Estimating Consumption Parameters for Food Policy Analysis

C. Peter Timmer and Harold Alderman

Paper presented at the American Agricultural Economics Association Summer Meetings, Pullman, Washington, July, 1979.

Introduction. -- Food policy analysis links nutrition objectives to macro economic policies and performance. At the heart of the analysis is a matrix of price and income elasticities that must be income-strata-specific. Obtaining this matrix for aggregated income classes requires a blend of complex theory and sophisticated econometric analysis that is only possible with restrictive assumptions about the separability of the impact of price changes for one commodity class on changes in demand for other commodity groups.

The separability assumptions are not overly restrictive in the context of such highly aggregated commodities as food, housing, or clothing. But when important nutritional effects occur due to substitution of one quality of wheat for another, or the substitution of cassava for rice, then the level of commodity detail needed to reproduce accurately the impact of relative price changes forcloses the "econometric" approach even for combined income classes. Obtaining the full matrix for disaggregated income classes requires a new approach and this paper reports one attempt.

The Consumption Model. -- Although consumer theory is developed from the decision perspective of an individual consumer or consuming household, it is usually applied empirically in per capita or per household terms to aggregate market data. Thus the opportunity for consumers at different levels to behave differently with respect to economic parameter variation, e.g. changes in prices, which is an integral aspect of the theory, is usually obliterated in the data aggregation process.

Cross section analysis has been used to understand more about how household decision parameters vary at different income levels. Income-class-specific income elasticities are quite easy to derive from cross section consumption surveys, but some care must be used in interpreting such cross section parameters in a dynamic projection contect. The use of cross section data to derive income-class-specific price elasticities has been extremely limited for fairly obvious reasons. Households are sampled only once at a particular time when the prices they face are given. If the whole sample is taken during a brief period, e.g., one week, then the only price variation observed will be due to spatial differences.

These price differences will by necessity be faced by different households which may have different tastes. In such a situation it is difficult to infer causality to regionally different consumption patterns even when prices are different. The solution to the impass is either to have a cross section panel of consumers whose consumption expenditures are recorded over time or to draw a large sample over enough geographical and temporal diversity to capture significant variance in the relevant variables. Both approaches are quite expensive, but the second does have the advantage of more rapid results if prices show significant seasonal variation. Data from the Indonesian Socio-Economic Survey V (1976) -- Susenas -- used in the empirical analysis reported here capture these effects. With three separate samples of 18,000 households drawn in each trimester of 1976, the sample is large enough so that cell means can be used as observations for analysis. This averages out most individual taste differences but leaves adequate variations in incomes and prices for statistical analysis. Such analysis could be conducted directly on the raw data when it is accessible by large computers.

At the level of the individual consumer decision-maker, economic theory is quite clear about what economic variables should be included in principle as arguments in the consumption function -- own income, all commodity prices, and any factors determining tastes. Given the more than 100 food commodities alone reported by Susenas V, inclusion of all prices is clearly not possible. Even with 54,000 observations some aggregation of commodities is necessary to make any sense of the data.

The analysis reported here deals only with rice, fresh cassava, and total calorie intake from rice, fresh cassava, and corn. Attempts to unraval the factors influencing shelled corn consumption alone have not been successful. Since rice, corn, and cassava are the three most important foodstuffs for most Indonesian consumers, accounting for over two-thirds of average calorie intake, whatever functional specification and approach is ultimately chosen must permit accurate estimation of the coefficients determining their use.

Equation 1 presents the standard, general form of a household consumption function.

Equation 1 $Q_{ih} = f(Y_h, P_i, P_j \dots P_z, H_h, T_h)$, where

Q_{ih} = quantity of commodity i consumed by household h (for a given time)

Y_h = income for household h

P_i = price of commodity i

$P_j \dots P_z$ = prices of other commodities j to z that might influence the consumption of i (significantly)

H_h = household size (and perhaps age and sex distribution)

T_h = household tastes (perhaps captured by educational, regional, ethnic, and occupation variables).

The Susenas data available for analysis already converted household observations to per capita terms, and no opportunity existed to investigate the impact of variations in H_h on consumption. Similarly, no educational, ethnic or occupational variables were available in the provincial level data; only regional and urban/rural effects could be specified. The possibility that "taste" changes seasonally was investigated.

Determining a specific functional form from the general specification of Equation 1 is a matter of judgment and empirical fit. Equation 2 shows the general form that was used throughout this analysis.

Equation 2

$$Q = A + A_i + a_1 TX + a_2 YX^2 + a_{3_i} P_i + a_{4_i} XP_i + a_{5_j} R_j + a_{6_k} T_k + a_{7_h} D_h + E$$

where Q = log of per capita commodity consumption in kg per week for each income class, round, province and urban or rural observation,

A = intercept,

A_i = income class specific intercept,

TX = log of total expenditures for respective cell mean observation,

TX^2 = TX squared,

P_i = log of own price of commodity for each observation, calculated as commodity value divided by commodity quantity,

XP_i = log of cross price term, calculated as above,

R_j = zero-one dummy variable for region j,

T_k = zero-one dummy variable for sample rounds Jan-Apr, May-Aug and Sept-Dec,

D_n = other zero-one dummy or interaction variables, as specified in text, and

E = error term assumed normally distributed in logarithms.

The Engel function within the overall equation is a double-log quadratic so that the income (i.e., total expenditure) elasticity of demand for the commodity is specified as $a_1 + 2_{a_2} TX$. Since a_2 is consistently negative for all regression speficications, the income elasticity declines smoothly with higher incomes. A number of alternative Engel specifications were investigated, but Equation 2 gives the best results for the low income observations where our policy interest lies.

Regression Results. -- The data used in this analysis are cell means reported for twelve income classes for 24 provinces (plus Jakarta), separately for urban and rural consumers, for each of three time periods, or approximately 1800 observations in all. Since the number of households in each cell varied roughly according to its relative frequency in the Indonesian population, all regressions were weighted by the square root of the number of individuals reported in each cell. To avoid the influences of extreme observations due to small cell size, no observation with fewer than 10 individuals (approximately 2 households) was retained. All regressions reported here were run on the entire sample; separate runs by geographic area, by sample round, and by income class are also under investigation.

Table 1 presents the basic statistical results for the rice, fresh cassava, and calories from rice, fresh cassava and corn regressions. For each of the three categories a general regression is reported (Numbers 1, 3, and 5) followed by our best regression with income-class-specific price effects (Numbers 2, 4, and 6). Such directly estimated income-class-specific price effects have never been reported in the literature. But the income elasticities are also quite important because of the debate in the nutrition planning literature over the response of calorie-deficit populations to higher incomes. Table 2 shows that for both specific commodities and for calories from the three sources, the income elasticities for the Indonesian poor are quite substantial.

Rice income elasticities are extremely high for the first two income classes, indicating it is effectively a luxury good for the bottom 30-40 percent of the Indonesian population. Even high income populations increase their rice intake with higher incomes, especially in the rural areas. Regression 2 does not show a negative income elasticity of demand for rice in urban areas until per capita total expenditures reach Rp12,600 per month, and the figure is Rp16,300 per month in rural areas. Substitution away from rice with higher incomes is occurring for less than 5 percent of the Indonesian population.

Income elasticities for fresh cassava are also surprisingly high. They exceed one for the bottom 10-15 percent of the rural population and remain positive for 50-60 percent of the population. Although the effective income elasticity of demand for cassava in the past decade has no doubt been negative due to the concentration of income growth among upper income groups, higher incomes among the bottom half of the population, and especially the rural population, would be likely to generate significant increases in demand for fresh cassava. Statistical results for gaplek, a form of dried cassava, are not available currently, but graphical analysis shows that virtually all gaplek is consumed by the bottom two income classes, and the income elasticity is probably negative even for these groups.

The calorie income elasticities are obviously somewhere between the rice and fresh cassava elasticities. The calorie regression was run on rice, maize and fresh cassava calories, and it shows income elasticities of about 0.7 for the bottom 10-15 percent of the population, declining to about 0.2 for the upper quarter. Since these income elasticities are likely to be lower bounds to the actual elasticities because fish, meat, eggs and milk calorie sources are not included, the conclusion must be that directing income to the poor will be a quite efficient way to improve their calorie intake.

Income-class-specific income elasticities of demand for various foods and for calories are standard in the nutrition planning literature if for no other reasons than the good fit of semi-log consumption functions. The same is not true of price elasticities, which are frequently hard to estimate for an entire population where data series are short and none too accurate, as is typical of data from many developing countries. Estimating price elasticities by income class simply has not been done with any confidence.

Consequently, the income-class-specific price elasticities reported in Tables 1 and 2 are important just on methodological grounds. More important, however, is the boost they give to the a priori notion that the poor respond much more sensitively to price changes than do the rich. Although the Slutsky relationship argues that this is likely becuase the budget proportion and income elasticity for basic food staples vary systematically by income class, the more significant price substitution by the poor extends <u>beyond</u> the Engel component of the total Slutsky effect. At least for rice and cassava, the information in Table 2 permits the calculation of pure substitution effects which also vary systematically by income class.

Both the income and (average) price elasticities reported in Table 2 are substantially larger in absolute magnitude than most of the standard coefficients reported in the literature. It is important to realize, however, that these elasticities are not likely to be representative of short-run change parameters. Since they are estimated from cross-section data, the only appropriate interpretation is that these elasticities refer to long-run responses expected after several years of adjustment to new income or price levels. Although regional and temporal covariance analysis via dummy variables for important provinces and survey rounds mitigates this short-run/long run dichotomy to a substantial extent (and reduces the own price response as well, some of which depends on regional and temporal price differences that are removed by covariance specification) it would be hazardous to use the parameters in Table 2 for predictions of annual changes in commodity or calorie consumption in the face of income or price changes. However, even if the immediate response is only half of the long-run response (implying an adjustment coefficient of 0.5 in a Nerlovian adjustment model, a figure in keeping with what little empirical evidence exists) the parameters in Table 2, and especially the price parameters, remain dramatically large.

Are they surprisingly large? The question can be answered only relative to expectations. But in the multi-staple food economy of Indonesia with prevailing low levels of average caloric intake, such parameters would be quite consistent with an economically calculating population. Relatively wealthy populations can afford both strongly held food preferences and consumption patterns. The income elasticities for rice show that Indonesians do have strongly held food preferences and will exercise them as income permits. But the price elasticities reflect an ability to adjust consumption patterns in economically rational directions despite those preferences. At least among the bottom 30-40 percent of the population income and price policies will meet with very sensitive and appropriate response.

Implications for Food Policy Analysis. -- Raising basic food prices as an incentive to farmers clearly has an adverse effect on food intake by consumers, especially those poor consumers already at substantial risk of consuming inadequate protein and calories. The results reported here argue that for this society "food" should be disaggregated into its important calorie sources. Doing so opens the possibility of providing farmers incentive prices for the preferred food (rice) and charging consumers relatively higher prices as well, while keeping the prices of secondary grains (maize) and root crops (cassava) low, even subsidized, to protect the poor.

A differential price policy targets the nutritional impact without the enforcement costs and leakages of programs using more preferred foods. The policy is self-enforcing because the poor eat staples no longer attractive to the higher income groups.[1/] This avoids subsidizing the food consumption of the entire population, which tends to bankrupt a poor country. The strategy calls for high political commitment to increasing the access of the poor to adequate food supplies, but it may also be the only financially feasible way of coping with protein-calorie malnutrition over the next several decades.

As this paper indicates, the data and analytical costs of such a multi-commodity price policy are quite high. But these high analytical costs must be compared with the costs of subsidizing food consumption for much of the population or of attempting to enforce target-oriented food distributions that really reach the poor. The combination of high analytical and high political costs is not very attractive. But neither are the alternatives. Domestic resource constraints and international market realities will force the political costs of higher rice prices to be paid eventually. Paying the analytical costs now may prevent the political costs from being paid without any return in nutritional well-being for the poor.

C. Peter Timmer is Professor of the Economics of Food and Agriculture in the Department of Nutrition, Harvard School of Public Health, and is a Faculty Fellow of the Harvard Institute for International Development. Harold Alderman is a research assistant in the Department of Nutrition and a graduate student in the Economics Department.

FOOTNOTE

1/ We recognize that fresh cassava is eaten in about equal per capita quantities by all income groups, but even this is a much more "equitable" consumption pattern than for rice. Maize seems to be in between rice and fresh cassava in this regard. Hence subsidizing fresh cassava would involve about equal subsidies to all income groups whereas subsidizing rice subsidizes the rich more than the poor in per capita terms (perhaps not in percent of income terms). Subsidizing gaplek would target the impact almost entirely on the poor unless diversions to livestock feeding became significant.

Table 1. -- Indonesian Per Capita Food Demand Regressions (t-statistics in parentheses)

		A	TX	TX^2	UTX	PTX	PRICE	XPRICE	URBAN	RND 1	RND 2	W JAVA	C JAVA	E JAVA	SUMATRA	KALIMAN	SULAWESI	UPCAL	Regression Number	R^2
RICE																				
Overall Coefficient		-16.477	4.874	-0.252	-0.151	0.056	-1.163	-0.033	1.207	-0.043	-0.106	0.039	-0.059	-0.149	0.148	0.133	-0.370		1	0.69
			(12.8)	(11.1)	(3.2)	(2.1)	(8.8)	(0.8)	(3.0)	(1.2)	(3.0)	(1.1)	(1.1)	(2.4)	(3.0)	(2.3)	(6.4)			
Income Class:	G	-27.69	6.732	-0.347	-0.80	0.114	--	--	1.452	-0.046	0.105	0.049	-0.068	-0.158	0.146	0.115	-0.361		2	0.72
			(10.7)	(9.9)	(3.8)	(4.0)			(3.6)	(1.3)	(3.0)	(0.9)	(1.3)	(2.6)	(3.0)	(2.0)	(6.4)			
	1	6.445					-1.921	-0.073												
		(4.0)					(7.1)	(0.8)												
	2	3.971					-1.475	-0.004												
		(2.4)					(4.9)	(0.0)												
	3	2.472					-1.156	-0.082												
		(1.8)					(5.1)	(1.2)												
	4	--					-0.743	-0.005												
							(4.0)	(0.1)												
FRESH CASSAVA																				
Overall Coefficient		-30.713	6.450	-0.361	-0.140	0.066	-0.893	0.765	--	0.480	0.240	0.088	0.281	0.424	0.014	0.417	1.056		3	0.39
			(4.7)	(4.5)	(9.9)	(0.6)	(5.9)	(1.45)		(3.5)	(1.7)	(0.4)	(1.3)	(1.7)	(0.1)	(1.8)	(4.7)			
Income Class	G	-27.582	5.781	-0.326	-0.140	--	--	--	--	0.477	0.232	0.072	0.285	0.420	0.010	0.414	1.038		4	0.39
			(2.8)	(9.9)						(3.5)	(1.7)	(0.4)	(1.3)	(1.7)	(0.1)	(1.8)	(4.6)			
	1						-1.281	0.996												
							(3.4)	(1.8)												
	2						-0.818	0.709												
							(2.0)	(1.2)												
	3						-0.943	0.787												
							(3.4)	(1.5)												
	4						-0.800	0.685												
							(4.0)	(1.3)												
CALORIES FROM RICE, CORN & FRESH CASSAVA																				
Overall Coefficient		-0.953	3.270	-0.169	-0.023	0.012	-0.514	--	--	0.042	0.002	-0.071	-0.180	-0.164	0.014	-0.015	-0.198	--	5	-.72
			(14.4)	(12.7)	(10.1)	(0.7)	(7.6)			(1.9)	(0.1)	(2.1)	(5.0)	(4.1)	(0.5)	(0.4)	(5.5)			
Income Class	G	-8.598	2.852	-0.142	-0.098	0.013	--		-0.115	0.028	0.018	-0.048	-0.156	-0.146	0.039	0.016	-0.178	-0.232	6	0.73
			(7.0)	(6.3)	(3.0)	(0.7)			(0.2)	(1.3)	(0.8)	(1.4)	(4.4)	(3.7)	(1.3)	(0.4)	(5.0)	(1.4)		
	1	0.849					-0.329													
		(1.6)					(3.7)													
	2	-0.895					-0.849													
		(1.2)					(4.6)													
	3	-0.427					-0.579													
		(0.7)					(4.7)													
	4	--					-0.579													
							(4.3)													

Note: All continuous variables are specified in logarithms. UTX is the URBAN dummy variable multiplied by TX, the log of per capita total expenditures. PTX is TX times POOR, a dummy variable equal to one for the lowest of twelve expenditure classes in the sample survey (TX ≤ Rp1000/month). UPCAL is URBAN times the logarithm of calorie prices. PRICE always refers to own price for the commodity in question and XPRICE refers to cross price (cassava prices in the rice regressions; rice prices in the cassava regressions). All regressions were estimated with SPSS regression programs using the WEIGHT procedure with the square root of cell size weights for each cell observation.

Table 2. -- Income and Price Elasticities of Demand for Food in Indonesia

	Income Class				
	1 Low	2 Low-Mid	3 High-Mid	4 High	Average
Per Capita Total Expenditure (Rp/month)					
Value (TX)	1484	2532	3968	9578	6151
Logarithm	7.302	7.837	8.285	9.167	8.724
Range	<2000	2000-3000	3000-5000	>5000	6151
Proportion of Indonesian Population					
Susenas sample	0.100	0.140	0.290	0.469	
Population weight	0.154	0.237	0.324	0.285	
Income Elasticities					
Rice: Urban	1.436	1.100	0.794	0.121	0.527
Rural	1.677	1.297	0.987	0.455	0.952
Cassava: Urban	0.835	0.524	0.231	-0.401	-0.010
Rural	1.037	0.674	0.383	-0.116	0.350
Calories[1/]: Urban	0.660	0.525	0.398	0.122	0.288
Rural	0.783	0.628	0.501	0.283	0.486
Price Elasticities					
Rice	-1.921	-1.475	-1.156	-0.743	-1.105
Cassava	-1.281	-0.818	-0.943	-0.800	-0.804
Calories[1/]: Urban	-0.561	-1.081	-0.943	-0.811	
Rural	-0.329	-0.849	-0.711	-0.579	-0.514
Cross Price Elasticities					
Rice with Cassava	ns	ns	ns	ns	
Cassava with Rice	0.996	0.709	0.787	0.685	0.765

[1/] Calories from rice, shelled maize, and fresh cassava only