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AIDS in the Philippines: New Estimates for Policy Analysis

by

Arsenio M. Balisacan

ABSTRACT

Information about demand patterns and how they are likely to change as prices and income change is an extremely important input into the estimation of the welfare and distributional impact of technological change (or, alternatively, of economic policies). This paper employs the Deaton and Muellbauer's Almost Ideal Demand System (AIDS) to derive parameter estimates of consumer demand systems in the Philippines. The estimates are generally comparable with those obtained in other studies and, more importantly, are guaranteed to satisfy the restrictions of consumer demand theory.

AIDS in the Philippines: New Estimates for Policy Analysis

Arsenio M. Balisacan[*]

1. Introduction

An important goal of agricultural policy in many developing countries is the creation of income opportunities for the rural population. The process typically involves the development and dissemination of agricultural technologies. Presumably, farmers' adoption of modern technologies increases their incomes and, hence, their demands for consumer goods. As prices also probably change owing to agricultural supply shifts, the technological change generates spillover effects on the rest of the economy. These effects, in turn, may feed back on agriculture, further changing prices and farm incomes. The technological change is also likely to affect the various population groups differently owing to differences in resource endowments (including the quality of labor) and in the degree of factor mobility.

Clearly, information about demand patterns and how they are likely to change as prices and income change is an extremely important input into the estimation of the welfare and distributional impact of technological change (or, alternatively, of economic policies). In the Philippines, a number of studies

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have been undertaken to estimate consumer demand systems, especially food demand systems. There are, however, constraints -- apart from (non-trivial) methodological problems -- in using previous estimates of price and income elasticities. None of these studies, for example, come close to the level of commodity aggregation deemed desirable for the Agricultural Policy Experiments (APEX) model, a large computable general equilibrium model of the Philippine economy. This model is designed for the analysis of technological change, economic policy, and income distribution.

This paper presents our estimates of consumer demand systems in the Philippines. The model employed is Deaton and Muellbauer's Almost Ideal Demand System (AIDS). Section 2 discusses the structure of the model. Section 3 describes the data and the estimation procedure. Section 4 presents the results of the estimation, including the derived set of income and price elasticities for seven groups of consumer goods. The elasticity estimates are also compared with those obtained in previous studies. Finally, section 5 provides concluding comments.

2. Model Structure

In theory, the following restrictions are expected to be satisfied by a system of demand equations: (a) homogeneity of degree zero in prices and income, (b) share-weighted some of income elasticities equal to unity, and (c) symmetry and negative definiteness of compensated cross-price terms. Demand systems derived from constrained maximization of a specified utility function automatically satisfy these restrictions. Such systems are, however, restrictive; their estimation may be quite complicated and clumsy to handle without the imposition (often unrealistic) of separability conditions in the utility functions (see Deaton and Muellbauer, 1980b).

An alternative approach to deriving a demand system is the so-called "duality approach." This approach involves only the minimization of a cost problem and, therefore, allows moving relatively easily between demands and the cost function. Moreover, given a correctly specified cost function, the approach guarantees the existence of corresponding preferences, even though the utility function need never be explicitly evaluated (Christensen, Jorgenson, and Lau, 1975; Deaton, 1986). This "flexible" property turns out to be very useful in applied work.

The basic form of Deaton and Muellbauer's Almost Ideal Demand System model, hereafter referred to as DM/AIDS model, is one class of flexible functional forms. The model preserves the generality of both Rotterdam and translog models, but has considerable advantages over both. The demand functions derived from it are first-order approximations to any demand system derived from utility-maximizing behavior. The model satisfies the axioms of choice exactly, aggregates perfectly over consumers, and has functional form which is consistent with available household consumption data. While the homogeneity and Slutsky symmetry restrictions of consumer demand theory can be easily imposed, the model allows the testing of these restrictions against the data through linear restrictions on fixed parameters.

Preferences in the AIDS model are represented by the following cost (expenditure) function:

$$\log c(u,p) = \alpha_0 + \sum_j \alpha_j \log p_j + \frac{1}{2}\sum_i \sum_j \gamma^*_{ij} \log p_i \log p_j + u\beta_0 \Pi_j p_j^{\beta_j} \tag{1}$$

where p_i and p_j are commodity prices, u is utility, and α_i, β_i, and γ^*_{ij} are parameters. Applying Shephard's lemma to this function and substituting for u into the resulting system of equations (after inverting (1) to give u as a function of p and x), we find

$$s_i = \alpha_0 + \sum_j \gamma_{ij} \log p_j + \beta_i \log(m/P), \tag{2}$$

where s_i is the budget share of commodity i, m is total nominal expenditures, and P is a price index defined by

$$\log P = \alpha_0 + \sum_j \alpha_j \log P_j + \frac{1}{2}\sum_i \sum_j \gamma_{ij} \log P_i \log P_j. \tag{3}$$

In many practical situations, where prices are relatively collinear, Stone's (1953) price index given by

$$\log P^* = \sum_k w_k \log p_k.$$

provides an excellent approximation to (3).

The theoretical restrictions on (2) apply directly to the parameters:

$$\sum_i \alpha_i = 1, \quad \sum_i \beta_i = 0, \quad \sum_i \gamma_{ij} = 0 \tag{4}$$

$$\sum_j \gamma_{ij} = 0 \tag{5}$$

$$\gamma_{ij} = \gamma_{ji} \tag{6}$$

Equations (4) and (5) are the adding-up and homogeneity restrictions, respectively, which are implied by utility maximization. Equation (6) provides the symmetry condition. It bears noting that the unrestricted estimation of (2) only satisfies automatically the adding-up restriction. The model thus offers the opportunity of testing homogeneity and symmetry by imposing (5) and (6).

The γ_{ij} parameters measure the change in the *i*th budget share following a 1 proportional change in p_j with (m/P) constant. The β_i parameters, on the other hand, indicate whether the goods are luxuries or necessities. With $\beta_i>0$, s_i increases with m so that commodity i is a luxury; with $\beta_i<0$, commodity i is a necessity.

A natural generalization of (2) would be to add a quadratic term in the logarithm of expenditures (Swamy and Binswanger, 1983). While this specification of the AIDS demand system may not be consistent with the specificied functional form for the cost function which permits exact aggregation, the inclusion of a quadratic term allows more realistic (though more complex) consumer behavior. As shown below, a number of the estimated demand equations exhibit a quadratic term significantly different from zero. With the quadratic term, equation (2) becomes

$$s_i = \alpha_0 + \sum_j \gamma_{ij} \log p_j + \beta_{1i} \log (m/P) + \beta_{2i} [\log (m/P)]^2, \qquad (7)$$

This specification of the AIDS model is hereafter referred to as the SB/AIDS model.

In the empirical literature, the homogeneity restriction is almost universally rejected (Thomas, Strauss, and Barboza, 1989). Symmetry (at least conditional on homogeneity), on the other hand, is seldom rejected by the data. It is, of course, well known that, in any test of demand theory, the researcher must maintain that the structure of the model he employs represents the correct underlying behaviorial relationship of demand systems. Unfortunately, theory provides little guidance as to actual functional forms. Thus, it is not clear whether what is being rejected is the theory or whether the additional maintained assumption is causing the rejection. In our estimation of the two "variants" of the AIDS model, we have chosen to impose homogeneity and symmetry restrictions.

3. <u>Data and Estimation Procedure</u>

Data on household expenditures were derived from the *Family Income and Expenditures Survey* (FIES) for 1985 and 1988. The FIES is a national household budget survey regularly carried out by the

National Statistics Office. The sampling frame of the survey is deemed sufficient to provide reliable estimates of income and expenditure levels for each region of the country.

Expenditures are classified into 7 groups (Table 1). Unlike in published national tabulations and in previous studies which lumped food into one category, we have chosen to disaggregate food into three groups: (i) cereals, (ii) marine and meat products, and (iii) beverages and other foods. This grouping is deemed important for income distribution analysis because of the likely different responses of various groups of consumers to changes in prices of certain sub-groups of food. Moreover, while the responsiveness of aggregate food demand to price and income changes might not be strong, the composition of food consumption is expected to change with income (partly owing to the increase in demand for food variety as income increases and to changing tastes).

With the 7-commodity classification, average expenditure shares were estimated for each region (including Metro Manila, but excluding the Cordillera Autonomous Region) and by area (whether rural or urban). For both 1985 and 1988 FIES, these make up 50 observations for each commodity group. Table 2 shows the national average expenditure shares for each quintile.

As expected, Table 2 shows that the share of cereals in total expenditures declines as per capita income rises. For the bottom 20 percent of the population, about 40 percent of their income is spent on cereals. For food as a whole, the proportion rises to about 60 percent. In contrast, the top 20 percent of the population, spend only slightly greater than 15 percent on cereals. This difference in the consumption patterns of various groups of households has an important implication on the distributive impact of price policies on cereals.

The FIES does not contain information about prices. Consumer price indices for each region and for sufficiently disaggregated commodity groups are also obtained from the NSO. The regional price indices, however, do not make a distinction between rural and urban areas. Consumer prices for some commodities (e.g., cereals) are expected to be higher in urban areas than in rural areas, and so the expenditure shares may be systematically related with the location of households. We have "augmented" the DM/AIDS and SB/AIDS models by including an URBAN dummy variable to capture the independent influence of location. The inclusion of this variable does not affect the homogeneity and symmetry restrictions of the AIDS model.

Because of the fact that the budget shares must add up to one, the error terms across equations of the demand system are correlated. Using ordinary least squares (OLS) would give consistent and unbiased, but inefficient, parameter estimates of the demand system. We have employed the iterative Zellner estimation procedure in obtaining efficient parameter estimates of the augmented AIDS models. Since the budget shares add up to one, only n-1 equations are linearly independent and one equation must be dropped for estimation purposes. We have arbitrarily deleted the "MISC" commodity group and applied the Zellner estimation to the remaining budget share equations. (The Zellner estimation is invariant to which budget share is deleted.) The process thus automatically satisfies the adding-up restriction of consumer demand theory. In addition, we have imposed both homogeneity and symmetry restrictions on the demand system.

4. Results

Tables 3 and 4 present the parameter estimates of the DM/AIDS and SB/AIDS models. The quadratic expenditure term is significant only for the house and cloth equations. The coefficients of total expenditures (in the DM/AIDS model) are negative and significant for CEREALS and MARINE, indicating that these commodity groups are necessities. FUEL and HOUSE have positive coefficients, suggesting that they are luxuries, although only the latter is statistically significant. The URBAN dummy variable is significant only for the CEREAL equation of each demand system.

The coefficients of the price terms are significant for slightly less than one half of the price parameters of the demand systems. Most of the own-price terms, however, are insignificant. This might be due to the limited price variation in the data set.

The implied income and uncompensated (Marshallian) price elasticities are shown in Tables 5 and 6. The compensated (Hicksian) price elasticities are given in Tables 7 and 8. These elasticities are evaluated at the sample means, i.e., means of the expenditure shares and, for the SB/AIDS model, of the total expenditures. In general, the demand for CEREALS, MARINE, and BEVE are income inelastic, while FUEL and HOUSE are income elastic. Among the food groups, CEREALS have the lowest income elasticity.

The own-price elasticities have the negative signs, although most of the coefficients from which they are based on are statistically not significant. The uncompensated cross-price elasticities, the signs of which indicate whether the paired goods are subsitutes or complements, suggest that there is a significant substitutability between foodgroups and nonfood groups. The price of CEREALS, for example, has a significantly positive effect on the demand for FUEL and HOUSE and a negative effect on the demand for CLOTH and MISC. The price of BEVE, on the other hand, has a significantly negative impact on the demand for CEREAL, FUEL and HOUSE.

Income and own-price elasticities by quintile are shown in Tables A1 and A2.

It would be interesting to compare our elasticity parameter estimates with those obtained in other studies. The comparison is, of course, made difficult by the fact that the various studies on consumer demands have employed different levels of commodity aggregation as well as different estimation procedures. We have chosen to select only studies which estimated a complete consumer demand system. Representative parameter estimates of these studies are given in Table 9. In general, for similarly grouped commodities, the orders of magnitude of our elasticity parameter estimates are comparable with these studies.

5. Concluding Comments

Our parameter estimates of income and price elasticities are generally comparable with those obtained in other studies. However, for policy analysis involving the interactions of various production sectors and consumer groups, our estimates offer an advantage to those of other studies -- they are guaranteed to satisfy the restrictions of consumer demand theory. Picking up elasticity estimates from various studies -- perhaps involving different functional forms and estimation procedures -- for the commodity groups and then forcing these estimates to satisfy the restrictions of demand theory, as often done in computable general equilibrium modelling exercises, introduces (additional) arbitrariness in the exercise (and possibly the outcome of the analysis).

The parameter estimates, however, can be further improved. One avenue of improvement would be the addition of data points in the sample to allow for greater variation in prices and hence more precise estimates of price elasticities. The 1991 FIES, once it becomes available, offers a good opportunity to extend the data set used in this paper.

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Table 1
Aggregation of Commodities

Variable Name	Components
CEREAL	Cereals and cereal preparation, fruits and vegetables
MARINE	Meat and dairy products, eggs, fish
BEVE	Beverages, tobacco, miscellaneous foods
FUEL	Fuel, light and water, transportation and communication
HOUSE	Housing and repairs, household furnishing and equipment, household operations
CLOTH	Clothing
MISC	Personal care and effects; medical, recreational, educational, personal, and other services; medical and pharmaceutical supplies; school supplies; other miscellaneous items

Table 2
Percentage Distribution of Per Capita Expenditures by Quintile

Quintile	CEREAL	MARINE	BEVE	FUEL	HOUSE	CLOTH	MISC	TOTAL
TOTAL	24.22	18.35	13.67	9.37	15.73	4.03	14.63	100.00
First	39.40	18.41	12.79	8.89	9.94	3.17	7.39	100.00
Second	33.70	19.49	14.04	8.77	11.15	3.69	9.16	100.00
Third	29.44	19.54	14.70	8.91	12.51	3.96	10.93	100.00
Fourth	24.85	19.56	14.87	8.98	14.32	4.18	13.24	100.00
Fifth	16.62	17.10	12.92	9.93	19.78	4.24	19.41	100.00

Table 3
Constrained Parameter Estimates of the DM/AIDS Model a/

Equation	Constant	Price							Total Expen-ditures	Urban
		CEREAL	MARINE	BEVE	FUEL	HOUSE	CLOTH	MISC		
CEREAL	0.551 (16.56)	-0.023 (-0.77)	0.029 (1.37)	-0.041 (-2.54)	0.054 (4.06)	0.097 (3.83)	-0.052 (-3.24)	-0.064 (-2.37)	-0.113 (-9.07)	-0.034 (-4.75)
MARINE	0.255 (8.64)	0.029 (1.37)	-0.008 (-0.30)	-0.008 (-0.52)	-0.005 (-0.39)	0.011 (0.46)	0.028 (2.00)	-0.047 (-1.82)	-0.027 (-2.40)	0.002 (0.35)
BEVE	0.145 (5.67)	-0.041 (-2.54)	-0.008 (-0.52)	0.051 (3.06)	-0.026 (-2.78)	-0.062 (-3.36)	0.024 (2.46)	0.063 (2.91)	-0.001 (-0.09)	-0.001 (-0.20)
FUEL	0.076 (3.25)	0.054 (4.06)	-0.005 (-0.39)	-0.026 (-2.78)	-0.014 (-1.23)	-0.025 (-1.65)	-0.015 (-2.39)	0.030 (1.80)	0.010 (1.11)	0.007 (1.46)
HOUSE	-0.069 (-1.46)	0.097 (3.83)	0.011 0.46)	-0.062 (-3.36)	-0.025 (-1.65)	-0.018 (-0.43)	-0.018 (-1.30)	0.016 (0.45)	0.088 (4.96)	0.014 (1.36)
CLOTH	0.045 (2.87)	-0.052 (-3.24)	0.028 (2.00)	0.024 (2.46)	-0.015 (-2.39)	-0.018 (-1.30)	0.012 (0.55)	0.021 (1.55)	-0.001 (-0.20)	0.000 (0.11)

Likelihood Ratio test statistic = 51.12.
Critical chi-square at 18 d.f. (alpha=0.05) = 28.87.

a/ Homogeneity and symmetry restrictions imposed.

Note: Figures in parentheses are asymptotic t-ratios. Prices and expenditures are in natural logarithm.

Table 4
Constrained Parameter Estimates of the SB/AIDS Model a/

Equation	Constant	Price							Total Expen-ditures	Square of Total Expen-ditures	Urban
		CEREAL	MARINE	BEVE	FUEL	HOUSE	CLOTH	MISC			
CEREAL	0.678	-0.038	0.023	-0.031	0.057	0.077	-0.042	-0.046	-0.205	0.016	0.031
	(5.80)	(-1.24)	(1.10)	(-1.89)	(4.10)	(3.10)	(-2.71)	(-1.75)	(-2.36)	(0.98)	(-4.32)
MARINE	0.281	0.023	-0.010	-0.005	-0.003	0.007	0.030	-0.043	-0.046	0.003	0.003
	(2.73)	(1.10)	(-0.36)	(-0.31)	(-0.24)	(0.30)	(2.26)	(-1.72)	(-0.61)	(0.24)	(0.45)
BEVE	0.011	-0.031	-0.005	0.045	-0.030	-0.054	0.019	0.056	0.099	-0.018	-0.003
	(0.12)	(-1.89)	(-0.31)	(2.76)	(-3.18)	(-3.10)	(2.01)	(2.63)	(1.46)	(-1.45)	(-0.47)
FUEL	0.122	0.057	-0.003	-0.030	-0.011	-0.012	-0.020	0.020	-0.029	0.008	0.005
	(1.49)	(4.10)	(-0.24)	(-3.18)	(-1.00)	(-0.84)	(-3.30)	(1.23)	(-0.48)	(0.71)	(1.02)
HOUSE	0.329	0.077	0.007	-0.054	-0.012	-0.014	-0.019	0.015	-0.216	0.057	0.013
	(2.42)	(3.10)	(0.30)	(-3.10)	(-0.84)	(-0.37)	(-1.45)	(0.47)	(-2.17)	(3.11)	(1.41)
CLOTH	-0.074	-0.042	0.030	0.019	-0.020	-0.019	0.013	0.020	0.090	-0.017	0.001
	(-1.50)	(-2.71)	(2.26)	(2.01)	(-3.30)	(-1.45)	(0.60)	(1.52)	(2.49)	(-2.58)	(0.16)

Likelihood Ratio test statistic = 52.02.
Critical chi-square at 24 d.f. (alpha=0.05) = 36.41.

a/ Homogeneity and symmetry restrictions imposed.

Note: Figures in parentheses are asymptotic t-ratios. Prices and expenditures are in natural logarithm.

Table 5
Uncompensated Price and Income Elasticities, DM/AIDS Model

Equation	With Respect to the Price of							Total Expenditures
	CEREAL	MARINE	BEVE	FUEL	HOUSE	CLOTH	MISC	
CEREAL	-0.982	0.204	-0.105	0.266	0.473	-0.194	-0.194	0.533
MARINE	0.192	-1.018	-0.022	-0.011	0.081	0.159	-0.235	0.853
BEVE	-0.298	-0.055	-0.629	-0.191	-0.454	0.172	0.463	0.993
FUEL	0.549	-0.067	-0.293	-1.154	-0.285	-0.162	0.310	1.101
HOUSE	0.480	-0.035	-0.472	-0.213	-1.200	-0.140	0.020	1.560
CLOTH	-1.273	0.701	0.588	-0.364	-0.452	-0.703	0.533	0.968
MISC	-0.508	-0.377	0.389	0.180	0.061	0.134	-1.183	1.306

Table 6
Uncompensated Price and Income Elasticities, SB/AIDS Model

	With Respect to the Price of							Total Expenditure
	CEREAL	MARINE	BEVE	FUEL	HOUSE	CLOTH	MISC	
CEREAL	-1.038	0.187	-0.059	0.280	0.396	-0.155	-0.116	0.506
MARINE	0.165	-1.025	-0.005	-0.001	0.061	0.171	-0.212	0.847
BEVE	-0.227	-0.037	-0.675	-0.221	-0.397	0.137	0.406	1.012
FUEL	0.566	-0.059	-0.341	-1.135	-0.156	-0.222	0.194	1.152
HOUSE	0.349	-0.063	-0.422	-0.133	-1.179	-0.144	0.013	1.578
CLOTH	-1.039	0.760	0.473	-0.497	-0.464	-0.688	0.500	0.955
MISC	-0.384	-0.348	0.342	0.111	0.059	0.124	-1.197	1.292

Table 7
Compensated Price Elasticities, DM/AIDS Model

	With Respect to the Price of						
	CEREAL	MARINE	BEVE	FUEL	HOUSE	CLOTH	MISC
CEREAL	-0.853	0.302	-0.033	0.315	0.557	-0.173	-0.116
MARINE	0.399	-0.861	0.095	0.069	0.215	0.193	-0.110
BEVE	-0.058	0.127	-0.493	-0.098	-0.298	0.212	0.608
FUEL	0.815	0.135	-0.143	-1.050	-0.112	-0.118	0.471
HOUSE	0.858	0.251	-0.259	-0.067	-0.955	-0.077	0.248
CLOTH	-1.038	0.878	0.720	-0.274	-0.299	-0.664	0.675
MISC	-0.192	-0.137	0.567	0.302	0.267	0.187	-0.992

Table 8
Compensated Price Elasticities, SB/AIDS Model

	With Respect to the Price of						
	CEREAL	MARINE	BEVE	FUEL	HOUSE	CLOTH	MISC
CEREAL	-0.916	0.280	0.010	0.327	0.475	-0.134	-0.042
MARINE	0.370	-0.870	0.111	0.078	0.194	0.205	-0.089
BEVE	0.018	0.149	-0.537	-0.126	-0.238	0.178	0.554
FUEL	0.845	0.153	-0.183	-1.027	0.025	-0.175	0.363
HOUSE	0.732	0.227	-0.207	0.015	-0.930	-0.080	0.244
CLOTH	-0.807	0.935	0.603	-0.408	-0.314	-0.650	0.640
MISC	-0.071	-0.111	0.519	0.232	0.263	0.176	-1.008

Table 9
Elasticity Estimates in Other Studies, Philippines

Source	Sample Period	Model/Data	Commodity	Uncompensated Own Price Elasticity	Income Elasticity
Quisumbing et al. (1988)	1960-75	Translog, FIES a/	Food	-0.77	0.79
			Shelter	-0.33	1.20
			Clothing	-0.41	1.13
			Fuel, light & water	-0.36	0.82
			Miscellaneous	-0.28	1.45
Lluch, Powell and Williams (1977	1953-65 b/	Extended Linear Expenditure System, national account data	Food	-0.35	0.52
			Clothing	-0.12	0.75
			Housing	-0.40	1.82
			Durables	-0.25	2.23
			Personal care	-0.22	1.72
			Transport	-0.27	2.39
			Recreation	-0.19	1.69
			Open services	-0.34	2.08
Pante (1977)	1949-74	Linear Expenditure System, national accounts data	Food	-0.16	0.99
			Beverages and Tobacco	-0.35	1.12
			Durables	-0.33	1.10
			Miscellaneous	-0.26	0.96

a/ For survey rounds: 1960, 1965, 1971, and 1975.
b/ Years 1954, 1956, 1957, and 1959 ommited.

Source: Quisumbing (1988).

Table A1
Income Elasticities by Quintile, using the DM/AIDS Parameter Estimates

Quintile	CEREAL	MARINE	BEVE	FUEL	HOUSE	CLOTH	MISC
First	0.713	0.853	0.993	1.107	1.886	0.959	1.608
Second	0.664	0.861	0.994	1.108	1.790	0.965	1.489
Third	0.615	0.862	0.994	1.107	1.704	0.967	1.411
Fourth	0.544	0.862	0.994	1.106	1.615	0.969	1.338
Fifth	0.319	0.842	0.993	1.096	1.445	0.969	1.231

Table A2
Uncompensated Own-Price Elasticities by Income Quintile,
using DM/AIDS Parameter Estimates

Quintile	CEREAL	MARINE	BEVE	FUEL	HOUSE	CLOTH
First	-0.945	-1.018	-0.603	-1.161	-1.265	-0.623
Second	-0.955	-1.015	-0.639	-1.163	-1.246	-0.676
Third	-0.965	-1.015	-0.655	-1.161	-1.229	-0.698
Fourth	-0.980	-1.015	-0.659	-1.160	-1.211	-0.714
Fifth	-1.026	-1.021	-0.607	-1.145	-1.177	-0.718