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Demand for Meat in Malaysia: An Application of the Almost Ideal Demand System Analysis

AHMAD ZUBAIDI BAHARUMSHAH and ZAINALABIDIN MOHAMED
Faculty of Economics and Management,
Universiti Pertanian Malaysia,
43400 UPM, Serdang, Selangor Darul Ehsan, Malaysia.

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ABSTRAK

Artikel ini membentangkan nilai anggaran permintaan bagi lima kumpulan daging di Malaysia dari model AIDS (Almost Ideal Demand System). Versi model AIDS yang linear boleh dianggar dengan menggunakan perisian komputer komersial yang tersedia ada dan mempunyai beberapa sifat teori yang di ingini. Keputusan yang di perolehi menunjukkan bahawa keanjalan harga adalah negatif, mempunyai keertian statistik yang tinggi kecuali untuk daging ayam yang berada dilengkongan tidak anjal. Secara keseluruhan, keanjalan silang harga mempunyai kaitan yang positif. Permintaan untuk daging khindzir, ayam, kambing dan ikan didapati anjal terhadap perbelanjaan.

ABSTRACT

This article presents the estimates of the Almost Ideal Demand System (AIDS) for five meat groups in Malaysia. The linear version of the AIDS model is easily estimated using most of the available commercial computer software that have several desirable theoretical properties. The results show that own-price elasticities were negative, statistically significant, and except for chicken, in the inelastic range. In general, the cross-price elasticities were positive. The demand for pork, chicken, mutton and fish were all found to be elastic with respect to expenditure.

INTRODUCTION

In recent years the growth of the overall agricultural sector in Malaysia has been low. However, the livestock sector has grown steadily over the years and as a result has earned a place in the agricultural economy. The positive growth in the livestock sector is expected to contribute substantially to agriculture and food production in Malaysia. Currently, the livestock industry contributes approximately 0.8 percent to the Gross Domestic Product (GDP) and more than 6.0 percent to the value added in the agriculture sector (Economic Report, 1991).

Numerous changes have occurred in the livestock-meat industry with the growth of the economy, especially in regard to the monogastric animal and particularly, the poultry sub-sector where the production has increased significantly. This growth has been caused primarily by the adoption of modern technology in production process resulting in lower retail prices for poultry meat[1]. Consequently the composition of demand for meat products has changed considerably over the last few decades. As poultry continues to contribute a larger percentage of the total meat supply, the nature of the meat market will substantially be altered. From a historical perspective, the consumption pattern for beef relative to poultry has trended downwards over the past two decades (see *Figure 1*). This pattern

[1] Note that the growth in the livestock-meat industry in Malaysia is also due to other factors such as increase real income and changing food habits among the affluent population.

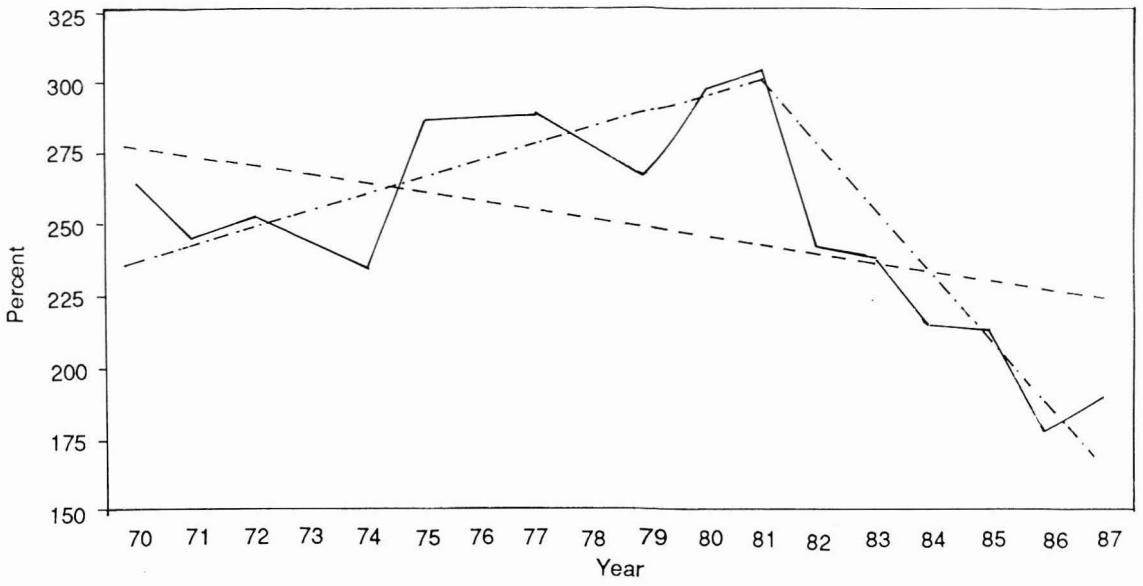

Figure 1: Per capita beef consumption as a percent of per capita poultry meat consumption

indicates that the per capita consumption of chicken has steadily increased relative to per capita beef consumption.

Similarly, per capita consumption of pork relative to poultry meat consumption has trended steadily downwards but the observed changes are not as drastic as in the case of beef *(Figure 2)*. Other explanations postulated for the changes in the pattern of meat demand include changes in income distribution, demographic variables and a growing awareness of health hazards due to large intake of cholesterol and other saturated fats. The increase in the poultry consumption pattern in Malaysia is typical of any rapidly growing economy and may have important policy implications for the meat sector.

The primary objective of this paper is to conduct empirical demand analyses for the meat industry in Malaysia via the Almost Ideal Demand System (AIDS) model. The empirical aim of this study is to explain the expenditures on five meat categories: beef, chicken, pork, mutton and fish in Malaysia, assuming weak separability between these products and all other goods. This study intends to provide a matrix of price and income elasticities for the various meat groups. The empirical analyses will show the position of various meats in the Malaysian diet and the implication to meat demand in Malaysia.

The application of the AIDS model to the meat demand in Malaysia has several attractions. Firstly, little empirical work has appeared in the literature about meat demand for the country. Second, the changing demand for meat patterns in Malaysia may be of wider interest because the observed pattern in meat expenditure could approximately describe the trends of many of the rapid income growing economies in this region. Finally, there is a need to evaluate the few empirical studies on meat demand in Malaysia which include those by Zainalabidin *et al*, (1988), Zainalabidin and Ghaffar (1989) and Fauzi *et al*, (1988) which examined the factors influencing the demand for meat by using the single equation technique. These studies are inconsistent with ultility maximization since the models used do not necessarily satisfy two sets of assumptions: homogeneity and symmetry. Hence a more recent picture on the pattern of meat consumption using a different approach is warranted[2].

[2] The demand equations derived from the classical, constrained, utility-maximization problem state that quantitites are functions of all prices and income. The implication here is that consumer purchase decisions are interrelated and should be viewed from a system context.

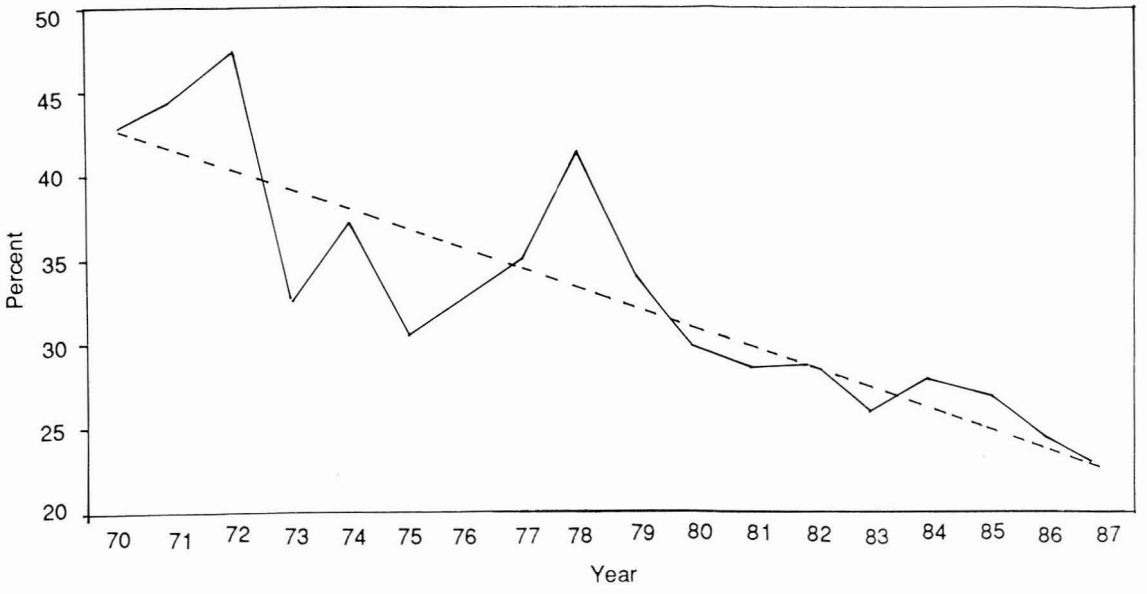

Figure 2: Per capita pork consumption as a percent of per capita poultry meat consumption

The remainder of this paper is organized as follows. The first section briefly describes the theoretical model for analyzing the meat sector via the AIDS model. This is followed by the data, estimation and the results of the analysis. The final section offers summary comments on the major results.

A MODEL FOR THE MALAYSIAN MEAT DEMAND

The development of the Almost Ideal Demand System (AIDS) by Deaton and Muellbauer (1980) offers an alternative method of estimating demand system. The advantages of the AIDS model are: (1) it gives an arbitrary first order approximation to any demand system; (2) it satisfies the axioms of choice exactly; (3) it aggregates perfectly over consumers; (4) it has a functional form which is consistent with previous household budget data; (5) it is simple to estimate in its linear form and (6) it can be used to test homogeneity and symmetry.

Besides being theoretically superior compared to other complete demand systems, several applications of the AIDS model have produced encouraging results. Further, the AIDS model is consistent with household budget data in at least one developing economy (Ray, 1980). Because of these reasons the AIDS model has found favour in recent studies (examples are Eales and Unnevehr, 1988; Fulponi, 1989; Megros and Donatos, 1989; and Chesher and Rees, 1987)[3].

The AIDS model is derived from an underlying structure of consumer preferences via a cost or expenditures function (Deaton and Muellbauer, 1980). Using Shepard's Lemma the demand functions are obtained by simple price differentiation of the cost function and appropriate substitutions, the AIDS model expresses W_i, the ith budget share for a good as:

(1) $W_{i,t} = a_i + \Sigma c_{ij,t} \log p_{j,t} + b_i \log(X/P)_t$, for all i, j and t = 1, ... ,T.

[3] For example, Megros and Donatos (1989) favor the AIDS over the Rotterdam model and The Generalized Linear Expenditure models based on a priori expectations although no claims can be made with respect to the properties of its estimators. Hayes *et al.* (1990) noted that the LA/AIDS technique combines the best of the theoretical features of both the Rotterdam and trans-log models with the ease of the estimation of the Linear Expenditure model (LES). The only disadvantage of the complete AIDS model is that it involves a large number of parameters. For example, for 4 commodities, there are 12 unknown parameters and for 8 commodities, there are 42 unknown parameters.

Where, c_{ij} and b_i are the parameters to be estimated, X is the total expenditure on all commodities in the system, and P is a price index defined by:

$$(2)\ \log P = a_0 + \sum_j a_k \log P_k + 1/2 \sum_k \sum_j c_{kj} \log P_k \log P_j$$

The empirical estimation of the complete AIDS involves the estimation of equation (1). However, to avoid non-linear estimation, equation (2) is often replaced by Stone Index (P*) which is defined so as

$$(3)\ \ln P^*_t = \sum_{k=1}^{n} \bar{W}_k \log P_k$$

where, $\bar{W}_k$ is the mean of the budget share (see, for example, Mergos and Donatos, 1989 and Kim, 1990). Therefore, the linear approximation of the system is[4]

$$(4)\ W_{i,t} = a_i^* + \sum c_{ij,t} \log p_{j,t} + b_i \log(X/P^*)_t$$

The model expresses the average budget share as a function of prices and real income or expenditure. The demand properties (commonly known as adding up, homogeneity, and Slutsky symmetry) can be imposed on the system by the following relationships:

$$(5)\ \sum a_i = 1;\ \sum c_{ij} = 0 \text{ and } \sum b_i = 0;$$

$$(6)\ \sum c_{ij} = 0; \text{ and}$$

$$(7)\ c_{ij} = c_{ji}$$

The first of these are the adding up conditions. Equation (6) implies that the demands are homogenous of degree zero in prices and income and finally, equation (7) shows the Slutsky symmetry condition[5].

DATA

Annual time-series data on prices and incomes for the period 1960-1990 were used to estimate the AIDS model. The meats considered in the analysis are beef, chicken, fish, mutton and pork. Consumption data were obtained from the Division of Veterinary Services (DVS), while data on prices were obtained from various Federal Agricultural Marketing Authority (FAMA) bulletins. Population, income and consumer price index (CPI) were obtained from various Malaysia Plans and Economic Reports. All retail prices and income data were deflated by CPI (1980=100). The per capita consumption figures were derived by dividing the total consumption or disappearance with the total consuming population[6].

ESTIMATION AND RESULTS

Because the meat expenditure shares (W_i) sum to one, a demand system composed of all the five individual expenditure share equations would be singular (see for example, Berndt and Savin, 1975). Therefore, one of the equations has to be dropped at the estimation stage. For our analysis, the fish share equation was chosen for deletion and the systems estimator can be applied to the remainder of the system. The parameters of omitted equation can be calculated by using the adding up restriction from (5). Under the assumption that the error terms (u_{it}) are multinormally distributed but contemporaneously correlated with

$$(8)\ E(u_{it}) = 0$$

$$(9)\ E(u_{it} u_{jt}) = w_{ij}$$

$$(10)\ E(u_{it} u_{js}) = 0 \text{ for } t = s$$

maximum likelihood estimator is consistent, asymptotically normal and asymptotically efficient and is independent of whichever equation is deleted (see Barten, 1969)[7].

The unrestricted model, that is, equation 4 can be estimated equation by equation using Ordinary Least-Square (OLS), since the same regressors appear in each of the equations and

[4] Blanciforti, Green and King called this model the linear approximate almost ideal demand system (LA/AIDS). The model is often a good first-order approximation to the complete AIDS system (equation 1).

[5] The LA/AIDS does not implicitly impose these theoretical restrictions but these can easily be imposed in the estimation.

[6] In this analysis we have treated domestic and imported meats as identical commodities because of the problem of data. Some researchers (e.g., Hayes *et al.*) claimed that this restriction may be inappropriate.

[7] Hayes, Wahl and William (1990) pointed out that the omitted share equation parameters calculated by using restrictions (5) are identical to those that would be estimated by using ordinary least squares (OLS).

both Full Information Maximum Likelihood (FIML) and Iterative Seemingly Unrelated Regression (SUR) collapses to OLS in this special case. However, the imposition of Slutsky symmetry requires a system approach and in this case the FIML and SUR are asymptotically equivalent (see Judge *et al*, 1985, p. 470).

Both the unrestricted (that is, without any constraint on the parameters) and the restricted models were estimated using the iterative SUR method and the results along with the single equation statistics are summarized in Table 1. In general the data fit the equation reasonably well except for the mutton equation where the fit is only satisfactory. The Durbin-Watson (DW) statistics are also reported in Table 1. These statistics show no evidence of strong auto-correlation in the residuals, suggesting that the specification of the model is acceptable[8].

An examination of Table 1 reveals that the magnitude of the estimated parameters is sensitive to the estimation procedures in some of the equations. For example, in the pork equation the own-price coefficient is 0.042 in the unconstrained model whereas in the constrained model it is 0.001. The t-statistics for most cases were larger and statistically significant for the model when the demand restrictions were imposed, suggesting that the efficiency of the estimators increased by incorporating the demand restrictions as implied by theory. Similar results were reported by Ahmad Zubaidi (1990) when examining the demand for food grains in Malaysia.

Demand systems that are consistent with utility maximization assumptions should satisfy two sets of restrictions: homogeneity and symmetry. Testing and imposition of demand restrictions are central to demand analysis and are easily done in the AIDS model. Homogeneity and symmetry can be tested utilizing the asymptotic Likelihood Ratio (LR) tests. The LR statistics for these tests are given in Table 2. Homogeneity was tested jointly and rejected at the one percent level. The failure of the homogeneity is consistent with other food demand analyses such as those of Bewley (1986) and Blanciforti and Green (1986)[9].

The calculated LR statistic for symmetry conditional upon homogeneity is 10.28. Clearly, the LR test suggests that the data with homogeneity are not rejected at one percent level. The results are consistent with those reported by Hayes *et al.* (1990) for the Japanese meat demand. However, the symmetry condition was rejected when the homogeneity is not

TABLE 1
Estimated parameters of unrestricted and restricted AIDS models

Meat Type	Unrestricted				Restricted			
	C_{ii}	b_i	R^2	DW	C_{ii}	b_i	R^2	DW
Beef	0.001	0.015	0.99	1.24	0.033	−0.33	0.98	1.01
	(0.17)	(1.78)			(12.55)	−(2.35)		
Mutton	−0.001	0.001	0.61	2.59	−0.001	0.002	0.34	2.39
	−(0.03)	(1.54)			−(3.61)	(1.90)		
Poultry	−0.038	0.014	0.93	1.16	−0.004	0.014	0.81	0.74
	−(1.87)	(8.17)			−(5.79)	(6.14)		
Pork	0.042	0.011	0.77	1.61	0.001	0.0136	0.75	0.94
	(1.16)	(3.53)			(1.211)	(3.43)		

Notes: The restricted model refers to the system of equations where the homogeneity and symmetry are imposed. The model was estimated by iterative SUR method and the convergence occurs after 15 iterations. The share equation for the fish is omitted here. Figures in the parenthesis are the t–statistics.

[8] The tests were conducted at the one percent level. In the restricted model three out of the four of the DW statistics were in the inconclusive zone. Following Deaton and Mullbauer (see also Eales and Unnevehr), we re-estimated the model using the first difference share equation method to correct for autocorrelation. The results that we obtained were unsatisfactory in terms of the signs and t-statistics.

[9] For a general discussion on the failure of the homogeneity, see for example, Deaton and Muellbauer (1980). The result is consistent with the meat demand analysis reported by Bewley and Young (1987) earlier for the U.S.

TABLE 2
The test of restrictions

Hypothesis				Critical Values		
H_0:	H_1:	-2logL	d.f.	(.05)	(.01)	Conclusion
Homogeneity	No Restricition	40.95	4	9.49	13.27	Rejected
Symmetry	Homogeneity	10.28	6	12.59	16.81	Do not Reject
Symmetry	No Restriction	31.96	10	18.31	23.21	Rejected

Notes: H_0 and H_1 denote the null and alternative hypothesis, respectively. The degree of freedom (d.f.) for the χ^2 equal 4 for homogeneity with no restriction, 6 for symmetry with homogeneity imposed and 10 for symmetry with no restriction.

imposed in the estimation. Given the upward bias of the LR statistic rated in Bera, Byron and Jarque (1981); Bewley (1983, 1986), we have little hesitation in accepting symmetry[10].

On the basis of the foregoing test procedures, we conclude that the preferred model is the system of equations with both homogeneity and symmetry imposed. The parameters estimates for the complete model are presented in Table 3. Except for the mutton equation, the own-price and income parameters for all the other equations are statistically significant at 5% level.

The Marshallian and Hicksian measures of elasticities could be derived from the estimated parameters of the LA/AIDS model as follows:

$$(11)\quad \varepsilon_{ii} = -1 + C_{ii}/W_i - b_i,$$

$$(12)\quad \varepsilon_{ij} = C_{ii}/W - b_i(W_j/W_i)$$

$$(13)\quad \delta_{ii} = -1 + C_{ii}/W_i + W_i, \text{ and}$$

$$(14)\quad \delta_{ij} = C_{ii}/W + W_j,$$

where ε denotes the Marshallian elasticities and δ denotes the income-compensated, or Hicksian measures. Expenditure elasticities (n_i) are obtained from the following formula:

$$(15)\quad n_i = 1 + b_i/w_i$$

The estimated elasticities are reported in Table 4. In general, the results are in accordance with *a priori* expectations. All own-price elasticites are negative, while all of the income (expenditure) elasticities are positive. Although the Marshallian cross-price elasticities are not all positive, the Hicksian cross-price elasticities for this subset of the food expenditure are mostly positive, indicating gross substitution among these commodities[11]. The results also suggest that fish and pork are complements[12].

The estimated own-price elasticities indicate relatively inelastic demand for all meat groups, except for chicken where the elasticity is greater than unity (–3.78). The estimates appear credible and in line with other studies. The results also suggest that mutton, chicken, pork and fish are all luxury goods (that is, expenditure elasticities

[10] The test statistics holds only asymptotically. Given the upward bias of this statistic, some reseachers adjust the LR statistic with by a small sample correction factor. In this study, we have little hesitation in accepting symmetry given size of the computed LR statistic. Further, the results that obtained with symmetry condition imposed are far superior compared to the unrestricted model.

[11] It is useful to examine the compensated elasticities as well to enable the classification of commodities into substitutes, complements, or independent. The compensated elasticities exclude the income effect of price changes. Thus, these elasticities should be interpreted as indicating gross substitutes, gross complements, or independent. It is important to note here that we are dealing with aggregate data; and pork is not consumed by the Muslim population (approximately about 55% of the population). Our analysis shows that the cross-price elasticity between pork and beef is very inelastic, suggesting that the substitutability could come from the non-Muslim population.

[12] The negative Marshallian cross-price elasticities are in accordance with results of the U.S. meat and Japanese demands by Chalfant (1987) and Hayes *et al* (1990) respectively. For example, Hayes *et al.* reported four out of five of the cross-price elasticities are negative for the share equation of the chicken demand.

TABLE 3
The restricted meat demand model

	Beef	Mutton	Chicken	Pork	Fish
Constant	0.142	0.133	–0.032	0.047	0.830
	(2.22)	(2.074)	–(3.09)	(3.43)	
C_{1i}	0.033	–0.001	0.004	0.001	–0.036
	(12.55)	–(3.61)	(5.79)	(1.211)	
C_{2i}	–0.001	0.009	0.277	–0.292	–0.006
	–(3.60)	(1.00)	(3.52)	–(4.62)	
C_{3i}	0.003	0.028	–0.900	0.025	0.033
	(5.79)	(3.52)	–(7.59)	(2.52)	
C_{4i}	0.001	–0.029	0.025	0.028	0.025
	(1.211)	–(4.62)	(2.52)	(2.19)	
C_{5i}	0.036	–0.006	0.033	–0.025	0.034
	(2.35)	–(1.13)	(2.88)	–(1.36)	
b_i	–0.033	0.001	0.014	0.014	0.004
	–(2.357)	(1.90)	(6.14)	(3.44)	

Notes: The model was estimated by iterative SUR method and the convergence occurs after 15 iterations. Figures in the parenthesis are the t-statistics. The independent variables are the cij where i = 1, ..., 5 are the coefficients of the prices of beef, mutton, chicken, pork and fish respectively. The bi's (i = 1, ..., 5) are the income elasticities for each group.

TABLE 4
Price and expenditure elasticities.

Type Expenditure	Hicksian Elasticities	Marshallian Elasticities
1. Beef Demand		
Beef	–0.873	–0.553
Mutton	–0.005	0.122
Chicken	0.007	0.022
Pork	–0.006	0.092
Fish	–0.118	0.063
Expenditure	0.061	
2. Mutton Demand		
Beef	–0.499	0.268
Mutton	–0.438	–0.420
Chicken	1.685	1.755
Pork	–1.925	1.731
Fish	–0.574	–0.215
Expenditure	1.117	
3. Chicken		
Beef	–0.038	0.465
Mutton	0.799	0.870
Chicken	–3.782	–3.736
Pork	0.691	0.860
Fish	0.907	1.198
Expenditure	1.432	

TABLE 4 (Cont'd)
Price and Expenditure Elasticities.

	Type Expenditure	Hicksian Elasticities	Marshallian Elasticities
4.	Pork		
	Beef	–0.043	0.364
	Mutton	–0.330	–0.311
	Chicken	0.275	0.312
	Pork	–0.696	–0.593
	Fish	–0.343	–0.115
	Expenditure	1.152	
5.	Fish		
	Beef	–0.227	0.135
	Mutton	–0.037	–0.021
	Chicken	0.201	0.234
	Pork	–0.126	–0.062
	Fish	–0.799	–0.629
	Expenditure	1.023	

Notes: Both elasticities were computed from the restricted model. The expenditure elasticities compares favorably with those reported by Bewly and Young, 1987 for the Great Britain. The food expenditure elasticities for beef, lamb, chicken, pork and other food are 1.73, 1.31, 1.00, 1.114 and 0.91 respectively. The parameters of the fish share equation are calculated using the adding up restriction. All models have both homogeneity and symmetry and symmetry imposed.

are greater than 1). Note that similar results were obtained by Blanciforti and Green (1983) for meats in the U.S. The high expenditure elasticities indicate that future increase in meat consumption is expected, given that the consumers' income and wages are expected to rise.

Our results suggest that beef and not fish is the necessity food among the meat group. The results may be inconsistent to a priori expectations given that fish enjoys a major share of the meat consumption[13]. The expenditure elasticity of chicken is largest while beef has the lowest expenditure elasticity. This is not the case as in a developed economy such as the U.S and Japan (Hayes *et al.*, 1990 and Chalfant, 1987).

CONCLUSION

This study demonstrates that the AIDS is a viable system for analyzing the demand for meat in Malaysia. Besides having most of the desirable theoretical properties usually considered in demand analysis, the linear approximation version, with the demand restrictions imposed, performs reasonably well with the data. The estimated demand system used in this study is well behaved in that it satisfies the theoretical restrictions of homogeneity and the Slutsky symmetry.

The matrix of price-income elasticities for this study have some interesting patterns. Firstly, the presence of significant own-price effect shows that pricing policy can be an important domestic policy instrument. Second, substitution between these groups of goods exist, although the possibilities are limited as indicated by the small cross-price elasticities in some cases. Finally, the meat groups have acquired an important position in the Malaysian diet as indicated by their high expenditure elasticities (elastic) and low own-price elasticities.

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[13] In general the price of fish is lower and the variety is numerous compared to the other meat group considered in the analysis.

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