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Testing Restrictions on a Model of Indonesian Fish Demand

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ABSTRACT

This paper presents the estimates of the Almost Ideal Demand System (AIDS) analysis for five fish species in Semarang, Indonesia. The results provide the first empirical estimates of own-price and expenditure elasticities of demand of fish species by households. Fish was found to be a necessity good while the tilapia, the freshwater fish species was inferior to other fish species. The tests of demand restrictions results concluded that the preferred demand specification was one with symmetry (and homogeneity) imposed.

ABSTRAK

Kertas ini membentangkan anggaran analisis Sistem Permintaan Hampir Unggul (AIDS) untuk lima jenis ikan di Semarang, Indonesia. Keputusan yang diperolehi adalah merupakan anggaran empirikal yang pertama bagi keanjalan harga dan keanjalan perbelanjaan permintaan terhadap ikan oleh isirumah. Ikan ialah barangan mesti sementara tilapia, sejenis ikan air tawar adalah inferior berbanding dengan ikan jenis lain. Ujian ke atas pembatasan keputusan permintaan merumuskan bahawa spesifikasi permintaan yang lebih baik ialah dengan mengenakan simetri (dan homoginiti).

INTRODUCTION

The importance of the fishery sector to many Asian countries is widely acknowledged. Its significance lies in three main areas: (1) as a source of animal protein, (2) as a source of employment, (3) as an earner of foreign exchange.

The fishery sector in Indonesia employs about 1.347 million marine fishermen, 440,000 inland open water fishermen and 1.509 million fish farmers in 1987. Similarly Indonesia's foreign exchange earnings from the fisheries sector have grown rapidly from US$7.0

million in 1970 to US$480.0 million in 1987. The most important contribution from this sector, however, is that fish provides about 67 percent of the total domestic animal protein supplies with fish consumption per capita at 14.67 kg in 1987 (Fisheries Statistics, Indonesia).

Most of the research in the fishery sector in Indonesia has, however, been conducted on the production aspects, and very few studies so far being focused on the demand side. This phenomena is not peculiar in agricultural commodity research. Research on demand for fish is of recent vintage. An inventory of the historical development of fishery models is provided by Nash and Bell (1969). Until the pioneering work of Stone (1953) with the Linear Expenditure System, demand analysis in general focused primarily on single-equation estimations with little attention being given to the basic theory. The more commonly used demand system in empirical work are the Rotterdam Model (Theil 1975-76; Barten 1977), and the Translog Model (Christensen, Jorgensen and Lau 1975). Specifically for fisheries, there has been some interest in recent years in multiequation models that include studies on the U.S Market for Shrimps (Doll 1972), groundfish (Tsao et al. 1982) and fishmeal products (Huppert 1980). More recently, the Almost Ideal Demand System (AIDS) has been suggested and used for empirical demand studies for some commodities and services.

The objective of this paper is to conduct an empirical demand analysis for fresh fish in Semarang, Indonesia using the AIDS model and to test some restrictions on the desirable properties of the theoretically consistent demand system. The application of the AIDS model to the fish demand in Indonesia has several attractions. Firstly, little empirical work has appeared in the literature about fish demand there and secondly there is a need to evaluate the few empirical studies on fish demand in Indonesia which include those by Poerwono (1990) and Susilowati (1991) which examined the factors influencing the demand for fish by using the single equation technique. These studies are inconsistent with utility maximization since the model used do not necessarily satisfy two sets of assumptions in demand: homogeneity and symmetry. Hence a new study on fish demand using a different approach is warranted.

This paper is organised as follows. Section one describes the theoretical model of the Almost Ideal Demand System. This is followed by the data, estimation and the results of the analysis. The final section offers summary comments on the major results.

THE ALMOST IDEAL DEMAND SYSTEM (AIDS) MODEL

The AIDS model developed by Deaton and Muellbauer (1980) offers an alternative method of estimating demand system. The advantages of AIDS model are: (1) it gives 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.

This model builds on earlier work by Working (1943) and Lesser (1963). Beginning with an Engel Curve formulation in terms of expenditure shares, the system can be described as follows:

$$w_i = \alpha_0 + \beta_i \log X \tag{1}$$

where w_i is the expenditure share of good i and X is the total expenditure.

It is assumed that market demand results from a preference ordering as derived from a minimum expenditure or cost function, that is the required expenditure necessary to achieve a given level utility at a given set of prices. Consider the following general expenditure/cost function (Deaton and Muellbauer 1980 a, b):

$$\log e(p,u) = (1-u) \log [\alpha(p)] + u \log [\beta(p)] \tag{2}$$

and defines $\alpha(p)$ and $\beta(p)$ as follows:

$$\log \alpha(p) = \alpha_0 + \sum_k \alpha_k \log P_k + 1/2 \sum_k \sum_j \gamma_{kj} \log P_k \log P_j \tag{3}$$

$$\log \beta(p) = \log \alpha(p) + \beta_0 \prod P_k \beta_k \tag{4}$$

$$e(p,u) = m(p,u) = X \tag{5}$$

where $e(p,u)$ is the expenditure or cost function for prices p and utility level U^0 and $m(p, u)$ is the minimum expenditure function at price p and U^0. Given the relationships, the AIDS cost function can be written in terms of prices and utility as:

$$\log e(p,u) = \alpha_0 + \sum \alpha_k \log P_k + 1/2 \sum\sum \gamma_{kj} * \log P_k \log P_j$$

$$+ U\beta_0 \prod P_k \beta_k \qquad (6)$$

where α_i, β_i and γ_{ij} are the parameters of the model. Applying Shephard's Lemma, the partial derivative of (6) with respect to price yields the quantity demanded:

$$\frac{\delta e(p,u)}{\delta P_i} = q_i,$$

and multiplying by $P_i/e(p,u)$; yields

$$\frac{\delta \log e(p,u)}{\delta \log P_i} = \frac{P_i q_i}{e(p,u)} = w_i \qquad (7)$$

By differentiating (6) with respect to log P_i, the AIDS demand function in expenditure (budget) share is obtained:

$$w_i = \alpha_i + \sum_j \gamma_{ij} \log P_j + \beta_i \log \left(\frac{X}{P}\right) \qquad (8)$$

where

$$\log P = \alpha_0 + \sum_k \alpha_k \log P_k + 1/2 \sum_k \sum_j \gamma_{kj} \log P_k \log P_j \qquad (9)$$

To be consistent with the theory of consumer demand, it is necessary that the following conditions hold:

$$\sum_i \alpha_i = 1; \quad \sum_i \gamma_{ij} = 0; \quad \sum_i \beta_i = 0 : \quad \text{(Adding-up)} \qquad (10)$$

$$\sum \gamma_{ij} = 0 : \text{(homogeneity)} \qquad (11)$$

$$\gamma_{ij} = \gamma_{ji} : \text{(symmetry)} \qquad (12)$$

These conditions (10)-(12) ensure that the demand system satisfies adding-up, homogeneity in prices and income and Slutsky symmetry. In addition, it should be noted that the AIDS model is indirectly non-additive and thus it does not impose substitution limitations as in other additive models such as the Linear Expenditure System (Blanciforti and Green 1983).

For this model, the expenditure and uncompensated own-price elasticities can be computed as:

$$\eta_i = 1 + \beta_i / w_i \tag{13}$$

and

$$\xi_{ii} = -1 + [\gamma_{ii} - \beta_i(\alpha_i + \sum_k \gamma_{ik} \log P_k)] / w_i \tag{14}$$

respectively. Given that the marginal budget shares are not restricted to positive values, the expenditure elasticity may decrease with a decrease in budget shares.

MODEL SPECIFICATION AND DATA SOURCES

The model described above is used to estimate a demand system for fresh fish in Semarang during 1988. The fish group is divided into 5 important fish species namely, milkfish, mullet, tilapia, tuna and others. Cross-sectional data of households were used for this study. Respondents (housewives) were selected through stratified random sampling and interviewed using questionnaire as a survey instrument.

Semarang city was chosen as the location for study as it is the main market for fish in Central Java province (Hermanto et al. 1980), besides being the capital of the province. Initially, a two day listing of buyers together with their home addresses were made at six retail markets in Semarang: Langgar, Peterongan, Bulu, Karangayu, Jatingaleh and Gayamsari. At each market place, buyers for every fish species (milkfish, mullet, tilapia, tuna and others) were recorded, including the quantity and price of fresh fish purchased. From the sample frame, 6 respondents were randomly chosen for every fish species bought in each market place. A total of 180 respondents (= 6 x 5 x 6) were selected as samples for this study.

Interviews were conducted at the respondents' homes, and this was followed by daily monitoring and recording of each household consumption of fish, chicken and meat for a month after the initial interview. In estimating the demand for fresh fish, it is obvious that only households with non-zero consumption of all species of fresh fish were used. It is found that only 150 households fulfilled this requirement. A full month of monitoring and recording for prices of all fresh fish species, meat prices and chicken prices were also made in all market places.

In order to permit equation (8) to be expressed in linear form and estimated by OLS log P was replaced by an index developed by Stone (1953). The index is:

$$\log P^* = \sum w_k \log P_k \tag{15}$$

This linear approximate (LA) version of AIDS estimated by OLS automatically satisfies the adding-up condition while permitting the homogeneity condition to be tested. To estimate the LA/AIDS while imposing both homogeneity and symmetry, Zellner's Seemingly Unrelated Regression (SUR) method was used. This permits cross-equation restrictions to be imposed and with the iterative solutions, estimates are Maximum likelihood.

EMPIRICAL RESULTS

The results for the Linear Approximate Almost Ideal Demand System for fish in Semarang Indonesia are shown in Table 1. The estimates for fish group fits the data well, as shown by the adjusted R-squared. An examination of the table reveals that all fish species can be considered as necessities where expenditure coefficients, BETA, are all negative and highly significant. The estimated elasticities are in accordance with a priori expectations. All own price elasticities are negative, while expenditure elasticities are positive. However, the expenditure shares for all these fish species are inelastic, with mean expenditure elasticity ranging from 0.919 for tuna to 0.954 for tilapia. What this implies is that when prices of these fish species go up by 1 percent, their expenditure share will only increase by 0.9 percent.

The direct price coefficients (G_{ii}) for fish species are all positive except tilapia, where its coefficient is –0.086. For tilapia, this implies that for every one percent increase in its real price with real expenditure held constant, its budget share will decrease by 0.09 percent. In this case, tilapia could be considered as an "inferior" specie compared to others. This finding is consistent with the general belief that most freshwater fishes (including tilapia) are less demanded due to their muddy flavour.

TABLE 1. Linear approximate almost ideal demand system parameter estimates for major fish species in Indonesia*

Commodity	Constant	Beta	G1	G2	G3	G4	G5	R^2 Adjusted	SSE	Expenditure Elasticity	Own-Price Elasticity
Milkfish	0.199 (3.339)	-0.016 (-13.46)	0.170 (1.304)	-0.056 (-0.659)	0.101 (1.451)	-0.057 (-0.474)	-0.158 (-2.217)	0.565	0.255	0.946	-0.464
Mullet	0.148 (3.220)	-0.016 (-14.505)	-0.055 (-0.669)	0.179 (1.626)	-0.010 (-0.169)	0.019 (0.166)	-0.132 (-1.795)	0.593	0.253	0.926	-0.305
Tilapia	0.078 (2.093)	-0.007 (-12.0)	0.101 (1.451)	-0.010 (-0.169)	-0.086 (-1.239)	0.082 (1.016)	-0.087 (-2.318)	0.522	0.123	0.954	-1.557
Tuna	0.395 (6.035)	-0.047 (-35.36)	-0.057 (-0.474)	0.019 (0.166)	0.082 (1.016)	0.040 (0.215)	-0.084 (-1.078)	0.897	0.298	0.919	-0.926
Other	0.409 (9.788)	-0.047 (-30.205)	-0.158 (-2.217)	-0.132 (-1.795)	-0.087 (-2.318)	-0.084 (-1.078)	-0.461 (4.459)	0.865	0.347	0.928	-0.507

Note: BETA = Expenditure coefficients
G1 to G5 = Price coefficients
SSE = Standard error to equation estimate
* Equations estimated by iterative SURE with homogeneity and symmetry imposed
Figures in parenthesis are The t-statistics.

Similar interpretation holds for cross-price coefficient (G_{ij}) of fish species. Milkfish tends to be complement to Mullet, Tuna and others ($G_{ij} < 0$) but a substitute for Tilapia ($G_{13} = 0.101$). Mullet complements milkfish, tilapia and others but is a substitute for tuna. Interestingly enough, the less important fish species ("Other" fish) tends to be complements to the major species listed in the Table.

TEST OF DEMAND RESTRICTIONS

Demand systems that are consistent with utility maximization assumptions should satisfy two sets of restrictions: homogeneity and symmetry. Testing and imposion 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.

TABLE 2. Test of demand restrictions

Hypothesis		-2logL	df	Critical Values		Conclusion
H_0	H_1			(0.01)	(0.05)	
Homogeneity	No Restriction	278.94	3	12.8	11.3	Reject H_0
Symmetry	Homogeneity	220.48	3	12.8	11.3	Reject H_0
Symmetry	No Restriction	58.46	6	14.4	16.8	Reject H_0

Note: H_0 and H_i denote the null and alternative hypotheses, respectively.

Note that homogeneity was tested and rejected at both 1 and 5 percent levels. This results are consistent with other food demand studies such as those of Megros and Donatos (1989) and Blanciforti and Green (1983). The calculated LR statistic for symmetry both conditional and unconditional on homogeneity was also rejected at the 5 percent level. Based on the results of these tests we conclude that the preferred specification is the one with symmetry (and homogeneity) conditions imposed. This finding is consistent with the approach used in this paper, the results of which were already shown in Table 1 and discussed in the previous section.

CONCLUSION

The AIDS model was used in this paper to estimate the demand for fresh fish in Semarang, Indonesia. This model is purported to possess most of the properties desirable in demand analysis. Our results provide the first empirical estimates of income (expenditure), own and cross-price elasticities of demand for fish by households. Fish was found to be a necessity good which implied that more fish will be consumed as the GNP or per capita income increases. The finding that tilapia, a popular freshwater fish specie in many Asian countries, is an inferior good is consistent with the belief that they are not well demanded because of their "muddy" flavor and more so among the effluent, urban population such as in Semarang where this study was conducted. Efforts to improve the acceptability of freshwater fish among consumers should be stepped up through rigorous promotions, "eat fresh water fish campaigns" and advertisements. Relevant authorities should also promote the nutritious value and food preparation that this cheap protein source is capable of providing to consumers.

The tests on demand restrictions found that the preferred specification for demand system is the one with symmetry and homogeneity imposed. This is consistent with the analysis done in this paper and we argued that the results obtained in this study are consistent with the theory of demand analysis. The findings shown here should, however, be considered as an inertia towards a more detailed study in this area. Further work should be carried out to test for the presence of heteroscedasticity on this cross-sectional data and check if the results obtained in this study is robust enough before any conclusion can be drawn for future policy prescriptions with regards to demand for fish in Indonesia.

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