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Introduction

An understanding of food consumption patterns and parameters is fundamental to predicting the effects of policy changes on households with different characteristics.[1] Timmer, Falcon, and Pearson have argued that disaggregation by income class and region is vital to any analysis of consumer choices and the formulation of enlightened food policy.[2] This paper illustrates a methodology for, and application of, disaggregated food policy analysis, predicting the impact of changes in incomes and prices on food energy (i.e., calorie) intake among different population groups in Sri Lanka. The data used to analyze the food acquisition behavior of households are from the 1980/81 Labour Force and Socio-Economic Survey, conducted by the Department of Census and Statistics of Sri Lanka's Ministry of Plan Implementation. The survey was designed to be nationally, sectorally, and regionally representative. The consumption and expenditure data were collected during a 7-month period, from the beginning of October 1980 to the end of April 1981.

Food Consumption and Expenditure Patterns

In Sri Lanka, 81% of the 3,058,000 households live in rural areas, of which 9% reside and work on plantations. This latter group of rural households makes up what is referred to as the estate population and will be distinguished as such from other rural households for the remainder of this paper. Nineteen percent of the households in Sri Lanka live in the urban areas.[3] The average household size for the entire island is 5.2 persons, while the average for the rural areas (excluding those living in the estate sector) is 5.2; estates, 4.6; and urban areas, 5.4.

Table 1 provides data on each commodity group's mean share of

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TABLE 1

SHARE OF HOUSEHOLD BUDGETS ALLOCATED, QUANTITIES CONSUMED ANNUALLY, AND SOURCES OF CALORIES CONSUMED BY HOUSEHOLD, COMMODITY GROUP, AND EXPENDITURE DECILE, ALI-ISLAND, 1980/81

COMMODITY GROUP	EXPENDITURE DECILE										AVERAGE
	1	2	3	4	5	6	7	8	9	10	
Share of household budget (%):											
Rice	30.7	29.0	27.5	26.1	24.7	24.0	21.9	19.8	16.9	10.8	23.1
Wheat flour	1.9	2.2	1.8	2.3	2.0	1.7	1.5	1.4	1.2	.5	1.6
Coconuts	8.1	7.3	7.0	6.7	6.7	6.3	6.1	5.6	5.2	3.6	6.3
Bread	4.1	3.7	3.9	3.5	3.5	3.1	3.0	3.2	2.8	2.4	3.3
Condiments	6.0	6.3	5.8	5.9	5.9	5.8	5.7	5.3	5.0	3.7	5.6
Pulses	1.0	1.[illegible]	1.5	1.6	1.7	1.7	1.7	1.8	1.8	1.5	1.6
Other grains	.3	.3	.2	.2	.1	.04	.2	.04	.03	.1	.1
Meat	.4	.5	.5	.7	.9	.8	1.1	1.1	1.4	1.7	.9
Fish	3.8	4.6	5.1	5.3	5.5	5.7	5.2	6.3	6.8	5.7	5.5
Sugar	6.1	6.4	6.3	6.2	6.2	6.4	6.0	5.6	5.5	4.2	5.9
Oils	1.3	1.5	1.6	1.6	1.7	1.7	1.7	1.7	1.7	1.6	1.6
Roots and tubers	1.2	1.1	1.1	1.1	1.0	1.1	1.2	1.2	1.3	1.1	1.1
Milk products	1.1	1.3	1.7	1.8	1.7	2.1	2.2	2.6	2.7	2.7	2.0
Vegetables	4.0	4.1	4.2	4.4	4.3	4.1	4.3	3.9	3.9	3.0	4.0
Other foods	1.1	1.6	2.2	1.8	2.4	2.4	2.4	3.2	3.2	5.1	2.6
Nonfoods	28.9	28.7	29.6	30.8	31.[illegible]	33.1	34.8	37.3	40.6	52.3	34.8
Quantities consumed (per capita/year):											
Rice (lb.)	149.5	193.8	213.8	226.8	243.7	265.0	279.2	290.4	307.5	300.6	247.1
Wheat flour (lb.)	9.6	15.0	14.7	21.2	19.9	19.5	20.5	20.6	21.6	14.5	17.7
Coconuts (no.)	54.0	68.0	77.4	83.3	91.9	99.4	109.8	115.0	130.9	139.9	97.0
Bread (lb.)	22.2	27.1	33.6	34.4	39.1	39.4	43.1	53.5	58.0	81.0	43.2
Condiments (oz.)*	256.8	337.5	373.0	419.8	463.8	510.9	571.0	602.0	693.1	821.1	505.3

Pulses (lb.)	2.2	4.2	5.0	6.1	6.9	7.9	9.4	10.9	13.0	16.9	8.3
Other grains (lb.)	2.7	2.7	3.0	3.5	1.7	.8	4.8	.8	.4	1.6	2.2
Meat (lb.)	.9	1.1	1.4	2.2	3.2	3.1	4.6	6.0	8.3	16.7	4.8
Fish (lb.)	10.1	14.2	18.0	20.7	23.7	26.6	33.5	33.2	42.9	50.7	27.4
Sugar (oz.)	154.5	220.3	266.4	293.4	326.4	375.7	430.4	442.1	536.2	670.3	372.0
Oils (btl.)	1.7	2.4	3.1	3.5	4.1	4.8	5.2	5.8	7.3	9.3	4.7
Roots and tubers (lb.)	16.8	16.4	14.9	16.9	15.5	18.0	19.4	19.9	22.5	25.3	18.6
Milk products	...	...	...	...	...	...	...	...	...	...	...
Vegetables (lb.)	44.1	58.7	64.7	72.3	75.7	81.8	93.2	88.3	102.9	124.1	80.7
Other foods	...	...	...	...	...	...	...	...	...	...	...
Sources of calories (%):											
Rice	52.5	52.5	51.2	49.8	49.3	49.5	47.6	46.6	44.4	38.0	48.1
Wheat flour	3.4	3.9	3.3	4.3	3.9	3.4	3.2	3.1	3.0	1.9	3.3
Coconuts	18.4	17.8	17.8	17.6	17.9	18.0	18.1	18.0	18.2	17.1	17.9
Bread	5.9	5.6	6.2	5.8	6.2	5.7	5.7	6.8	6.7	8.8	6.3
Condiments	1.8	2.0	2.0	2.0	2.1	2.1	2.2	2.2	2.3	2.4	2.1
Pulses	.8	1.1	1.2	1.3	1.4	1.4	1.6	1.7	1.8	2.1	1.4
Other grains	1.2	1.1	1.1	1.1	.9	.8	1.6	1.1	1.2	2.4	1.3
Meat	.2	.2	.2	.3	.4	.4	.5	.6	.8	1.5	.5
Fish	1.7	1.8	2.1	2.2	2.3	2.3	2.6	2.4	2.6	2.5	2.3
Sugar	4.4	4.9	5.6	6.0	5.9	6.3	6.3	6.5	7.2	8.8	6.2
Oils	2.5	2.9	3.3	3.2	3.7	3.8	3.9	4.2	4.6	5.2	3.7
Roots and tubers	2.1	1.5	1.2	1.2	1.0	1.1	1.1	1.0	1.0	1.0	1.2
Milk products	.7	.8	1.0	1.0	1.1	1.3	1.5	1.7	2.1	3.0	1.4
Vegetables	1.9	1.5	1.4	1.4	1.6	1.3	1.2	1.3	1.3	1.5	1.4
Other foods	2.5	2.4	2.4	2.8	2.3	2.6	2.9	2.8	2.8	3.8	2.9

SOURCE.—Calculated by the author from the raw data tape of the "1980/81 Labour Force and Socio-Economic Survey," conducted by the Sri Lanka Ministry of Plan Implementation, Department of Census and Statistics, Colombo.

* This commodity group includes chilies, onion, garlic, cumin, fennel and mathe seed, coriander, maldive fish, ginger, tumeric, mustard, tamarind, goraka, salt, pepper, vinegar, limes, and a few other less important condiments.

the household budget, quantities consumed, and share of total calorie intake. These data indicate that a single staple, rice, plays an overwhelming role in the food economy of Sri Lanka. It is the major food in the diets of all Sri Lankans, regardless of sector or income. The next most important commodity in calorie contribution and budget share is coconuts. Like rice, coconuts are included in the food baskets of virtually all Sri Lankan households. Not only does policy affecting the consumption of rice and coconuts determine nutrient intake, but rice and coconuts are also the two most important agricultural commodities produced in Sri Lanka. Thus, they directly link production and consumption in the food system. Their dual role will be discussed in greater detail below.

Other commodity groups have important shares in the household food basket. Bread (especially important for urban households), wheat flour (especially important for estate households), and sugar, together with rice and coconuts, make up more than 80% of household calorie intake. Yet these commodity groups make up a much smaller share of total food expenditures. This indicates that while they are the major source of calories, other food commodities, such as protein-rich animal foods or vitamin- and mineral-rich condiments and fruits, are also important in the Sri Lankan diet. Obviously, households do not consider just the number of calories when purchasing food.

Other important findings include the increase in the budget shares and quantities of high-quality protein-rich foods (meat, milk, and, most important, fish) that come with increases in expenditures. For example, the budget share of meat increased four times over the income range, while the actual quantity of meat products consumed increased almost 17 times. Similarly, the budget share for milk products increased two and one-half times between the lowest to highest expenditure groups, as the percentage of households that purchased these products rose from less than 20 to almost 90. Among comparable expenditure groups, more high-quality foods, such as meat and fish, are consumed in urban areas.[4]

Another point to be made is that virtually all commodity groups, including staples, are consumed in larger quantities by households at the higher end of the income distribution despite declining budget shares. Thus, any subsidy on commodity prices of major staple foods (such as bread, oil, rice, and sugar) will, in fact, transfer a larger absolute amount of income to the rich than to the poor. Although the poor would be helped more, relative to their needs, there would be a high economic cost in reaching those in need through an untargeted food subsidy.

Some findings about the consumption of minor crops are also of interest. Few pulses, a potentially low-cost protein source, are consumed. Roots and tubers, a potentially low-cost calorie source, are

also consumed in small quantities. In fact, if costly white potatoes, which are rapidly becoming a favored commodity, are excluded from this category, the contribution of roots and tubers to the food-energy intake and the budget share becomes negligible, even among the poor. Also, only small amounts of other cereals (i.e., maize, millet, and sorghum) are consumed in rural areas, and virtually none are consumed in urban areas and on estates. Thus, the potential nutritional impact of subsidizing these crops is limited by their small share in the food basket.[5]

The commodity of wheat flour, as distinguished from bread, is generally not consumed in increasing quantities after the third decile. However, these all-island figures do not capture the fact that the average yearly consumption of wheat flour is only 13.7 and 14.0 pounds per capita in the urban and rural areas, respectively, while it is 75.2 pounds per capita on the estates. In addition, the high level of consumption on the estates is relatively stable across the expenditure distribution. Thus, wheat flour is eaten in sufficient quantitites among the poor to represent a possible effective vehicle for subsidizing the consumption of plantation workers. However, if this were done, care would be necessary to assure that the bakeries are not able to purchase the low-priced flour to produce the bread being consumed primarily by higher income families in the urban and rural areas.

Table 2 shows that calorie intake increases markedly with rising per capita expenditures. For a given expenditure decile, estate households have the highest calorie and protein intake, followed by rural households, with urban households having the lowest. These findings are mediated by the fact that the food share is highest on the estates and lowest in the urban areas (see table 3); and the rupees expended per calorie is highest in the urban areas because there, as discussed above, a different bundle of goods is consumed, consisting of a larger quantity of expensive sources of calories, especially meat, milk, and fish.

It is similarly interesting to examine the monthly total per capita expenditure levels of households ranked on an all-island basis according to their calorie intake (table 4). The data show, as expected, that total per capita expenditures increase for households in successively higher deciles of the distribution of calorie intake. What is especially noteworthy is that for comparable levels of calorie intake, total per capita expenditures of households are markedly higher in urban areas than in rural areas and are somewhat higher in rural areas than among households living on the estates. Given that food prices are not higher in the urban areas, this suggests that for comparable income levels urban households are at greater nutritional risk because of the choices they make as consumers. Nonetheless, the share of households that fall beneath the all-island cutoff point, which distinguishes the lowest

TABLE 2

AVERAGE DAILY CALORIE CONSUMPTION PER ADULT EQUIVALENT UNIT AND PER CAPITA BY PER CAPITA EXPENDITURE DECILE AND SECTOR, 1980/81

Expenditure Decile	Calories per Adult Equivalent Unit per Day				Calories per Capita per Day			
	Urban Areas	Rural Areas	Estates	All-Island	Urban Areas	Rural Areas	Estates	All-Island
1	1,466	1,613	1,564	1,587	1,138	1,239	1,222	1,221
2	1,853	2,076	2,088	2,047	1,433	1,617	1,595	1,590
3	2,099	2,309	2,322	2,280	1,625	1,815	1,811	1,788
4	2,282	2,525	2,717	2,525	1,785	1,977	2,047	1,964
5	2,375	2,696	2,864	2,661	1,875	2,144	2,269	2,113
6	2,517	2,914	3,314	2,890	2,002	2,331	2,580	2,303
7	2,678	3,211	3,272	3,124	2,139	2,586	2,691	2,519
8	2,816	3,339	3,935	3,286	2,248	2,716	3,223	2,666
9	3,082	3,765	4,269	3,627	2,434	3,119	3,310	2,971
10	3,372	4,248	4,104	3,877	2,765	3,595	3,754	3,261
Average	2,629	2,807	2,994	2,791	2,095	2,257	2,400	2,240

SOURCE.—Calculated by converting into calories the quantities consumed of the 220 food commodities contained in the raw survey data tape of the "1980/81 Labour Force and Socio-Economic Survey," conducted by the Sri Lanka Ministry of Plan Implementation, Department of Census and Statistics, Colombo.

NOTE.—Expenditure deciles in this and the following tables were determined by ranking all the households living in urban areas, rural areas, and on estates according to total reported expenditures per capita. Thus, 10% of the households, on an all-island basis, fall in each decile. The actual cut-off points between deciles is the same for all sectors. This means that the share of households in each decile for a given sector does not make up 10% of the households living in that sector. The first decile had the smallest expenditures; the tenth, the largest.

TABLE 3

FOOD SHARES BY PER CAPITA EXPENDITURE DECILE AND SECTOR, 1980/81

Expenditure Decile	Food Share			
	Urban Areas	Rural Areas	Estates	All-Island
1	.77	.76	.75	.76
2	.77	.76	.76	.76
3	.75	.74	.75	.75
4	.74	.73	.75	.74
5	.73	.73	.73	.73
6	.71	.71	.74	.71
7	.68	.70	.72	.70
8	.67	.67	.73	.67
9	.62	.65	.70	.64
10	.48	.54	.64	.52
Average	.66	.71	.73	.70

SOURCE.—Calculated from the raw data tape of the "1980/81 Labour Force and Socio-Economic Survey," conducted by the Sri Lanka Ministry of Plan Implementation, Department of Census and Statistics, Colombo.

NOTE.—The food share is the ratio of a household's expenditures on food to its total expenditures.

TABLE 4

AVERAGE MONTHLY PER CAPITA EXPENDITURE (Rs/month) BY DAILY PER CAPITA CALORIE CONSUMPTION DECILE AND SECTOR, 1980/81

Per Capita Daily Calorie Decile	Urban Areas	Rural Areas	Estate	All-Island
1	172.49	118.48	104.34	131.96
2	171.35	146.25	145.00	151.57
3	216.32	166.67	165.28	176.70
4	283.73	189.59	168.71	211.59
5	322.51	207.27	179.83	233.29
6	362.89	230.97	203.46	259.58
7	393.46	253.91	212.76	277.70
8	447.81	288.69	251.11	318.86
9	565.38	340.76	308.87	370.91
10	705.15	478.62	396.22	500.30
Average	337.44	244.97	231.85	263.21

SOURCE.—Calculated from the raw data tape of the "1980/81 Labour Force and Socio-Economic Survey," conducted by the Sri Lanka Ministry of Plan Implementation, Department of Census and Statistics, Colombo.

expenditure decile, is smaller in urban areas than in the rural areas or on estates.

Estimating Price and Income Parameters

Assessment of the effects of income growth and price changes requires moving beyond descriptive analysis and employing econometric techniques to model the behavior of households in acquiring food.[6] The intent is to estimate a matrix of own- and cross-price elasticities by income group in order to trace the effects of income and price changes on households with different economic and demographic characteristics.[7] To do so, consumption functions were directly estimated without placing restrictions on the parameters.[8]

A theoretical problem in estimating consumption functions directly is that not all households consume all food commodities. Some food groups, such as coconuts, fish, and rice, are consumed by virtually all households, and the use of ordinary least squares to estimate demand functions is appropriate. But only between half and two-thirds of the households consume meat, milk, and wheat. A large number of zero values in the demand functions will bias the estimates of the coefficients. In addition, if functions are estimated using the truncated sample, they do not avoid the bias, and they lose information contained in the sample.[9]

One method of dealing with this problem is to use a two-step approach for the estimation of demand parameters. The technique combines two separately specified functions.[10] The first is a binary choice model, such as a probit.[11] The second function to be estimated

in the two-step approach is an ordinary least squares regression (OLS) estimate using the truncated sample of consuming households, including the inverse of the Mill's ratio as a regressor.[12] Thereafter, the probit estimates and the truncated OLS can be combined to estimate the population parameter.[13]

A final major consideration in estimating income and price parameters is choosing the functional form that provides the best fit for the observed data. The log-log quadratic form, which is specified as follows, is employed for each commodity function:

$$\begin{aligned}\ln Q_i = {} & \alpha + \beta_1 LPCEXP + \beta_2 (LPCEXP)^2 + \gamma_i \ln P_i \\ & + \sum_j \gamma_j \ln P_j + \lambda_i \ln P_i \cdot LPCEXP + \sum_j \lambda_j \ln P_j \\ & \cdot LPCEXP + \sum_k \phi_k Z_k + \sum_m \theta_m Z_m \cdot LPCEXP\end{aligned} \tag{1}$$

for households 1,2,3, . . . n, where

n = the number of observations,
$\ln Q_i$ = the natural log of per capita consumption of commodity i,
$LPCEXP$ = the natural log of per capita expenditures,
$\ln P_i$ = the natural log of the price of commodity i,
$\ln P_j$ = the natural log of the vector of prices of all other commodities j, which does not include i,
Z_k = the vector of demographic and structural variables, and
Z_m = a subset of Z_k.

The cross-price terms in the models are included to reduce biases in income and own-price parameters as well as to elucidate trade-offs in the consumption of different foods.

The vector of other independent variables, Z_k, is included to prevent the income and price parameters from picking up effects that are in reality attributable to household structure and other demographic characteristics. A few variables were included in the Engel function to do this. First is the ratio of adult equivalency units to household size. This variable compensates for the effects that the age and sex composition of a household of a given size have on the average per capita requirements for the household and, thus, on the demand for individual commodities.

Just as the adult equivalent index is a vital demographic variable, so are household size and an interaction term between household size and per capita expenditure. Together these capture the effects of economies of scale in food purchases.[14]

The other demographic variable in the models was a dummy variable that takes the value one when a household member is a farmer or cultivator and zero otherwise. This variable picks up demographic, cultural, and price differences in the population of farmers.

Four other dummy variables were also included in the individual commodity models. The first takes a value of one when a household resides in an urban area and zero otherwise. The second takes a value of one when a household lives on an estate and zero otherwise. These enable the models to pick up how consumption patterns in urban areas and on estates differ from the patterns in rural areas. In addition, multiplying the log of per capita expenditures by those sectorial dummies results in slope shifters that test whether the expenditure elasticities for urban areas and estates differ significantly from those of rural areas.

Other interaction terms between price and expenditures were included in each of the models to test whether poor households are more price responsive than others. Some, however, were removed because of problems of multicollinearity with other variables.[15]

Elasticities

Analysis of the elasticities derived from the consumption functions for specific commodities produces several generalities.[16] The elasticities derived from the functions are given in tables 5 and 6. First, the significance of the quadratic term in most of the equations is reflected in the decline in expenditure elasticities that occurs as income rises. Second, it was possible to estimate the own-price elasticities, by income group, for many of the commodities, such as coconuts, sugar, and fish. These, too, usually decline in absolute value as incomes rise. The poor are more responsive to price and income changes than the well-off.

Also, for some commodities it was possible to estimate significant interaction terms between the dummy variables for each sector and the log of prices or expenditures. They indicate generally that the urban sector was less responsive to income and price changes than the rural sector. Similarly, the elasticities for the estate sector are generally higher than they are for the rural sector in absolute terms. But there are many instances in which it was not possible to estimate elasticities for the sectors because of multicollinearity between the sectoral dummy variables themselves and the multiplicative interaction terms between them and the log of expenditures.[17]

In general, the signs of the own- and cross-price elasticities correspond to expectations. For example, in the rice equation the coefficients for fish, coconuts, and oil are negative, meaning that as their prices rise, less rice is consumed. This is reasonable because they are all used in preparing curries. As expected, the positive cross-price elasticity of 0.19 for bread in the rice equation indicates that it is a

TABLE 5

EXPENDITURE ELASTICITIES AND OWN-PRICE ELASTICITIES BY EXPENDITURE GROUP, SECTOR, AND COMMODITY, 1980/81

COMMODITY/ SECTOR	EXPENDITURE ELASTICITIES			OWN-PRICE ELASTICITIES		
	Low*	Middle†	High‡	Low*	Middle†	High‡
Rice:						
Urban areas	.62	.43	.08	−.62	−.58	−.58
Rural areas	.69	.50	.15	−.70	−.67	−.67
Estates	.69	.50	.15	−.70	−.67	−.67
Coconuts:						
Urban areas	.61	.59	.29	−.55	−.45	−.25
Rural areas	.67	.65	.35	−.67	−.57	−.37
Estates	.67	.65	.35	−.67	−.57	−.37
Sugar:						
Urban areas	1.02	.82	.34	−.90	−.82	−.63
Rural areas	1.09	.89	.40	−.84	−.76	−.57
Estates	1.26	1.06	.57	−.67	−.59	−.41
Fish:						
Urban areas	1.79	1.30	.12	−1.68	−1.28	−.35
Rural areas	2.17	1.68	.50	−1.68	−1.28	−.35
Estates	2.17	1.68	.50	−1.68	−1.28	−.35
Condiments:						
Urban areas	.99	.84	.43	−.57	−.57	−.57
Rural areas	1.06	.90	.50	−.51	−.51	−.51
Estates	1.06	.90	.50	−.51	−.51	−.51
Vegetables:						
Urban areas	.99	.83	.36	−.79	−.73	−.57
Rural areas	.96	.79	.32	−.79	−.73	−.57
Estates	.82	.65	.18	−.63	−.57	−.40
Bread:						
Urban areas	.47	.36	.21	−.33	−.33	−.33
Rural areas	.90	.79	.64	−.81	−.81	−.81
Estates	2.39	2.29	2.14	−.81	−.81	−.81
Oil:						
Urban areas	.82	.68	.36	−.51	−.51	−.51
Rural areas	.94	.80	.49	−.51	−.51	−.51
Estates	1.10	.96	.65	−.51	−.51	−.51
Pulses:						
Urban areas	.89	.71	.25	−1.66	−1.13	−.76
Rural areas	1.47	1.29	.33	−1.65	−1.13	−.76
Estates	1.47	1.29	.33	−1.65	−1.13	−.76
Wheat flour:						
Urban areas	.15	.07	−.15	−1.33	−1.11	−1.11
Rural areas	.15	.07	−.15	−1.33	−1.11	−1.11
Estates	.15	.07	−.15	−1.33	−1.11	−1.11
Milk:						
Urban areas	1.72	1.64	1.51	−1.95	−1.57	−1.16
Rural areas	1.72	1.64	1.51	−1.87	−1.39	−1.24
Estates	1.72	1.43	1.51	−1.87	−1.39	−1.24
Meat:						
Urban areas	.76	.73	.66	−1.13	−1.11	−1.08
Rural areas	.76	.73	.66	−1.13	−1.11	−1.08
Estates	.76	.73	.66	−1.13	−1.11	−1.08
Root crops:						
Urban areas	1.07	1.13	1.27	−1.33	−1.24	−1.24
Rural areas	1.07	1.13	1.27	−1.33	−1.24	−1.24
Estates	.07	.82	.97	−1.33	−1.24	−1.24

* This corresponds to the second expenditure decile.
† This corresponds to the mean of the population.
‡ This corresponds to the tenth expenditure decile.

substitute for rice in the diet. Milk and meat are also substitutes for rice, although their elasticities are small in absolute value. This may be partly because households revert to using their limited resources to obtain favored foods whenever the price of a luxury food increases. Also, in the rice demand equation the significant interaction term between the price of meat and per capita expenditures indicates that as incomes increase, the trade-offs between commodities decrease. That can be attributed to a combination of the decline in the pure substitution effect and the expected lower income elasticities and reductions in the budget shares of rice as expenditures increase.

Wheat was the only commodity for which important trade-offs with rice were expected (at least for estate households) but for which a robust coefficient was not estimated. The problem might have arisen because all wheat is imported and transformed into flour by a single miller. There is considerably less price variation than for other commodities, which in this instance precludes estimating cross-price elasticities from cross-sectional data.

The signs of the income and own-price elasticities for the other major commodities—bread, coconuts, and sugar—are as expected. For coconuts, as incomes increase, households become less responsive to prices. This is attributed to a decreasing budget share and income elasticity of demand combined with the reduction in the value of the compensated cross-price term as income rises. Bread, fish, oil, pulses, rice, and other grains are all gross complements, which reflects the use of coconuts as an ingredient in many recipes.

An increase in the price of rice results in a decline in sugar consumption. The opposite is true of coconuts, a gross complement to sugar. In the demand function for bread, which is the most important of the commodities estimated using the two-stage technique, all commodities except fish and oil are gross substitutes. Most important in that regard are the trade-offs between bread and coconuts, pulses, sugar, and wheat flour.

Determining Calorie Elasticities

The elasticities estimated in the preceding section predict how household purchases of commodities shift in response to changes in income and food prices. But understanding the implications of those changes for calorie intake requires the use of price and income elasticities of demand for calories. To estimate these, the individual commodity demand functions are aggregated by taking a weighted average:

$$M_c = \left(\sum_i C_i q_i M_i\right) \Big/ \left(\sum_i C_i q_i\right); \text{ and} \tag{2}$$

$$E_{ci} = e_{ii}\alpha_i + \sum_j e_{ji}\alpha_j, \tag{3}$$

TABLE 6

MATRIX OF OWN-PRICE AND CROSS-PRICE ELASTICITIES BY EXPENDITURE GROUP AND RURAL SECTOR, 1980/81

Commodity/ Expenditure Group	Rice	Coconuts	Sugar	Condiments	Vegetables	Fish	Bread	Pulses	Oil	Wheat Flour	Milk Products	Root Crops	Meat
Rice:													
Low*	−.70	.00	−.11	−.21	...	−.25	.09	−.48	−.72	...	...	...	.04
Middle†	−.67	−.05	−.11	−.14	...	−.25	.09	−.48	−.07	...	...	...	.04
High‡	−.67	−.05	−.11	.04	...	−.25	.09	−.48	.16	...	...	...	04
Coconuts:													
Low	−.05	−.67	.04	.05	...	−.37	.27	.30	.41	.28	.64	.68	.25
Middle	−.05	−.57	.04	.12	...	−.37	.22	.30	.41	.28	.19	.68	.25
High	−.05	−.37	.04	.28	...	−.37	.11	.30	.41	.28	.19	.68	.25
Sugar:													
Low	−.05	...	−.84	−.11	...	−.06	.83	...	...	...	...	...	...
Middle	−.05	...	−.76	−.11	...	−.27	.86	...	...	...	...	...	...
High	−.05	...	−.57	−.11	...	−.79	1.30	...	...	...	...	...	...
Condiments:													
Low	−.02	...	−.15	−.51	.07	.22	.25	.10	−.12	...	...	...	...
Middle	−.02	...	−.12	−.51	.07	.22	.25	.10	−.12	...	...	...	...
High	−.02	...	−.05	−.51	.07	.22	.25	.10	−.12	...	...	...	...
Vegetables:													
Low	−.00	...	−.05	−.02	−.79	.26	...	...	...	−.34	.04	.57	...
Middle	−.03	...	−.05	−.02	−.73	.26	...	...	...	−.34	.04	.57	...
High	−.10	...	−.05	−.02	−.57	.26	...	...	...	−.34	.04	.57	...
Fish:													
Low	−.03	−.05	.06	−.13	.05	−1.67	−.05	...	−.12	...	.48	...	−.23
Middle	−.03	−.05	.06	−.13	.05	−1.28	−.05	...	...	...	.48	...	−.10
High	−.03	−.05	.06	−.13	.05	−.35	−.05	...	...	...	.48	...	−.10
Bread:													
Low	.19	−.53	...	...	.40	−1.26	−.81	1.10	.90	.52	−1.10	−.97	...
Middle	19	−.34	...	...	.40	−1.26	−.81	1.10	.90	.52	−1.10	−.97	...
High	.19	.10	...	...	.40	−1.26	−.81	1.10	.90	.52	−1.10	−.97	...

Pulses:													
Low	...	-.08	.06	...	...	.26	.44	-1.65	...	-.47	.20	.08	...
Middle	...	-.08	.06	...	...	.26	.44	-1.13	...	-.47	.20	.08	...
High	...	-.08	.06	...	...	.26	.44	-.76	...	-.47	.20	.08	...
Oil:													
Low	-.06	-.09	...	...	-.04	-.16	.37	-.32	-.25	.05	.18	-.25	.17
Middle	-.06	-.09	...	...	-.04	-.16	.37	-.24	-.25	.05	.18	-.25	.17
High	-.06	-.09	...	...	-.04	-.16	.37	.24	-.25	.05	.18	-.25	.17
Wheat flour:													
Low	...	...	-.05	-.11	...	.77	.27	...	-.72	-1.33	...	...	...
Middle	...	...	-.23	-.11	...	.77	.27	...	-.72	-1.11	...	...	...
High	...	...	-.67	-.11	...	.77	.27	...	-.72	-1.11	...	...	...
Milk:													
Low	.02	.16	...	...	.14	.20	...	...	-.25	-1.65	-1.87	...	...
Middle	.02	.10	...	...	.09	.20	...	...	-.25	...	-1.39	...	...
High	.02	-.05	...	...	-.05	.20	...	...	-.25	...	-1.24	...	...
Root crops:													
Low	.01	.04	.04	-.05	.02	-.10	.08	...	-.05	-.25	...	-1.33	.15
Middle	-.02	.04	.04	-.05	.02	.03	.08	...	-.05	-.25	...	-1.24	.15
High	-.09	.04	.04	-.05	.02	.31	.08	...	-.05	-.25	...	-1.24	.15
Meat:													
Low	.17	.24	-.88	.14	-.21	1.03	-.67	-.15	.12	.31	.88	...	-1.13
Middle	.09	.13	-.12	.05	-.21	.71	-.67	-.07	.12	.73	...	...	-1.11
High	-.08	-.12	-.07	-.16	-.21	-.05	-.67	.14	.12	1.04	...	...	-1.08
Other grains:													
Low	-.20	-.05	.11	-.16	-.17	...	2.20	...	.09	...	.69	-.06	...
Middle	-.20	-.05	.11	-.16	-.17	...	2.20	...	.09	...	.69	-.06	...
High	-.20	-.05	.11	-.16	-.17	...	2.20	...	.09	...	.69	-.06	...

NOTE.—Where ellipses appear, no significant cross-price elasticity could be estimated.
* This corresponds to the second expenditure decile.
† This corresponds to the mean of the population.
‡ This corresponds to the tenth expenditure decile.

where

M_c = the income elasticity of demand for calories,
M_i = the income elasticity of demand for commodity i,
C_i = per unit calorie content of commodity i,
q_i = the quantity consumed of commodity i,
E_{ci} = the elasticity of calorie consumption with respect to a change in the price of commodity i,
e_{ii} = the own-price elasticity for commodity i,
e_{ji} = the cross-price elasticity with respect to a change in the price of commodity i, and
α_i or α_j = the share of total calories from commodity i or j, respectively, before an income or price change.

It is not readily apparent from equation (3) whether E_{ci} should be negative or positive. Which it is depends on whether the calorie availability from the gross complements or from the substitutes for i is more dominant. Nor is it obvious whether E_{ci} should be higher or lower for households in the lower expenditure deciles than for wealthier households. Two conflicting forces are at work here. On the one hand, it was shown above that e_{ii} is always negative and has a higher absolute value for low-income households. But on the other hand, one would expect that poor households substitute more readily, changing their food baskets more efficiently to maintain adequate calorie intake as prices change.

The price elasticities of demand for calories (see table 7) are much lower than the own-price elasticities presented in table 6. Clearly, households adjust their consumption bundle to mitigate the deleterious consequences of rising prices for food. Second, most calorie elasticities are negative, which is also as expected. Exceptions exist, however. For example, the own-price elasticity of meat is greater than unity for all income classes, but the elasticity of calories with respect to the price of meat is positive for all but the richest consumers. A rise in the price of meat discourages meat consumption; the subsequent substitution toward more calorie-efficient commodities increases the household's calorie intake. Among upper-income households, the lower own-price elasticity, coupled with less efficient substitution and the larger share of calorie intake derived from meat products, make the meat price elasticity of demand for calories negative.

Also, for rice, the price elasticity of calorie intake is nearly four times higher in absolute value among low-income households than it is for its closest rival, coconuts. This suggests that although the reduction in calorie consumption caused by an increase in rice prices is less than what would be predicted from the own-price elasticity, it is still significant. The large proportion of the budget that low-income house-

holds devote to rice coupled with these households' reluctance to substitute other commodities for rice result in an outstandingly high value for the rice price elasticity of demand for calories (see table 7). It is clear that any price policy concerned with nutrition must moderate sharp increases in rice prices.

With the exception of rice and, to a lesser extent, coconuts and fish, changes in an individual commodity price, holding others constant, will not seriously jeopardize nutritional well-being in the short run. Once again, this can be attributed to the small share that the other commodities have in total calorie intake and to the high degree of substitution between foods.

Simulating the Effects of Income and Price Changes

The following equation can be used to calculate the expected change in calorie intake from changes in real income and changes in commodity prices:

$$Q_c^1 = (Q_c^0 M_c)(Y^1 - Y^0/Y^0) + (Q_c^0 E_{ci})[(P_i^1 - P_i^0)/P_i^0] + Q_c^0 \quad (4)$$

where

Q_c^0 = calorie consumption of the household at present,
Q_c^1 = calorie consumption of the household at time 1,
Y^1 = per capita expenditures at time 1,
Y^0 = per capita expenditures at present,
P_i^1 = price of commodity i at time 1,
P_i^0 = price of commodity i at present,
M_c = income elasticity of demand for calories (from table 7), and
E_{ci} = elasticity of demand for calories with respect to the price of i (from table 7).

In table 8 the per capita calorie intake of rural households is shown before and after eight scenarios.[18] The first four scenarios change income but not prices. That is, they assume that there is a perfectly elastic supply curve or that the supply curve will shift to meet increases in demand with no change in prices. This is especially important because the major consumer-oriented food intervention in Sri Lanka is the food stamp program. The nature of this subsidy makes it, in effect, an income transfer program that does not affect commodity prices. In the first two scenarios, real expenditures increase 10%. The increase in the first scenario is 10% of the expenditures of each household. In the second scenario, the real expenditures for the whole economy are increased 10%, and this increase is distributed equally to all households. Given that mean per capita expenditures for the whole island are

TABLE 7

EXPENDITURE AND PRICE ELASTICITIES OF DEMAND FOR CALORIES, RURAL HOUSEHOLDS

COMMODITY	EXPENDITURE GROUP		
	Low	Middle	High
Expenditure	.76	.62	.28
Prices:			
Rice	−.41	−.35	−.30
Coconuts	−.10	−.08	−.04
Sugar	−.03	−.03	−.01
Fish	−.06	−.05	−.02
Bread	−.03	−.01	−.06
Oil	−.04	−.03	−.04
Wheat flour	−.03	−.05	−.07
Milk	−.02	.01	−.03
Meat	.09	.05	−.10
Roots and tubers	−.003	−.004	−.02
Condiments	−.03	−.01	−.01
Vegetables	−.01	−.03	−.05
Pulses	−.02	−.01	.01

Rs 3,158 per year, this represents an increase for each household of Rs 316 per year.

Under the second scenario, the per capita calorie intake of the poorest expenditure group rises from 1,239 to 1,544. Thus, the increment of 305 calories in per capita energy consumption of the lowest decile is three times greater than the increment of 111 calories that results from the increase in the first scenario.

A similar set of findings applies to the third and fourth scenarios, in which income rises 20%. With a 20% increase in total expenditures, distributed equally among all households (bringing about an increment of Rs 632), the mean per capita intake among the poor rises to 1,849 calories.

The fifth scenario shows the effect of lowering rice prices by 20% with no change in total expenditures. This has approximately the same effect on calorie consumption as the 10% proportional rise in real income of the first scenario. It shows that for rice the absolute value of the price elasticity of demand for calories is roughly half the income elasticity and that the rate of decline of the two parameters is comparable. Thus, a general consumer price subsidy and a proportional rate of income growth will have similar distributional effects that do not favor low-income households in absolute terms. This clearly indicates the need to target policies effectively—whether the policies be consumer subsidies that lower prices at the margin, food stamps that redistribute income, or a rationing scheme.

Finally, in the last three scenarios, rice prices are reduced 20%, and, at the same time, expenditures are either reduced by Rs 316 in one

TABLE 8

EFFECTS OF CHANGES IN INCOMES AND RICE PRICES ON THE PER CAPITA CALORIE INTAKE OF RURAL HOUSEHOLDS

Expenditure Decile	Calorie Consumption 1980/81	Scenario (Calories per Capita per Day)							
		1	2	3	4	5	6	7	8
1	1,239	1,350	1,544	1,461	1,849	1,362	1,667	1,057	1,972
2	1,617	1,744	1,872	1,871	2,129	1,757	2,014	1,499	2,271
3	1,815	1,940	2,031	2,065	2,258	1,953	2,179	1,726	2,406
4	1,977	2,188	2,184	2,259	2,391	2,132	2,339	1,926	2,545
5	2,144	2,292	2,335	2,440	2,522	2,307	2,494	2,119	2,681
6	2,331	2,481	2,504	2,631	2,676	2,495	2,667	2,323	2,839
7	2,586	2,738	2,739	2,890	2,892	2,756	2,909	2,604	3,062
8	2,716	2,870	2,849	3,021	2,975	2,886	3,012	2,760	3,138
9	3,119	3,273	3,228	3,427	3,333	3,291	3,395	3,187	3,499
10	3,595	3,703	3,647	3,811	3,692	3,725	3,777	3,680	3,829

NOTE.—The following describe the price and income changes in scenarios one through eight. Prices: In the first four scenarios, the prices of rice and all other prices are held constant; in the second four scenarios, rice prices declined by 20% while all other prices remain constant. Incomes: In the first scenario, expenditures rise by 10%; in the second and sixth scenario, expenditures rise by Rs 316 per capita. In the third scenario, expenditures rise by 20%. In scenarios 4 and 8, expenditures rise by Rs 632 per capita. Expenditures fall by Rs 316 per capita in scenario 7 and are constant in scenario 5.

scenario or, in the other two, increased by either Rs 316 or Rs 632. The reduction in consumption caused by a marked decline in income, even with reduced prices, reinforces the need for strong economic performance to raise the real income of the poor. When income increases and prices are reduced, the average consumption of the lowest expenditure group approaches 2,000 calories per capita. This is a 60% increase over current intake.

A number of points are worth considering. First, a 10% increase in real expenditures, distributed in proportion to current earnings, will raise the intake of the poorest households in Sri Lanka by 111 calories. Likewise, a 20% rise in real expenditures will have a bigger effect, although households in the lowest decile will still consume only 1,461 calories per capita—all of this despite calorie elasticities approaching unity.

The effect of a 10% or 20% rise in real expenditures on the number of households with inadequate intake is limited because a proportional rate of growth in income increases the expenditures in absolute terms of the better-off households more than those of the poor. Specifically, a 10% rise in real expenditures will increase the purchasing power of a rural household in the lowest decile by Rs 160 a year, but it will increase the purchasing power of those in the fifth decile by Rs 243 a year and those in the tenth by Rs 781 a year.

In sum, there are two important implications of these findings. First, a proportional, even if rapid, rate of growth of the expenditures among all expenditure deciles will not eliminate inadequate calorie intake in the near future. This supports the general conclusions of Reutlinger and Selowsky, who argue that during the normal pattern of development few countries will witness the elimination of malnutrition.[19] Second, these simulations show that the distribution of income growth, rather than its aggregate magnitude, is the key to reducing inadequate calorie intake in Sri Lanka.

The Effect of Price Changes on Paddy-Producing Households

The analysis presented above is limited because it does not take into account the effects of changes in the prices of food crops on the incomes of the many households in Sri Lanka that produce those crops. For example, survey results indicate that more than one-third of the rural households produce some paddy. Of those, approximately one-quarter produce 15 bushels or less per year. Virtually all the households producing these small quantities are net consumers (i.e., consume more than they produce) of paddy (table 9). In contrast, 99% of those producing more than 90 bushels are net producers, with 72% of such households falling in the upper half of the expenditure distribution. In total, 84% of households in rural areas are net consumers of paddy.[20]

TABLE 9

SHARE OF RURAL HOUSEHOLDS THAT ARE NET PADDY BUYERS BY AMOUNT PRODUCED AND EXPENDITURE QUARTILE, 1980/81

HOUSEHOLD PADDY PRODUCTION (Bushels/Year)	EXPENDITURE QUARTILE (%)*				AVERAGE
	1	2	3	4	
0	100.0	100.0	100.0	100.0	100.0
	(674)	(593)	(533)	(448)	(2,248)
1–15	97.9	98.9	96.3	97.7	97.7
	(94)	(90)	(81)	(44)	(309)
16–37	80.5	76.2	77.2	84.5	79.2
	(87)	(84)	(79)	(50)	(308)
38–90	33.3	44.4	52.2	35.6	42.1
	(60)	(72)	(90)	(87)	(309)
More than 90	.0	3.4	1.8	.0	1.3
	(28)	(59)	(111)	(108)	(306)
Average	90.7	86.7	80.4	75.8	83.9
	(943)	(898)	(894)	(745)	(3,480)

NOTE.—Numbers in parentheses equal sample size.
* Quartile cut-off points based on all-island data.

Interestingly, only about a quarter of the major income earners in households producing small quantities of paddy (i.e., valued at less than Rs 788 per year) list farming and cultivating as their primary occupation. Among these small paddy-production households, wage-earning activities off the farm are the most important source of income. In contrast, farming is the primary occupation of either the first or second income earner in 85% of the households with the highest value of paddy output. Only 8.2% of households that produce small amounts of paddy sell any of their produce on the market (see table 10). Fully 94% of their paddy output is consumed at home, and few landholders indicate that farming is their major occupation.

It is possible to evaluate the effects of price changes on calorie intake of paddy-producing households. The change in the quantity of calories consumed will be determined by the opposing effects of a higher paddy price that increases the income of farm households in their role as producers; and, concurrently, a higher market price will have a combination of negative income effects and negative price effects, the latter of which will encourage substitution away from rice toward other commodities.

The effects of a price increase on calorie intake can be calculated, assuming there is no short-term supply response, as follows:

$$d(Q_c/dP_i) = \partial Q_c/\partial P_i + mQ_i, \tag{5}$$

where Q_c = quantity of calories consumed per capita; m = the mar-

TABLE 10

OCCUPATIONAL CHARACTERISTICS OF HOUSEHOLDS GROWING PADDY, SHARE OF HOUSEHOLDS SELLING PADDY, AND RATIO OF HOME CONSUMPTION TO TOTAL PRODUCTION, 1980–81

	Value of Annual Paddy Production			
Characteristic	Less than Rs 788	Rs 788–1,900	Rs 1,901–4,760	More than Rs 4,760
Households in which the major income earner is a farmer (%)	26.6	48.6	58.4	74.9
Households in which the second income earner is a farmer (%)	12.2	10.3	9.7	11.2
Households in which the second occupation of major income earner is farmer (%)	10.0	8.2	14.8	7.8
Households selling paddy (%)	8.2	27.7	64.2	95.0
Households that produce more than they consume (%)	2.8	23.4	60.6	98.1
Mean ratio of home consumption to total production	.94	.83	.60	.31
Average size of paddy landholding (acres)	.44	.63	1.36	3.28
Number of households	319	329	310	319

ginal propensity to consume calories; P_i = the price of commodity i; and Q_i = the quantity of commodity i produced.[21]

Table 11 shows the effects of increasing rice prices by 20%, taking into account the dual role of prices in affecting the income of producers in rural areas and assuming that there is no short-term supply response.[22] The households producing 15 bushels or less have a net loss of 137 calories. The second group of paddy-producing households (producing 16–35 bushels) have a net loss of 110 calories, and the third (producing 38–90 bushels) have a net loss of 65 calories. In contrast, the households producing the most paddy have a net gain of 120 calories per capita as a result of the price rise, even though most are from upper expenditure groups and therefore have low income elasticities of demand for calories. With the exception of the largest producers, the increased income that accrues to paddy farmers as a result of an equal rise in farm-gate and market rice prices does not compensate for their losses as consumers. They are worse off after the price hike, and there is a net transfer of income from small farmers to larger producers. This says nothing of the majority of households in Sri Lanka who produce no paddy at all.

The important point, however, is that among producer households in the lowest income quartile, a rice price increase of 20% at the farm-gate and retail markets results in a reduction of food energy intake, even taking into account the positive effect of the price change on income.

TABLE 11

EFFECTS OF A 20% RICE PRICE INCREASE ON CALORIE CONSUMPTION UNDER TWO ASSUMPTIONS ABOUT THE OUTPUT RESPONSE OF PADDY FARMERS BY AMOUNT PRODUCED BY HOUSEHOLDS

EXPENDITURE QUARTILE/ SCENARIO	CALORIE CONSUMPTION PER CAPITA PER DAY OF HOUSEHOLDS PRODUCING BUSHELS PER YEAR				
	1–15 Bushels	16–37 Bushels	38–90 Bushels	More than 90 Bushels	Average
1:					
1980–81	1,507	1,562	1,560	1,954	1,550
After price increase:					
No output response	1,389	1,477	1,539	1,794	1,493
Supply elasticity of 0.2	1,392	1,484	1,553	1,829	1,503
2:					
1980–81	2,048	2,008	2,055	2,326	2,039
After price increase:					
No output response	1,915	1,902	2,000	2,189	1,984
Supply elasticity of 0.2	1,918	1,908	2,012	2,224	1,996
3:					
1980–81	2,532	2,596	2,566	2,647	2,590
After price increase:					
No output response	2,384	2,478	2,491	2,786	2,555
Supply elasticity of 0.2	2,386	2,484	2,502	2,823	2,570
4:					
1980–81	3,315	3,290	3,398	3,430	3,376
After price increase:					
No output response	3,148	3,147	3,303	3,511	3,325
Supply elasticity of 0.2	3,150	3,151	3,313	3,543	3,340
Average:					
1980–81	2,190	2,274	2,485	2,716	n.a.
After price increase:					
No output response	2,053	2,164	2,420	2,836	n.a.
Supply elasticity of 0.2	2,056	2,170	2,432	2,871	n.a.

This short-term analysis assumes that there is no supply response. Given the evidence from farm studies of how paddy farmers respond to prices, it is important to consider what happens if this assumption is relaxed. No reliable price elasticities of output are available for Sri Lanka. Work on other Asian economies suggests that, in the short term, these elasticities are between 0.15 and 3.0.[23] But these response parameters do not show how the output of secondary and minor crops is affected. It is likely that a change in the price of a dominant crop like rice will have a systematic and opposite effect on the supply of other crops such as coconuts, pulses, and oilseeds. The extent of this substitution, which is influenced both by reallocation of land and other factors of production, including labor, can only be guessed at, given the limitations of available data. Therefore, in the simulations that follow it is assumed that the short-term effect of a change in prices on paddy output is captured by an elasticity of 0.2.

To integrate the supply response of farm households into the model, assuming that the outward shift in the supply curve does not dampen prices, equation (6) is expanded as follows:[24]

$$dQ_i/dP_i = aQ_i/dP_i + mQ_i(1 + E_i D), \qquad (6)$$

where E_i = the price elasticity of supply of commodity i, and D = the change in price divided by the original price, or dP/P. Once again, multiplying through by dP will give the expected change in the calorie consumption of rice producers that results from a change in rice prices.

The effect on calorie intake of a 20% increase in farm-gate and market rice prices, taking into account the output response, is also found in table 11. There is still a net calorie loss for all but the largest producers. The effect of the output response over and above the income effect alone is negligible except for farmers producing more than 90 bushels per year, few of whom consume too few calories. Even a supply response of twice that used in this analysis will not change the fact that small producers, like the landless, are net losers.

There are limitations to this short-term analysis. The most severe is that the effects of price changes on rural employment and wages are not accounted for. These effects occur through factor utilization patterns (i.e., labor versus capital intensification) as production increases. Estimating the parameters to capture secondary effects is precluded due to data limitations. However, in analyzing the 1980/81 Labour Force and Socio-Economic Survey, it was determined that Sri Lanka has a rural unemployment rate of about 15%. In addition, nearly 60% of all rural major income earners said that, given the opportunity, they would choose to work more hours at the same pay. This figure was 77% among rural laborers and 60% among cultivators. These data suggest that the supply price of labor (i.e., wages) may remain stable even if

there is a robust supply response, which translates into increased use of labor, rather than capital. A long-term analysis of the expected effect of commodity price changes is an important subject for future research. Nevertheless, short-term dislocations that result from further increases in rice prices are important.

Conclusions

This paper examines food consumption levels and food acquisition behavior in Sri Lanka. The intent is to explain the effects of food policies on consumers. To do so, a set of price and income parameters is estimated, disaggregated by income groups and sector. The poor are shown to be much more responsive to price and income changes. In addition, the urban population generally exhibits lower income elasticities of demand for food commodities. Although the absolute values of own-price elasticities of demand for calories among the poor often approach or are greater than unity, there is considerable cross-commodity substitution in response to a change in an individual food price. The poor appear to be efficient substitutors, thereby mitigating the effects of a price change on calorie intake. The conspicuous exception is rice.

The study shows that for rice the elasticity of calorie consumption with respect to its price was approximately four times higher than for any other commodity. This is true even though the own-price elasticities of demand for other commodities are higher. The reluctance of households to substitute for rice, even when faced with rising prices, coupled with its large budget share, shows rice to be the most important consumption good.

Higher rice prices are an especially important determinant of poverty for landless and urban workers. Similarly, the relationship of the structure of production and farm holdings to consumption patterns shows that, at least in the short term, the small farmer—who is also likely to be poor and consuming inadequate calories—will not be a primary beneficiary of higher rice prices. Households with small holdings consume most of their production at home; they are net consumers in the market. Thus their earnings are not increased significantly by a rise in rice prices, whereas the higher price of the most important wage good reduces purchasing power. The question of whether higher prices will indirectly improve the plight of agricultural workers and laborers by increasing output and fueling agricultural development, which will in turn increase the demand for labor and drive up wages, remains to be explored. Nevertheless, this research supports the view that moderating food prices, preferably through technological change, is a key ingredient to raising consumption among the poor.[25]

A number of simulations illustrate the effects of income changes on calorie intake for the entire rural population. They show that, even

if there are rapid and proportional increases in expenditures of all income groups, this will not dramatically increase calorie intake among the poor. In contrast, if the absolute value of the increase in real expenditures were distributed equally to all households, there would be a marked increase in the percentage of households consuming an adequate diet. The distribution of income growth, rather than its aggregate size, is the most important factor that determines the degree of calorie adequacy in Sri Lanka.

Notes

1. John W. Mellor, "Food Price Policy and Income Distribution in Low-Income Countries," *Economic Development and Cultural Change* 27 (1978): 1–26.

2. C. Peter Timmer, Walter P. Falcon, and Scott R. Pearson, eds., *Food Policy Analysis* (Baltimore: Johns Hopkins University Press, 1983).

3. In Sri Lanka, estates (i.e., plantations) are worked primarily by Tamils who migrated from India, largely during the past two generations. The estate Tamils are distinguished from the Ceylon Tamils who have lived on the island for 2,000 years or more, along with the majority ethnic group, the Sinhalese. The Ceylon Tamils live and work in urban and rural areas, in contrast to the estate Tamils who arrived from India since the British began to develop the plantation economy. It is noteworthy that the present communal violence in Sri Lanka is largely between the Ceylon Tamils living primarily in the north of the country, and the Sinhalese majority.

4. For example, the average consumption of meat is 9.6, 3.5, and 2.9 pounds per capita in the urban, rural, and estate sectors, respectively. Similarly, average fish consumption per capita is 33.5, 26.6, and 18.9 in the corresponding sectors.

5. The small consumption of these secondary crops is not surprising since rice and wheat provide more calories per Rs 100 than sweet potatoes or manioc, and only slightly fewer calories per Rs 100 than millet. Likewise, rice provides more grams of protein per Rs 100 than pulses, such as cowpeas and green gram.

6. For a review of these techniques, see Harold Alderman, "The Effect of Income and Food Price Changes on the Acquisition of Food by Low-Income Households" (Washington, D.C.: International Food Policy Research Institute, 1986, mimeographed).

7. To estimate price elasticities, price variations must be real and not just due to quality differences. In the Sri Lanka data such differences are primarily due to large differences between locations. In addition, there is also temporal variability partially attributable to differences in the rate of price increases during the course of the survey.

8. The alternative of estimating a complete system of demand that puts restrictions on parameters was considered. Indirect techniqies, such as Almost Ideal Demand Systems (AIDS), cannot be used here because the 1980/81 Labour Force and Socio-Economic Survey does not make it possible to impute the prices of nonfood items. In addition, a high degree of aggregation is required to limit the parameters to a manageable number. Other methods for estimating systems of demand adopt restrictive assumptions about separability in the utility function (e.g., the Frisch methodology or the linear expenditure system). Statistical tests of these restrictions have generally resulted in their being rejected. (See, e.g., Anton P. Barten, "The Systems of Consumer De-

mand Functions Approach: A Review," *Econometrica* 45 [January 1977]: 23–51, who reports the results of a number of estimations. See also Angus Deaton, "Specification and Testing in Applied Demand Analysis," *Economic Journal* 88 [September 1978]: 524–36.)

9. This problem was first introduced by James Tobin, "Estimation of Relationships for Limited Dependent Variables," *Econometrica* 26 (January 1958): 24–36; and it is reviewed and discussed at length by G. S. Maddala, *Limited, Dependent and Qualitative Variables in Econometrics* (Cambridge: Cambridge University Press, 1983).

10. See James J. Heckman, "The Common Structure of Statistical Models of Truncation, Sample Selection and Limited Dependent Variables and a Simple Estimation for Such Models," *Annals of Economics and Social Movement* 5 (1976): 475–93; Zvi Griliches, B. Hall, and J. Hausman, "Missing Data and Self-Selection in Large Panels," *Annales de l'INSEE* 30–31 (1978): 137–76.

11. In this case, the standardized cumulative normal function, $F(z)$, is estimated to determine the probability of being a consuming household as a function of a variety of random variables, X. One can differentiate the function $F(z)$ with respect to X, such that $\partial F(z)/\partial X$ is meaningful.

12. This pitfall of biased estimators arising from the use of a truncated sample can be addressed by including the inverse of the Mill's ratio—the ratio of the unit normal density to the cumulative normal density—as a regressor in the OLS equation. The Mill's ratio can be determined from the probit equation discussed previously, which provides data on the probability that a household has a positive value, Q.

13. This can be expressed mathematically as

$$\partial Q/\partial X = F(z)\,\partial Q^*/\partial X + E(Q^*)\,[\partial F(z)/\partial X],$$

where Q^* is the truncated sample of consumers. This says that the expected change in commodity Q for a change in X_i is determined by summing the expected change in Q for a change in X_i, given the probability that someone is a consumer, and the expected change in the probability of consuming Q, weighted by the expected value of Q_i, if a household is already in the market. This combination of two functions to estimate the population parameters is required when the parameters for entry and quantity response should not be constrained to be the same (see Harold Alderman, "Allocation of Goods through Non-Price Mechanisms: Implications of Rationing and Waiting Times in Egypt" [Ph.D. diss., Harvard University, 1984]). When the parameters are the same, the method reduces to a Tobit. However, as remarked by Maddala, "in more complicated models in which ML [maximum likelihood] methods are computationally burdensome, the two-stage methods are worthwhile." Since the only Tobit procedures available to me could not handle the entire data set of nearly 5,000 households, the analysis uses the two-stage approach rather than the Tobit.

14. See Angus Deaton, *Three Essays on a Sri Lanka Household Survey*, Living Standards Measurement Study, Working Paper no. 11 (Washington, D.C.: World Bank, 1981): 10–20.

15. Specifically, interaction terms were formed by multiplying the log of prices by the log of per capita expenditures. This picks up any curvature in the price function that would not be captured by the log-linear relationship between prices and quantities. If an interaction term proved insignificant due to a problem of multicollinearity, it was removed and replaced by another interaction term formed by multiplying the log of prices by a dummy variable for low-

income households in order to determine if the poorest quartile responds differently to price changes than the remainder of the population.

16. The demand functions are available upon request from the author. They are not reproduced here because of the large number and length of the equations.

17. Both the sector dummy variable and the interaction term between the dummy and the log of expenditures were left in the same equation for two reasons. First, such dummies pick up variance and reduce the bias in the other price and expenditure parameters. Second, constraining the intercept while allowing the slope to vary may result in biased and contrary economic results.

18. The data are limited to the rural areas for ease of computational tractability, for clarity of presentation, and because nearly 80% of the population lives there. The following table depicts the changes that correspond to the eight scenarios:

	Per Capita Expenditures					
Rice Prices	+ 10%	+ Rs 316	+ 20%	+ Rs 632	− Rs 316	No change
No change	1	2	3	4	...	Base
20% decline	...	6	...	8	7	5

19. Shlomo Reutlinger and Marcelo Selowsky, *Malnutrition and Poverty: Magnitude and Policy Options*, World Bank Staff Occasional Paper no. 23 (Baltimore: Johns Hopkins University Press, 1976).

20. All estate households are net rice consumers and 97% of urban households are. This means that 87.6% of all Sri Lankan households are net consumers.

21. The analysis of the short-term effects begins with the expression of the derived demand for calories among farm households being a function of incomes and prices: $Q_c = f(Y, P_i)$, where Q_c = calories, Y = total income; and P_i = the vector of the prices of consumption goods. Then, taking the total derivative with respect to P_i, assuming that the prices of other commodities remain constant, $dQ_c/dP_i = \partial Q_c/\partial P_i + (\partial Q_c/\partial Y)(dY/dP_i)$. The quantity of commodity i produced, Q_i, can be substituted for dY/dP_i, resulting in equation (5) in the text.

22. This analysis assumes that the paddy producers are not tenants who have to give a share of the increased value of the paddy to the landowner. If some are and prices increased, the income increment and the increase in calorie consumption would be smaller than predicted in the models that follow.

23. Pat S. Ongkingco, Jose A. Galvez, and Mark W. Rosegrant, *Irrigation and Rice Production in the Philippines: Status and Projections*, Rice Policies in Southeast Asia Project, Working Paper no. 3 (Washington, D.C.: International Food Policy Research Institute, 1982), p. 34.

24. This model assumes that the supply curve is linear over the small range where the producer moves up the supply schedule as the price increases. It also assumes that there is a real cost in raising production, either in the form of cash or in the opportunity cost of family members' time.

25. John W. Mellor, *The New Economics of Growth* (Ithaca, N.Y.: Cornell University Press, 1976).