustment expenditure function may be written as:

\[ E_t = E(u^*, p_t) (1-\alpha) \prod_{i} q_{it-1}^{\alpha} \]

where $u^*$ is a desired long run level of utility, $q$ is a quantity demanded and $\alpha$ is a partial adjustment parameter. The first term represents a desired level of expenditure given $u^*$ and current prices. The second term is the expenditure required to maintain previous consumption levels at current prices.

The Hicksian compensated demand functions may be derived by applying Shepard's lemma and the product rule. For each expenditure category (type of meat) denoted by $i$, these demand functions are of the following form:

\[ \frac{\partial E_t}{\partial p_{it}} = h_{it}'(u^*, p_t) \frac{E_t}{E(u^*, p_t)} h_{i}'(u^*, p_t) + \alpha \frac{E_t}{\sum_{j} q_{jt}q_{jt-1}} q_{it-1} \]

where:

\[ h_{i}'(u^*, p_t) = \frac{\partial E(u^*, p_t)}{\partial p_{it}} \]

It is straightforward to show that the compensated demands are symmetric with respect to prices if the functions $q'(u^*, p)$ are symmetric with respect to prices. The uncompensated or Marshallian demands can be derived by substituting for $u^*$ using the budget constraint:

\[ q_i = (1-\alpha)q_i^*(p_{t}, m) + \alpha \frac{10}{\sum_{j} q_{jt}q_{jt-1}} q_{t-1} \]
where \( m \) is income. It may be shown that the uncompensated demands are homogeneous of degree zero and satisfy the budget constraint if the functions \( q^*(p,m) \) are homogeneous of degree zero and satisfy the budget constraint.

The model may be expressed in budget share form. Taking the derivative of the log of the expenditure function with respect to the log of price and using the budget constraint to substitute for \( w^* \):

\[
(4) \quad w_i = (1-\alpha)w_i^*(p_t,m) + \alpha \frac{p_{it}q_{it}^{\alpha-1}}{\sum_{j} p_{jt}q_{jt}^{\alpha-1}}
\]

where \( w \) denotes a budget share. Again, homogeneity, symmetry and adding up restrictions are met if \( w^* \) meets the corresponding restriction (more details are provided in the Appendix).

For the AIDS functional form proposed for this analysis, the budget share equation may be written as:

\[
(5) \quad w_{ikt} = (1-\alpha)[\beta_{ik0} + \sum_{j} \beta_{ij} \ln(p_{jkt}) + \beta_{iy} \ln(y_{kt}/P^*_k)] + \alpha \frac{p_{ik}q_{ikt}^{\alpha-1}}{\sum_{j} p_{jkt}q_{jkt}^{\alpha-1}}
\]

where \( i \) denotes the expenditure category, \( k \) denotes country, \( y \) is expenditure on meat and \( P^*_k \) is a price index. The unknown true price index was approximated by Stone's geometric price index, written as:

\[
P^*_k = \prod_{j} w_{jkt} p_{jkt}
\]

This choice of a price index makes estimation less complicated by avoiding inherent nonlinearities. The approximation is most accurate when individual prices are closely collinear (Deaton and Muellbauer 1980).

The theoretical restrictions are applied directly to the parameters. These are:

\[
\begin{align*}
\sum_{j} \beta_{ij} &= 0 \quad \text{homogeneity} \\
\sum_{i} \beta_{ik0} &= 1, \sum_{i} \beta_{iy} &= 0 \quad \text{adding up} \\
\beta_{ij} &= \beta_{ji} \quad \text{symmetry}
\end{align*}
\]

The own- and cross-price elasticities are time dependent. Formulas for the expenditure-held-constant price elasticities and the expenditure elasticities are:

\[
(6) \quad \eta_{ii}(t) = (1-\alpha)(\frac{\beta_{ii}}{\sum_{i} \beta_{ii}} - \beta_{iy} - 1) \quad \text{own-price}
\]
These formulas are exact in both the short and the long run (t=1 and t→∞); otherwise they are an approximation.

To obtain estimates of price elasticities when expenditure is not held constant (gross elasticities) it is necessary to consider the effect of a price change on meat expenditure. An ancillary expenditure equation with a lagged dependent variable was added to the model:

\[ \text{ln} y_{kt} = (1-\lambda) (\gamma_{ko} + \gamma_{1} \text{ln} \frac{p_{kt}^{*}}{cpi_{kt}} + \gamma_{2} \text{ln} \frac{gdpp_{kt}}{cpi_{kt}}) + \lambda \text{ln}(y_{kt-1}) \]

where the consumer price index is used as a proxy for the price of all other goods and gross domestic product is used a proxy for consumer income. An additional dummy variable was used for consumer income in Kuwait because gross domestic product data were unavailable. Gross national product was used instead of gross domestic product in Kuwait.

Formulas for the short run gross price elasticities can be derived by the application of the quotient rule:

\[ \epsilon_{ij}(t=1) = \frac{\partial q_{i}}{\partial p_{j}} \left[ \frac{p_{j}}{w_{i}} \frac{\partial E}{\partial p_{j}} + E \frac{\partial w_{i}}{\partial p_{j}} \right] - \frac{w_{i}E}{q_{i}} \]

to yield:

\[ \epsilon_{ij}(t=1) = (1-\lambda) \gamma_{1} w_{i} + (1-\alpha) \left[ \frac{\beta_{ij}}{w_{i}} + \beta_{iy} w_{j} ((1-\lambda) \gamma_{1} - 1) \right] \]

\[ \epsilon_{ij}(t=1) = (1-\lambda) \gamma_{1} w_{i} + \frac{1-\alpha}{w_{i}} \left[ \beta_{ij} + \beta_{iy} w_{j} ((1-\lambda) \gamma_{1} - 1) \right] \]

The income elasticity is given by:

\[ \epsilon_{iy}(t=1) = (1-\lambda) \frac{\gamma_{1}}{w_{i}} \left[ w_{i} + \beta_{iy} (1-\alpha) \right] \]

Longer run elasticities may be computed numerically.
The AIDS subsystem (equation 5) was initially estimated with annual data for the eight countries selected to represent the Middle East over the period 1970 to 1987. The system was estimated using an iterative Seemingly Unrelated Regression method available in SAS. For each country and type of meat, own- and cross-price elasticities of demand were computed numerically at the sample means. The standard errors (asymptotic) for these elasticities were computed numerically from Monte Carlo simulations because the elasticities are nonlinear functions of the coefficients. The estimated variance-covariance matrix of the model coefficients was used in the simulations. The own-price elasticities for each country were all significant, though the existence of a few positive price elasticities brought into doubt the validity of elasticities derived for each country separately. This suggested that grouping the countries together could yield a more reliable set of elasticity estimates for the region.

When the eight countries were grouped together the price and expenditure coefficients were restricted to be equal across countries, while the intercept parameters were allowed to vary across countries. The model estimates yielded credible own-price elasticities, but the estimates of the cross-price elasticities suggested some complementarity between meat types. It was apparent that the specification process needed still further refinement, and examination of the normalised residual plots indicated that the pooling of data across some countries and time periods was not appropriate. There was a large number of significant outliers throughout the sample period in both Turkey and Saudi Arabia, which raised questions about the quality of the data for these two countries. In addition, there appeared to be problems in the early part of the sample for Iraq, Israel, Kuwait and the United Arab Emirates, for which the most likely explanation was political turbulence in the early 1970s.

The demand system was re-estimated with Turkey and Saudi Arabia excluded. These countries were excluded because the apparent problems with data quality seemed to outweigh the costs of having fewer observations. The remaining observations were for the period 1970 to 1987 for Egypt, Iran and Israel; 1977 to 1987 for the United Arab Emirates and Kuwait; and 1975 to 1987 for Iraq. The parameter estimates, standard errors and model diagnostic statistics are shown in Table 1. The parameters not estimated by the system can be deduced using the properties of homogeneity, adding up and symmetry. These are also shown in Table 1.

The double logarithmic expenditure equation (7) was estimated using OLS with pooled data and additive dummy variables for each country. Income and consumer price index data were not available to construct a sample which exactly corresponded to the second-stage budget share estimates. Consequently, the expenditure equation was estimated using data pertaining to five countries: Israel (1974 to 1987), Egypt (1970 to 1987), Kuwait (1977 to 1986), Iran (1970 to 1985), and the United Arab Emirates (1977 to 1986).

The specification of the expenditure equation initially included a partial adjustment parameter. With this specification, the long run expenditure elasticity is given by the coefficient of the price series, and the short run elasticity can be computed using the long run elasticity and the adjustment parameter. The long run elasticity was estimated to be 1.00. Given that total meat expenditure is estimated to change only negligibly in the long run, the dynamic model was replaced with a straightforward static model. In the case of the static model the short run elasticity is given by the coefficient of the price series. This was estimated to be 0.66. The
results of the dynamic model (model 1) and the static model (model 2) are shown in Table 2.

Gross price elasticities were calculated using the parameter estimates obtained from the static expenditure equation and the AIDS model. These elasticities are time dependent. The short run, medium run and long run price elasticities are shown in Tables 3a, 3b and 3c respectively. The rates at which these elasticities converge to their long run values depend on the magnitude of the adjustment parameter estimated by the AIDS subsystem. The adjustment parameter was estimated to be 0.52. This means that over 70 per cent of total adjustment in demand will occur in the first two years after a price change. The adjustment path is shown in Figure 5. The income elasticities are presented in Table 4.

**TABLE 1**

Results of AIDS Model (Dynamic Specification)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Standard error</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constants ( (\beta_{ik0}) )</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Beef ((i=1))</td>
<td>0.665</td>
<td>0.109</td>
</tr>
<tr>
<td>Sheep ((i=2))</td>
<td>0.327</td>
<td>0.093</td>
</tr>
<tr>
<td>Poultry ((i=3))</td>
<td>0.009(a)</td>
<td></td>
</tr>
<tr>
<td>Own-price ( (\beta_{ii}) )</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Beef</td>
<td>0.149</td>
<td>0.022</td>
</tr>
<tr>
<td>Sheep</td>
<td>0.082</td>
<td>0.021</td>
</tr>
<tr>
<td>Poultry</td>
<td>0.082(a)</td>
<td></td>
</tr>
<tr>
<td>Cross-price ( (\beta_{ij}-\beta_{ji}) )</td>
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<td></td>
</tr>
<tr>
<td>Beef-sheep</td>
<td>-0.074</td>
<td>0.016</td>
</tr>
<tr>
<td>Beef-poultry</td>
<td>-0.073(a)</td>
<td></td>
</tr>
<tr>
<td>Sheep-poultry</td>
<td>-0.007(a)</td>
<td></td>
</tr>
<tr>
<td>Exponent ( (\beta_{iy}) )</td>
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<td></td>
</tr>
<tr>
<td>Beef</td>
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<td>0.040</td>
</tr>
<tr>
<td>Sheep</td>
<td>-0.086</td>
<td>0.035</td>
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<tr>
<td>Poultry</td>
<td>0.089(a)</td>
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<tr>
<td>Partial adjustment</td>
<td>0.520</td>
<td>0.054</td>
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</table>

(a) Derived from constraints.

Regression equation statistics

<table>
<thead>
<tr>
<th>Budget component</th>
<th>Mean square error</th>
<th>Durbin-Watson d</th>
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</thead>
<tbody>
<tr>
<td>Beef share</td>
<td>0.00143</td>
<td>2.477</td>
</tr>
<tr>
<td>Sheep share</td>
<td>0.00126</td>
<td>1.928</td>
</tr>
<tr>
<td>Poultry share</td>
<td>0.00183</td>
<td>2.140</td>
</tr>
</tbody>
</table>
**TABLE 2**

Results of Expenditure Equations

Model 1 (dynamic model):

\[ \ln \frac{y_{kt}}{\text{cpi}_{kt}} = (1-\lambda)\left[ \gamma_0 + \gamma_1 \ln \frac{p^{*}_{kt}}{\text{cpi}_{kt}} + \gamma_2 \ln \frac{\text{gdp}_{kt}}{\text{cpi}_{kt}} + \gamma_3 \ln \frac{\text{gnp}_{3t}}{\text{cpi}_{3t}} \right] + \gamma_4 \ln \frac{y_{kt-1}}{\text{cpi}_{kt}} \]

Model 2 (static model):

\[ \ln \frac{y_{kt}}{\text{cpi}_{kt}} = \gamma_0 + \gamma_1 \ln \frac{p^{*}_{kt}}{\text{cpi}_{kt}} + \gamma_2 \ln \frac{\text{gdp}_{kt}}{\text{cpi}_{kt}} + \gamma_3 \ln \frac{\text{gnp}_{3t}}{\text{cpi}_{3t}} \]

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Estimate</th>
<th>Standard error</th>
<th>t-ratio</th>
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<tr>
<td>Dynamic</td>
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<tr>
<td>700</td>
<td>7.4313</td>
<td>0.9303</td>
<td>7.988</td>
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<tr>
<td>710 (Israel)</td>
<td>1.0235</td>
<td>0.5664</td>
<td>1.807</td>
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<td>720 (Egypt)</td>
<td>0.8897</td>
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<td>1.379</td>
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<td>730 (Kuwait)</td>
<td>-0.7421</td>
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<td>-2.349</td>
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<td>740 (UAE)</td>
<td>-19.3142</td>
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<td>71</td>
<td>1.0013</td>
<td>0.0692</td>
<td>14.479</td>
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<tr>
<td>72</td>
<td>0.0656</td>
<td>0.0811</td>
<td>0.809</td>
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<td>73</td>
<td>1.8534</td>
<td>2.1158</td>
<td>0.876</td>
</tr>
<tr>
<td>\lambda</td>
<td>0.0606</td>
<td>0.0692</td>
<td>0.876</td>
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</table>

Diagnostics: $R^2 = 0.977$; $\bar{R}^2 = 0.973$

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Estimate</th>
<th>Standard error</th>
<th>t-ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Static</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>700</td>
<td>-3.1823</td>
<td>0.6154</td>
<td>-5.171</td>
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<tr>
<td>710 (Israel)</td>
<td>3.1942</td>
<td>0.2850</td>
<td>13.732</td>
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<td>720 (Egypt)</td>
<td>3.1615</td>
<td>0.3662</td>
<td>8.632</td>
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<td>730 (Kuwait)</td>
<td>3.5546</td>
<td>0.2103</td>
<td>16.902</td>
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<td>740 (UAE)</td>
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<td>71</td>
<td>0.6570</td>
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<td>72</td>
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<tr>
<td>73</td>
<td>-0.1241</td>
<td>0.2855</td>
<td>-0.435</td>
</tr>
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</table>

Diagnostics: $R^2 = 0.988$; $\bar{R}^2 = 0.987$
### TABLE 3a
Short Run (t-1) Own- and Cross-price Elasticities

<table>
<thead>
<tr>
<th>Demand for:</th>
<th>Elasticity with respect to price of:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Beef</td>
</tr>
<tr>
<td>Beef</td>
<td>-0.1793</td>
</tr>
<tr>
<td>Sheep</td>
<td>0.0328</td>
</tr>
<tr>
<td>Poultry</td>
<td>-0.0045</td>
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</table>

### TABLE 3b
Medium Run (t=3) Own- and Cross-price Elasticities

<table>
<thead>
<tr>
<th>Demand for:</th>
<th>Elasticity with respect to price of:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Beef</td>
</tr>
<tr>
<td>Beef</td>
<td>-0.3210</td>
</tr>
<tr>
<td>Sheep</td>
<td>0.0588</td>
</tr>
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<td>Poultry</td>
<td>-0.0081</td>
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### TABLE 3c
Long Run (t=7) Own- and Cross-price Elasticities

<table>
<thead>
<tr>
<th>Demand for:</th>
<th>Elasticity with respect to price of:</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Beef</td>
</tr>
<tr>
<td>Beef</td>
<td>-0.3696</td>
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<tr>
<td>Sheep</td>
<td>0.0677</td>
</tr>
<tr>
<td>Poultry</td>
<td>-0.0094</td>
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### TABLE 4
Income Elasticities

<table>
<thead>
<tr>
<th>Product</th>
<th>$\text{t=1}$</th>
<th>$\text{t=3}$</th>
<th>$\text{t=7}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beef</td>
<td>0.6546</td>
<td>1.1718</td>
<td>1.3116</td>
</tr>
<tr>
<td>Sheep</td>
<td>0.5523</td>
<td>0.9887</td>
<td>1.1385</td>
</tr>
<tr>
<td>Poultry</td>
<td>0.7577</td>
<td>1.3564</td>
<td>1.5620</td>
</tr>
</tbody>
</table>
Discussion and Conclusion

The aim of this study was to derive representative price elasticities of demand for three types of meat for the Middle East region. The model used to estimate a demand system was the Almost Ideal Demand System, extended to incorporate partial adjustment dynamics. The responsiveness of total expenditure on meat to changes in average meat prices was investigated using a straightforward multiple regression. Gross price elasticities of demand were derived using the results of the demand system and the expenditure equation.

Because of data deficiencies, the final sample used to estimate the AIDS model was limited to six countries: Egypt, the United Arab Emirates, Kuwait, Israel, Iran and Iraq. The expenditure equation was estimated with data pertaining to five countries: Egypt, the United Arab Emirates, Kuwait, Israel and Iran.

It is not possible to infer from this study the relative responsiveness of demand to changes in the price of freshly killed meat from local herds and in those of chilled and frozen or carcass imports. This deficiency arises because reliable local price data, necessary to estimate price
elasticities for meat classified according to 'state' (live or dead) and origin (domestic or imported), are unavailable. Despite this, the study provides some results which will be useful for future research into world meat trade flows. The documentation of the data problems encountered may also assist those who wish to use this paper as a basis for future research.

The own-price elasticity estimates are all less than one (inelastic) in absolute terms. Poultry appears to be the most responsive to changes in own price, followed by sheep and then beef. The results suggest that consumers of meat in the Middle East are less responsive to price changes than Australian consumers. For example, the own-price elasticities of demand of beef, lamb and poultry in Australia have been estimated to be -0.98, -1.43 and -0.77 respectively (Dewbre, Shaw, Corra and Harris 1985). (These results represent demand responsiveness to retail price changes.)

The estimated cross-price elasticities suggest substitution between meat types, with the exception of poultry demand in response to beef prices and, by symmetry, beef demand in response to poultry prices. The results indicate that the greatest price-induced substitution is away from sheep in favour of poultry in response to a change in the price of poultry. It is possible that poultry is becoming a relatively cheaper type of meat due to improvements in productivity and large increases in domestic production in some Middle Eastern countries. The extent to which the poultry market share continues to expand at the expense of sheep meat will also depend on the region's access to subsidised European Community poultry exports. Over the last two decades the European Community has been a major supplier of poultry meat to the Middle East.
The Partial Adjustment Demand System

Three properties which establish the theoretical consistency of the partial adjustment demand system are first demonstrated. These properties are homogeneity, symmetry and adding up with respect to the budget constraint. The first property is established by demonstrating the conditions under which the expenditure function is homogeneous of degree one. As the compensated demand curves are derived from an unconstrained expenditure function, the derivatives of the compensated demand curves will exhibit cross-price symmetry. However, the share equations are derived under the budget constraint. The conditions under which the share equations exhibit symmetry with respect to their compensated price derivatives are demonstrated. The third property is established by demonstrating the conditions under which the uncompensated demand functions exhaust the budget constraint.

The elasticity formulas for the partial adjustment demand model are derived in the last section of this appendix.

**Homogeneity**

The expenditure function:

\[ E_t = E(u^*, P_t) (1-\alpha) (\sum_{i} p_i q_{i,t-1})^\alpha \]

is homogeneous of degree one if the long run expenditure function:

\[ E(u^*, P_t) \]

is homogeneous of degree one. The expression:

\[ E(u^*, P_t) (1-\alpha) \]

is homogeneous of degree 1-\alpha. The expression:

\[ (\sum_{i} p_i q_{i,t-1})^\alpha \]

is clearly homogeneous of degree \alpha with respect to prices. Therefore, the product is homogeneous of degree one.

**Symmetry**

Cross-price symmetry of the compensated demand curves requires:

\[ \frac{\partial^2 E_t}{\partial p_i \partial p_j} = \frac{\partial^2 E_t}{\partial p_j \partial p_i} \]
which will hold at any regular point along the expenditure function. The derivatives of the implicit demands, represented by the share equations, are symmetric with respect to price if:

$$\frac{\partial \omega_j}{\partial \ln p_j} = \frac{\partial \omega_j}{\partial \ln p_j}$$

The derivatives of the partial adjustment share equations are given by:

$$\frac{\partial \omega_j}{\partial \ln p_j} = (1-\alpha) \frac{\partial \omega_j^*(p)}{\partial \ln p_j} + \alpha \frac{p_i q_{it-1} p_i q_{it-1}}{(\sum_i p_i q_{it-1})^2}$$

which is symmetric if:

$$\frac{\partial \omega_j^*(p)}{\partial p_j} = \frac{\partial \omega_i^*(p)}{\partial p_i}$$

Adding up

The Marshallian demand functions for the partial adjustment model are given by:

$$q_i = (1-\alpha)q_i^*(p_t, m) + \alpha \frac{m}{\sum_j p_j t q_{jt-1}} q_{t-1}$$

Clearly:

$$\sum_i m q_{it-1} p_{it} = m$$

and by assertion:

$$\sum_i q_i^*(p_t, m) p_i = m$$

Thus, the pathway given by the partial adjustment equation is a line segment which lies along the budget constraint \([m = (1-\alpha)m + \alpha m]\).

Elasticity formulas

At an initial or final point of equilibrium:

$$\sum_i m p_j t q_{jt-1} = 1$$
Thus, the long run uncompensated demands are given by:

\[ q_i^* = q_i^* (p_t, m) \]

with a corresponding long run elasticity formula:

\[ \frac{\partial q_i^*}{\partial p_j} \frac{p_i}{q_i} \]

The solution to the difference equation can be approximated by the exact solution at \( t=0 \):

\[ q_i(t) = (1-\alpha^t) q_i^* (p, m) + \alpha^t q_{i,t=0} \]

with a corresponding elasticity formula:

\[ (1-\alpha^t) \frac{\partial q_i^*}{\partial p_j} \frac{p_i}{q_i} \]
References


____ (1987b), *Production Yearbook* (and previous annual issues), Rome.