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Evaluating Demand for Calories for Urban and Rural Populations in the Philippines: Implications for Nutrition Policy Under Economic Recovery

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Summary. — A food demand model based on demand for characteristics is proposed, and food demand elasticity matrices are estimated for urban and rural populations in the Philippines. The nutritional status of low-income urban groups did not improve during the economic expansion which occurred from 1972 to 1982, despite substantially lower real cereal prices, because of falling real urban wages. Wages declined less sharply in rural areas, where nutrition improved marginally. The nutritional situation can be presumed to be much worse after the post-1982 economic collapse. The poor would appear to be vulnerable to food price increases which might result from economic readjustment.

1. INTRODUCTION

The decade of the 1970s was one of economic expansion for the Philippines. Between 1972, when martial law was declared, and 1982, a year before the Marcos administration would default on payments of its foreign debt obligations, real per capita GNP increased by 47% (National Economic and Development Authority, 1984). Agricultural growth, led by rapid technological change in the rice sector, was equally impressive. Rice yields increased from an average of 1.6 tons per hectare for 1970–72, to 2.3 tons per hectare for 1980–82, an annual growth rate of 3.7%. The Philippines, which had been a chronic importer of rice ever since its independence just after World War II, produced exportable surpluses from 1978 to 1981, which averaged just over 140,000 metric tons annually (International Rice Research Institute, 1986). Real cereal prices fell as aggregate incomes increased, seemingly sufficient conditions for a substantial improvement in the calorie intakes of the poor.

In 1988 the economic outlook for the Philippines is decidedly less optimistic. Real per capita GNP declined by 20% over the four-year period immediately following the suspension of payments on the foreign debt (Center for Research and Communication, 1988). Annual interest payments on that debt are now approaching $3 billion, for an economy whose exports approached, but never exceeded $6 billion before the onset of the economic crisis (NEDA, 1984; Montes, 1987). On a per capita basis, interest payments are roughly $50 annually, one-third the average income of someone in the bottom half of the income distribution. In the past two years, the Philippines has resumed imports of rice.

While it is clear today that the unwarranted optimism of the 1970s ran afoul of some combination of unwise investment decisions and unchecked corruption, it is much less clear what the optimal recovery strategy might be for a country with such a large foreign debt burden, a high population growth rate, and an unexpandable land base, which is already densely populated and farmed to a significant extent by tenants. How adversely has the nutritional status of urban and rural poor been affected by the downturn in the economy? Clearly, the drain on available capital for investment caused by the foreign debt will mean slower economic growth in the future than would otherwise have been possible. Are the poor now in position to absorb a significant share of the burden of the debt, for example by paying higher prices for rice, or by accepting a decline in real wages?

Because calorie intake and anthropometric data are as yet unavailable for a nationwide

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sample after the downturn in the economy, precise answers to these questions are difficult to come by. What is possible, however, is to analyze data collected during the period of the economic expansion to see how and why the poor fared as they did under these relatively favorable circumstances. It will then be possible to make a conjecture as to how their present situation might compare, based on food demand behavior exhibited during the economic expansion and trends in cereal prices and incomes since 1983. The analysis suggests that the urban poor did not significantly improve their nutritional status during the economic expansion despite lower cereal prices, because of falling real wages. The nutritional status of the rural poor (who are net purchasers of cereals), however, did appear to improve.

A new methodology is proposed for estimating food demand matrices, which are then derived for urban and rural populations using data from a nationwide nutritional survey undertaken in 1978. The model is found to predict changes in consumption levels of individual foods and overall calorie intakes reasonably well between 1978 and 1982, when a second nationwide nutritional survey was undertaken.

2. COMPARING THE 1978 AND 1982 NATIONWIDE NUTRITIONAL SURVEYS

This paper will rely heavily on published data taken from two nationwide nutritional surveys which were conducted in 1978 and 1982 (Food and Nutrition Research Institute, 1981, 1984). During the four years between these surveys, aggregate per capita gross national product increased by 8% while real rice and corn prices fell by 20%. Given the substantial decrease in the cost of the two main staple foods in the Filipino diet in the context of an expanding economy, one might expect to see a noticeable, broad-based improvement in nutritional status for a wide range of income and occupation groups.

In order to see how various groups fared nutritionally under the economic expansion, then, it would be desirable to compare anthropometric and calorie intake indicators across time for various occupation groups disaggregated by level of income. For rural occupation groups, for whom changes in food prices affect income on the supply side as well as consumption choices on the demand side, it would be further desirable to disaggregate farm operators and rural laborers by major crop type.[1] Also, demand parameters for rice and corn vary widely by region (see Bouis, 1982). In most of Luzon and Western Visayas, very little corn is eaten and rice is overwhelmingly the main staple even of low-income groups. By contrast, in the remaining southern regions, corn is an important staple of low-income households which substitute rice for corn as income rises.

Unfortunately, the published information available from the 1978 and 1982 surveys does not allow disaggregation to this extent. The 1978 survey publication does provide a disaggregation of calorie intakes by urban and rural populations by income group. This is shown in Table 1. A comparison of calorie intakes over time by income group is possible from the 1982 survey report.[2] A separate comparison of calorie intakes over time by occupation group is also possible, and these are shown as well in Table 1. The only disaggregation of an anthropometric indicator that can be compared over time is weight-for-age broken down by region. This information is provided in Table 2.

Table 1 shows, perhaps surprisingly given an increase in aggregate income and lower cereal prices, that aggregate calorie intakes hardly changed at all between 1978 and 1982. There was, however, an apparent marginal reallocation in the distribution of calorie intakes across income groups, with calorie intakes improving somewhat for the bottom 60% of the income distribution and declining for the upper 40%. Note from the last column in Table 1 that persons living in urban areas are relatively underrepresented at low-income levels. Calorie intakes disaggregated by occupation group show that households engaged in predominantly rural occupation improved their calorie intakes between 1978 and 1982, while households engaged in predominantly urban occupations suffered a decline in calorie intakes.

Somewhat indirectly, Table 2 provides some corroborating evidence for this pattern of improved nutrition in rural areas and declining nutrition in urban areas. For the country as a whole, there was a statistically significant decline in the percentage of children six years of age and less who were below 75% of the standard Z-score for weight-for-age, which is consistent with the better calorie intakes at lower income levels.[3] For the Metro Manila area, the most urbanized area in the country, there was a small *increase* in the incidence of children below 75% of the standard Z-score for weight-for-age, although the increase was not statistically significant. Malnutrition incidence levels decreased in the predominantly rural areas of Bicol and the Visayas.

This observed dichotomy between urban and rural areas is somewhat curious given the conven-

Table 1. *Per capita calorie intakes per day in 1978 and 1982, by approximate income quintile, by occupation, and by urban and rural population*

Approximate income quintile†	Percent of sample 1982	Percent of sample 1978	Calorie intakes* All 1982	All 1978	Urban‡ 1978	Rural‡ 1978	Percent of 1978 sample which is urban§
1	15.1	21.2	1,653	1,590	1,540	1,598	13.8
2	21.7	23.3	1,715	1,700	1,612	1,722	20.0
3	28.0	24.1	1,822	1,787	1,711	1,830	36.8
4	19.3	13.4	1,872	1,943	1,909	1,976	49.3
5	15.9	18.0	2,004	2,144	2,165	2,099	69.4
All	100.0	100.0	1,808	1,804	1,872	1,769	36.5
Occupation							
Professional‖	17.0	15.8	1,852	1,938	1,980	1,853	67.5
Farm owner	14.2	16.6	1,897	1,886	2,021	1,868	11.8
Farm laborer	19.7	25.2	1,780	1,707	1,706	1,707	8.6
Fisherman	8.6	6.7	1,773	1,645	1,568	1,666	21.4
Other¶	35.9	31.8	1,796	1,815	1,848	1,782	3.0
No occupation	4.7	4.0	1,663	1,736	1,750	1,725	44.0
All	100.0	100.0	1,808	1,804	1,872	1,769	36.5

Sources: Food and Nutrition Research Institute (1981 and 1984).

*The recommended calorie intake will vary by the age and sex composition of the population, but falls in the range of 2,030–2,040 calories per day.

†The cutoff points used to disaggregate the sample into income groups varied between the two surveys, primarily because nominal incomes were used for these cutoff points (which did not take account of inflation). The 1978 survey broke the sample down by six groups (of unequal sizes) and the 1982 survey into seven groups (of unequal sizes). Groups were aggregated (the data were weighted by sample size) to facilitate comparisons across the surveys, although caution must be used in making such comparisons since individual "quintiles" are of unequal size.

‡The 1982 survey did not provide a breakdown by income group for urban and rural population. 1982 aggregate calorie intakes were 1,831 and 1,797 calories for the urban and rural populations, respectively.

§The percent of sample that is urban and rural disaggregated by income group or by occupation group was not given, but can be computed from the formula:

$$X(U) + (1-X)\ R = N$$

where X = percent of sample which is urban; U = reported calorie intake for the urban population; R = reported calorie intake for the rural population; and N = reported calorie intake for the entire sample.

Unfortunately, the computed percent urban for the entire sample of 36.5% cannot be reconciled with the figure of 54.3% urban given in a discussion of the sampling procedure.

‖Also includes technical and skilled workers and entrepreneurs.

¶An aggregation of semiskilled workers, common laborers, students, housewives, and retired.

tional wisdom that, *ceteris paribus* falling cereal prices should benefit urban households and hurt rural households. This result is all the more puzzling, given the attention that has been paid to macroeconomic fiscal and trade policies that have distorted the terms of trade between industry and agriculture in favor of urban areas (see Bautista, 1987; David, 1983).

Why did aggregate calorie intakes not increase given the fall in real cereal prices? Why did nutrition improve in rural areas and not in urban areas, instead of the opposite result? Finally, do answers to these two questions provide any guidance for determining how nutrition might have been affected during the economic collapse which occurred after 1982, and for designing policies to improve nutrition during the hoped-for economic recovery?

To answer these questions, the strategy will be to estimate food demand matrices for urban and rural populations, to apply observed price and income changes to the estimated elasticities, and to compare the simulated changes in consumption of individual foods and total calorie intakes with observed changes. The implied validation of the estimated demand parameters, given a close fit between simulated and observed changes in demand for foods, will then allow an analysis of

Table 2. *Comparison of distribution of undernourished children, from birth to six years old, using weight-for-age standard by region: Philippines, 1978 and 1982*

Region	1978 Total subjects	1978 Percent of children 75% and below standard weight-for-age	1982 Total subjects	1982 Percent of children 75% and below standard weight-for-age	Increase (Decrease)
Ilocos	239	18.0	294	18.0	—
Cagayan	176	15.7	168	14.9	(0.8)
Central Luzon	318	15.1	388	16.7	1.6
Metro Manila	396	14.7	399	16.8	2.1
Southern Tagalog	552	22.6	550	18.7	(3.9)
Bicol	326	24.0	388	15.5	(8.5)*
Western Visayas	397	27.1	364	16.8	(10.3)*
Central Visayas	300	29.3	329	15.2	(14.1)†
Eastern Visayas	249	28.5	269	20.1	(8.4)*
Northern Mindanao	235	16.1	247	16.6	0.5
Southern Mindanao	213	27.7	240	20.0	(7.7)*
Total	3,400	21.9	3,634	17.2	(4.7)†

Source: Food and Nutrition Research Institute (1984).
*Significance level = 5%.
†Significance level = 1%.

the economic forces behind the observed outcomes between 1978 and 1982, of the probable effect of the economic downturn after 1982 on nutrition, and of appropriate policies for improving nutrition during the economic recovery. As mentioned above, a new methodology will be used for estimating the food demand matrices, so it will be necessary to outline this methodology first.

3. A FOOD DEMAND SYSTEM BASED ON DEMAND FOR CHARACTERISTICS

(a) *Parameter estimates by income level, occupation group, and region*

Several studies in the literature have shown that parameter estimates can vary widely across income groups (see Alderman, 1986 for a review). As already alluded to above, demand parameter estimates may also vary significantly by region as production environments and tastes change. Such regional and income variation in consumption behavior coupled with (1) differential supply-side impacts of agricultural commodity price changes and government investment strategies on various rural groups specializing in the production of particular crops, and (2) the need to disaggregate the food demand parameter matrix by a relatively large number of foods, makes the task of estimating a complete food demand matrix for several regional and socioeconomic groups a nearly intractable task (2 regions × 4 income groups × 4 major crops × 2 occupation groups [owners and laborers] gives 64 demand matrices for the rural areas alone in the Philippines).

The two broad methodologies available for estimation of the required food demand matrices (again, see Alderman 1986 for a review) are (1) direct econometric estimation requiring data with price variability (with or without parameter restrictions derived from demand theory) and (2) use of some type of expenditure system which makes assumptions about the form of the utility function. Direct estimation from cross-section or panel household food expenditure surveys is very data intensive and time consuming, and may introduce an array of econometric problems.

Use of some type of linear or quadratic expenditure system is a much more practical alternative to direct estimation in the sense that only *a priori* knowledge of income elasticities for individual foods (plus a minor number of additional parameters, the specific parameters depending on the particular technique used) is required for generation of a complete set of own-price and cross-price elasticities. Estimates of income elasticities and these other parameters can be estimated relatively quickly if they are not available from previous studies. However, this second group of techniques depends on an assumption of either strong or weak separability

between *food* groups in the utility function (the focus here is on nutrition policy so that a relatively disaggregate food demand matrix is required).

(b) *Separability of food items versus food characteristics*

For strong separability, this assumption means that utility derived from the consumption of an inexpensive staple (for example) depends not at all on the level of consumption of a more expensive, preferred staple.[4] This is obviously an unacceptable assumption for households where hunger is a problem. For weak separability, the assumption is made that the marginal rate of substitution between an inexpensive and expensive staple (how the consumer reacts to changes in the relative prices of these two staples) does not depend at all on the level of consumption of nonstaples.

It is perhaps less obvious why this is an unacceptable assumption. Consider the loss in utility when a low-income household trades one peso's worth (to use Philippine currency) of the inexpensive staple for one peso's worth of the preferred staple. If there were no loss in utility, then the two goods would be perfectly substitutable. However, the low-income household is presumably consuming the inexpensive staple (and low levels of nonstaples) to keep from going hungry. Spending one peso on the preferred staple instead of the inexpensive one would mean less "bulk" in the diet (more hunger), and a relatively large loss in utility. The two staples are not very substitutable. Assuming an exogenous increase in the level of nonstaples in the diet of this low-income household, however, would lower the loss in utility (less hunger suffered) when one peso is reallocated among the two staples. The two staples become more substitutable. Thus, the marginal rate of substitution between the two staples depends very much on the level of nonstaple consumption because of the bulk that nonstaples provide (bulk being a "characteristic" of each food consumed), violating the assumption of weak separability.

To carry this idea of food characteristics further in the context of the previous example, typically even for low-income households, the per kilo cost of nonstaples as a group is higher than the per kilo cost of an expensive, preferred staple. If this is the case, why would a low-income household, reluctant to trade an inexpensive staple for an expensive staple to prevent hunger, consume even more expensive nonstaples? At least two reasons are possible. First, the household desires some variety in its diet — for example, some meat and vegetables to go with the bland staples that constitute most of total calories consumed. Second, there is a desire for tastes inherent in particular foods. Viewed in this way, the food consumption decision becomes one of choosing a particular basket of individual foods, each food contributing to overall bulk and variety in the diet, which maximizes utility from bulk, variety, and tastes of individual foods. At low levels of income, considerations of bulk and variety weigh heavily in the food consumption decision, while at high incomes the food consumption decision is driven mainly by tastes of individual foods. The marginal rate of substitution between any two foods depends very much on the level of consumption of all other foods, especially at low incomes.

(c) *An alternative demand system*

To summarize, then, an impasse is reached between the need for developing a large number of food demand matrices for policy analysis and the lack of a practical means for doing so — direct estimation because it is too data intensive, time consuming, and the appropriate methodologies are still being debated, and an expenditure system approach because the underlying assumptions are unacceptable. A food demand system based on demand for characteristics along the lines argued in the example above provides a means out of this dilemma.

In this system, the three characteristics — bulk, variety, and tastes of individual foods — are assumed to be additive in the utility function, as contrasted, for example, with additive utilities for individual food items using the Frisch technique. Bulk and variety enter the utility function in such a way that utility from consumption of one food depends on the level of consumption of all other foods. By specifying an explicit function form for these characteristics in the utility function, it turns out that the entire matrix of price and income elasticities can be derived for a system of n foods and one nonfood good from prior knowledge of just *four* elasticities in the $(n+1)$ by $(n+2)$ matrix of price and income elasticities. A brief mathematical exposition of the model is provided in the appendix (see Bouis, 1989 for a full mathematical treatment and discussion of the properties of the model).

4. AN APPLICATION USING PHILIPPINE DATA

This methodology (a food demand model

based on demand for characteristics) is applied here to published data from the 1978 nationwide nutrition survey mentioned above, to derive food demand elasticity estimates for urban and rural populations.[5] Table 3 presents data on per capita consumption for 17 food groups, average price paid per kilo for each of these 17 food groups, and average household size and number of adult equivalents, disaggregated by urban and rural populations. Also provided in Table 3 are kilogram-to-calorie conversion rates (which are available for the survey-wide data, but not broken down by urban and rural groups), and nonfood budget shares which are not taken from

Table 3. *Per capita consumption levels, calorie conversion rates, prices paid for various food groups, household size, adult equivalents, and food budget shares, by urban and rural populations for the Philippines, 1978*

Before Aggregation			Urban		Rural	
Food group	Aggregation category	Calories per kilogram	Grams per day	Price pe kilo	Grams per day	Price per kilo
Corn grits	Corn	3,608	18	1.77	49	1.60
Milled rice	Rice	3,452	255	2.12	323	2.11
Other cereal products	Other cereals	3,350	39	5.79	12	7.01
Fish	Fish	672	116	6.44	95	5.81
Meat and poultry	Meat	2,153	53	12.32	21	11.64
Green leafy/yellow vegetables	Fruits/vegetables	265	28	2.49	38	1.75
Vitamin C rich foods	Fruits/vegetables	307	54	2.34	44	1.98
Other fruits and vegetables	Fruits/vegetables	332	174	2.80	166	2.46
Rice products	All others	1,804	11	6.19	6	7.16
Corn products	All others	1,875	0	7.99	0	6.89
Starchy roots/tubers	All others	1,073	20	2.33	46	1.30
Sugars and syrups	All others	2,472	43	2.82	19	2.84
Fats and oils	All others	6,800	20	6.54	10	5.91
Eggs	All others	1,353	14	9.76	5	10.50
Milk and milk products	All others	2,843	55	8.61	22	6.58
Dried beans/nuts/seeds	All others	2,481	9	5.31	8	5.20
Miscellaneous	All others	601	23	12.02	19	8.35

After Aggregation	Urban					Rural				
Food group	Kilos per week	Price per kilo*	Calories per kilo	Food budget share	Price per 1,000 calories	Kilos per week	Price per kilo*	Calories per kilo	Food budget share	Price per 1,000 calories
Corn	0.13	1.04	3,608	0.01	0.29	0.34	0.94	3,608	0.03	0.26
Rice	1.79	1.25	3,452	0.13	0.36	2.26	1.24	3,452	0.24	0.36
Other cereals	0.27	3.41	3,350	0.05	1.02	0.08	4.12	3,350	0.03	1.23
Fish	0.81	3.79	672	0.18	5.64	0.67	3.42	672	0.20	5.09
Meat	0.37	7.25	2,153	0.16	3.37	0.15	6.85	2,153	0.09	3.18
Fruits/ vegetables	1.79	1.57	319	0.16	4.92	1.74	1.33	317	0.20	4.20
All others	1.37	3.93	2,539	0.31	1.55	0.95	2.67	2,042	0.22	1.31
Food budget share out of total expenditures†			0.45					0.55		
Household size			6.4					6.3		
Adult equivalents per household			5.09					4.92		

*Prices are normalized on a corn price of ₱1.70 per kilo.
†Food budget share out of total expenditures are taken from NEDA (1984); otherwise all other data are found in FNRI (1981).

the Food and Nutrition Research Institute (FNRI) surveys, but are suggested by other nationwide expenditure surveys (NEDA, 1985).

Kilograms consumed are converted to calories to provide a measure of the bulk in the diet, which enters the utility function in quadratic form. Noncereal kilograms are divided by total kilograms to provide a measure of variety in the diet. It will be seen below that even these simplistic notions of bulk and variety do a reasonable job of "explaining" food consumption behavior.

A final requirement for application of the methodology is prespecification of four price and income elasticities, one set of elasticities for the urban food demand matrix and a separate set of elasticities for the rural food demand matrix. Unfortunately, no direct estimates are available from other studies, specifically for urban and rural populations. However, several demand estimates are available for rice and corn (see Bennagen, 1982 for a survey of food demand elasticities for the Philippines), which are disaggregated by region and income group and which suggest that low-income groups are more price responsive than high-income groups.

National aggregate estimates of −0.6, 0.1, and −0.4 for the own-price elasticity of rice, the income elasticity of rice, and the income elasticity of corn were obtained by Bouis (1982), using quarterly household food expenditure surveys conducted by the Ministry of Agriculture. Urban and rural elasticity estimates are weighted averages of these national aggregate estimates, and it can be presumed that the lower-income rural households are more price responsive than urban households. Thus, rural elasticities are greater (in absolute value) than the national aggregate estimate, and urban elasticities are smaller.

Experiments were run with two sets of urban and rural estimates, as shown in Table 4, which bracketed these national base estimates.[6] One "low dispersion" set of elasticities assumed that there was relatively little difference in elasticities between urban and rural populations, while the second "high dispersion" set assumed that there was a relatively large difference in price responsiveness between the two populations.

Nonfood expenditure elasticities of 1.49 and 1.61, for urban and rural groups, respectively, shown in Table 4, are consistent with an estimate of 1.50 obtained by Canlas (n.d.) for the country as a whole, and correspond to food expenditure elasticities of 0.40 and 0.50, for urban and rural groups, respectively.

Application of the characteristic food demand methodology using the data contained in Tables 3 and 4 gives the demand elasticity matrices shown in Table 5 for an aggregation of seven food groups and one nonfood. Only two of the four demand matrices are shown, which correspond to the lower rice own-price elasticity estimates for the urban group (−0.40; high dispersion) and the lower rice own-price elasticity for the rural group (−0.65; low dispersion). As will be seen below, these estimates tend to do better in "predicting" actual consumption in 1982 than the two higher rice own-price elasticity estimates.[7]

Examining the two demand matrices, note the tendency for the higher-priced foods such as meats (for nonstaples) and other cereals (for staples) to have the highest income elasticities, and for these income elasticities to be higher for the (lower-income) rural group than for the (higher-income) urban group. The model structure ensures that the estimates conform to the four standard restrictions of demand theory: (1) adding up, (2) homogeneity, (3) symmetry, and (4) negativity, which, among other things, means that the cross-price elasticities of a high budget

Table 4. *Price and income elasticities specified* a priori *for application of characteristic demand methodology*

Simulation	Group	Rice own-price elasticity	Rice income elasticity	Corn income elasticity	Nonfood expenditure elasticity
High Dispersion	Urban	−0.40	−0.20	−0.45	1.49
	Rural	−0.90	0.35	−0.45	1.61
Low Dispersion	Urban	−0.50	−0.15	−0.45	1.49
	Rural	−0.65	0.20	−0.45	1.61

Table 5. *Demand elasticity matrices derived using characteristic demand methodology*

	Corn	Rice	Other cereals	Fish	Meat	Fruits/ vegetables	All others	Non-food	Income
Urban, High Dispersion (Low Elasticity) Assumptions									
Corn	−0.794	0.603	0.093	0.011	0.120	−0.102	0.672	−0.152	−0.450
Rice	0.036	−0.400	0.070	0.001	0.101	−0.108	0.569	−0.068	−0.200
Other cereals	0.010	0.131	−0.902	−0.016	0.031	−0.078	0.188	0.161	0.475
Fish	−0.003	−0.046	−0.008	−0.994	0.027	0.098	0.130	0.201	0.595
Meat	0.002	0.031	0.005	0.021	−1.096	0.053	0.031	0.241	0.712
Fruits/vegetables	−0.007	−0.109	−0.018	0.140	0.088	−0.761	0.420	0.063	0.186
All others	0.014	0.196	0.032	0.083	0.031	0.197	−1.205	0.165	0.487
Nonfood	−0.008	−0.106	−0.018	−0.043	−0.024	−0.088	−0.099	−1.109	1.495
Rural, Low Dispersion (Low Elasticity) Assumptions									
Corn	−1.429	1.383	0.035	0.039	0.061	−0.038	0.474	−0.076	−0.449
Rice	0.148	−0.650	0.017	0.007	0.034	−0.067	0.276	0.034	0.200
Other cereals	0.013	0.058	−1.007	−0.028	−0.000	−0.082	0.015	0.150	0.881
Fish	−0.013	−0.070	−0.003	−0.978	0.005	0.073	0.062	0.134	0.790
Meat	−0.002	−0.004	−0.001	−0.005	−1.073	0.007	−0.015	0.159	0.934
Fruits/vegetables	−0.017	−0.098	−0.003	0.123	0.033	−0.703	0.283	0.056	0.327
All others	0.044	0.250	0.006	0.075	0.010	0.227	−1.330	0.104	0.615
Nonfood	−0.034	−0.177	−0.006	−0.057	−0.016	−0.127	−0.092	−1.104	1.613

proportion item such as rice will tend to be higher (in absolute value) than the cross-price elasticities of items with a lower budget proportion.

5. SIMULATING REACTIONS TO CHANGES IN PRICES AND INCOME

(a) *Urban price changes*

How well do these elasticity estimates "predict" actual consumption levels which were surveyed in 1982? To answer this, changes in prices and incomes for the period 1978–82 need to be applied to the derived demand matrices. The published summary of the 1982 nutrition survey does not report prices paid for various foods, as does the 1978 report, so the consumer price indices compiled by the Bureau of Census and reported in Table 6 will be used instead. No breakdown is available by urban and rural groups, so the national aggregate consumer price index is used. Unfortunately, these national aggregate figures are available only for a limited number of aggregate food groups. Although it would have been technically feasible to further disaggregate the demand matrices shown in Table 5 into several other food groups, no information is available on price changes for these more disaggregate groups.

Table 6 shows that real rice and corn prices fell substantially, by about 20% over the four-year period. Real nonfood prices increased by 9%, while real meat prices declined by 9%. These price changes were applied to the urban demand elasticities.

(b) *Subsistence consumption and joint production-consumption decisions*

The derivation of appropriate price indices for rural areas (that is, changes in real prices as viewed from the demand side) is much more problematic, since so much of what is consumed in rural areas is own-farm production and never marketed. Production and consumption decisions, especially for the main staples, rice and corn, are joint decisions, so that consumption levels depend, for example, on production input prices which do not appear in the matrices in Table 5, but affect how rural households evaluate the relative costs of growing and consuming cereals from one's own farm, or buying staples in the market (see Singh, Squire, and Strauss, 1986). In this sense, it is unrealistic to attempt to separate out demand-side and supply-side effects of food price changes, which is implicit in the exercise being undertaken. Nevertheless, the goal here is to determine the extent to which consumption behavior can be understood using simplifying assumptions.

A substantial number of rural households grow rice and corn both for subsistence consumption

Table 6. *Price and income changes for urban and rural population in the Philippines, 1978–82*

Group	Urban: Price index for 1982 (1978=100)*	Urban: Percentage change	Rural: Recomputed price index for 1982 assuming a 5% increase in cereal prices	Rural: Percentage change
All items	168.4		176.0	
Nonfoods	183.1	+8.7	183.1	+4.0
Corn	137.5	−18.4	184.8	+5.0
Rice	132.0	−21.7	184.8	+5.0
Other cereals	198.1	+17.6	198.1	+12.6
Fish	176.0	+4.5	176.0	0.0
Meat	156.3	−9.3	156.3	−11.2
Fruits/vegetables	170.0	+1.0	170.0	−3.5
Miscellaneous foods	157.3	−6.5	157.3	−11.7

	Year: 1975	1976	1978	1980	1982	Growth: Period	Percentage change
Gross national product†	68.5	73.0	83.1	92.6	98.7	1978–82	18.8
Agriculture	18.2	19.7	21.6	23.7	25.4	1978–82	17.4
Industry	22.7	24.9	29.6	33.5	35.8	1978–82	21.0
Services	27.5	28.4	31.6	35.5	37.9	1978–82	20.0
Total population‡	42.1	43.4	45.8	48.1	—	1976–80	10.8
Urban	14.0	14.9	16.4	17.9	—	1976–80	20.7
Rural	28.0	28.5	29.4	30.1	—	1976–80	5.7
Wages							
Urban (nominal)§	12.5	13.2	14.4	15.8	—		
Rural (nominal)‖	7.5	9.0	10.1	11.7	13.9		
Urban (real)¶	72.9	72.3	68.3	53.4	—	1978–80	−21.2
Rural (real)¶	119.8	135.7	131.1	109.2	103.2	1978–82	−21.3

*Consumer price indices for February 1982, national level, Bureau of Census and Statistics.
†Billions of constant 1972 pesos, NEDA (1984), Table 3.10.
‡Millions of people, NEDA (1984), Table 1.3.
§Pesos per day, Central Bank of the Philippines.
‖Pesos per day, PIDS (1987), Table 5, p. III.17.
¶Index where 1972=100, money wage rate deflated by consumer price index.

and for sale in the market.[8] To the extent that rural households can be characterized as semi-subsistence producers of cereals, the price changes for rice and corn which would be appropriate for evaluating demand-side substitution effects should reflect changes in the relative cost of growing cereals for subsistence consumption versus (say) growing export crops and buying staples in the market. A powerful incentive to own-production is that farmers do not have to pay average marketing margins of about 25% for cereals (see Bouis and Haddad, forthcoming, Chapter 4), which comprise a high proportion of the total cost of food and nonfood items consumed by the household. Thus, for example, even if a (nonedible) cash crop were 20% more profitable to produce than rice, it would still pay a farmer to grow rice up to a maximum of the expected level of consumption of his family. Because of production variability and a desire for food security, the household may produce more than its subsistence needs. For various reasons, including the need for cash, even surplus producers may buy and sell rice in the same crop year, and consume rice out of own consumption.

As the price of rice falls and the attractiveness of rice production declines, farmers will, of

course, take some land out of rice production, which will mean more frequent market purchases of rice for consumption needs. The rice price decline leads to an unambiguous fall in income on the supply side. But how does the farmer evaluate the relative change in price on the demand side? The retail price was higher before, but the farmer grew more rice for own consumption, which was purchased at what might be thought of as wholesale prices. Retail prices are lower now, but more is purchased at retail prices. The net effect at the margin is that the rice price has not changed at all for the rice producer *qua* consumer. However, if the rice price had remained constant and input prices had risen instead, there would have been an unambiguous rise in the relative cost of rice consumption on the demand side.

The conclusion is that a 20% decline in the real cost of cereals may seriously misrepresent the actual relative price change for rural producers as consumers. Instead, a modest 5% *increase* in real cereal prices is assumed for rural residents, which is reflective of marginally increasing input costs for cereal producers.[9]

(c) *Income changes*

Turning now to income changes for urban and rural populations, no directly surveyed measure is available, so it will be necessary to derive approximations. Table 6 shows that real GNP increased by slightly less than 19% over the four years from 1978 to 1982, and that this growth was more or less uniform across the three aggregate sectors — agriculture, industry, and services. Agricultural sector growth can serve as proxy for rural income growth, and growth in industry and services as a proxy for urban income growth. The fact that growth was so uniform across sectors makes this assumption less restrictive.

These figures need to be corrected for population growth. Population censuses taken in 1975 and 1980 show that the overall population increased by just over 14% during this five-year period, but that the urban population grew much more rapidly than the rural population (again, see Table 6). Taking the 1976–80 percentage increases in urban and rural populations as proxies for 1978–82 gives a 21% increase in urban population and a 6% increase in rural population, or a weighted average of just under 11% for the whole population. This would indicate that, on a per capita basis, real urban incomes remained about constant, while per capita real rural incomes increased by 12%, with the weighted average being an 8% increase in real per capita incomes.

There is strong evidence that these changes in income within the urban and rural sectors were not equitably distributed. Table 6 shows the nominal and real wage rates for urban and rural workers over time.[10] Note, first, that nominal wages are much higher for the urban sector over the entire series than for the rural sector, which is consistent with rapid migration to urban areas indicated by the population figures given in Table 6. Second, and most importantly, real wages in both sectors declined quite precipitously, by 22% for urban workers from 1978 to 1980, and by 21% for rural workers from 1978 to 1982. Third, real wage rates appear to have fallen faster in urban areas over the four year period from 1978 to 1982 than in rural areas, which is consistent with the lower per capita real income growth rate for urban areas suggested above.

If, as appears to be the case, incomes of upper-income groups increased, while incomes of low-income groups declined (or at best increased substantially less than the incomes of upper-income groups), applying the average income change to the demand matrices derived previously will result in an overestimation of total calories consumed. This is because marginal propensities to buy food out of increments in income and to buy calories out of increments in food expenditures are higher for low-income groups than for high-income groups. Average per capita changes in income were thus adjusted downward to −7.5% for urban areas and to 10% for rural areas.[11]

(d) *Comparing predicted and observed changes in food consumption*

Given the derived demand matrices and the changes in prices and incomes just discussed, it is now possible to predict 1982 consumption levels and to compare these predicted values with the consumption levels that were actually surveyed, as a way of testing the validity of the methodology used to derive the demand matrices, in conjunction with the assumptions made as to the changes in prices and incomes facing urban and rural consumers. A comparison of the predicted and observed values is presented in Table 7, and graphed in Figures 1, 2, and 3. As mentioned above, the "low elasticity" demand matrices tended to do better in predicting actual consumption. Therefore, "high elasticity" results will not be discussed below, although they are shown in the figures and presented in Table 7.

Figure 1 shows predicted and observed consumption levels for various cereals for urban and rural populations. The model distinguishes quite well between an increase in rice consumption for

Table 7. *Observed and predicted changes in calorie intakes, by aggregate food groups and for all foods for urban and rural populations, in the Philippines, 1978–82*

Simulation	Changes in calories from consumption of cereals*			
	Rice	Corn	Other cereals	All cereals
Urban-observed	48.3	−25.3	−26.8	−3.7
Urban-low elasticity	47.8	−0.2	−29.4	18.2
Urban-high elasticity	61.4	−0.2	−31.0	30.2
Rural-observed	−44.9	−14.4	0.0	−59.3
Rural-low elasticity	−39.4	−15.3	−1.1	−55.8
Rural-high elasticity	−33.8	−19.6	−1.1	−54.5

Simulation	Changes in calories from consumption of noncereals*			
	Fish	Meat	Fruits/vegetables	All others
Urban-observed	−2.7	36.6	1.0	−18.8
Urban-low elasticity	−5.7	7.1	−1.9	9.7
Urban-high elasticity	−5.4	7.4	−1.8	9.7
Rural-observed	11.4	15.1	−8.6	66.3
Rural-low elasticity	4.5	10.2	1.3	63.1
Rural-high elasticity	4.1	9.7	1.2	63.7

Group	Total calorie consumption	
	1978	1982
Philippines-reported	1,804	1,808
Philippines-using 1978 calorie conversion rates	1,804	1,837
Urban-reported	1,872	1,831
Urban-using 1978 calorie conversion rates	1,845	1,857
Rural-reported	1,769	1,797
Rural-using 1978 calorie conversion rates	1,795	1,820

Simulation	Changes in total calorie consumption*	
	Estimated observed income change	Constant income
Urban-observed	+12	
Urban-low elasticity	27.5	45.9
Urban-high elasticity	40.2	62.1
Rural-observed	+25	
Rural-low elasticity	23.3	−24.9
Rural-high elasticity	24.3	−37.9

*All changes in calorie consumption are calculated using 1978 calorie conversion rates as reported for the total national sample.

the urban group and a decrease in rice consumption for the rural group. Similarly for "other cereals" (primarily wheat-based products), the model correctly predicts no change for the rural group (despite a hefty price increase) and a decrease in consumption for the urban group. The only instance where the model performs poorly is that it fails to predict a small decrease in corn consumption for the urban group, which results in a small overestimate in the overall change in calories consumed from cereals for the urban group.

Despite a substantial fall in cereal prices, urban consumers do not increase overall cereal consumption, but reveal a strong preference for noncereal items in the diet, which tend to be more expensive calorie sources. Rural consumers decrease cereal consumption as cereal prices fall, not because incomes go down (incomes are assumed to increase), but apparently because of

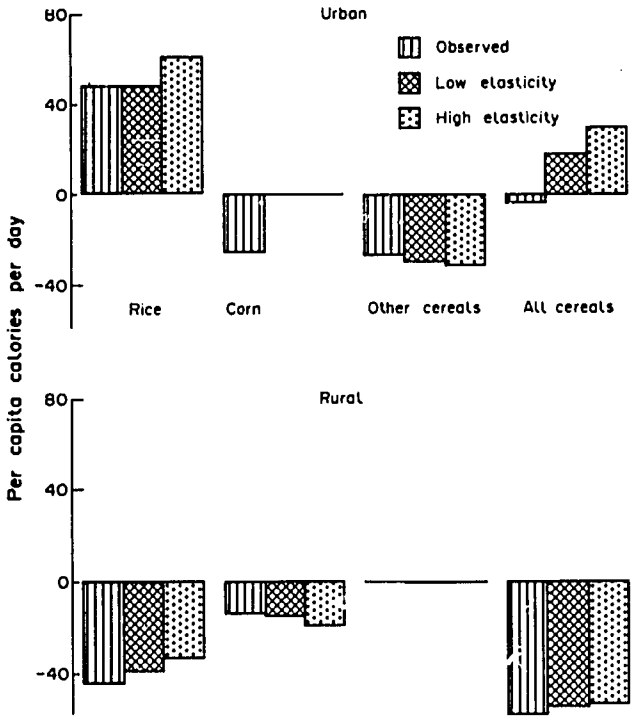

Figure 1. *Actual and projected change in per capita calorie consumption per day from 1978 to 1982, for various cereals by urban and rural populations.*

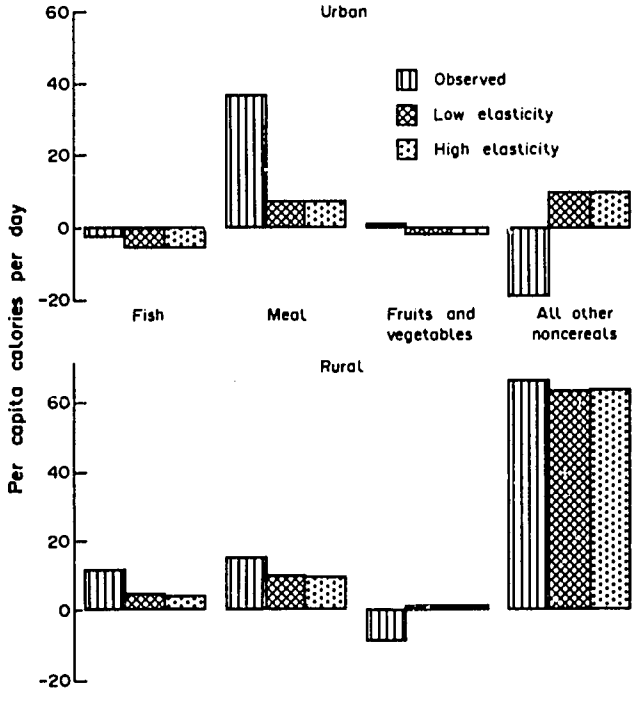

Figure 2. *Actual and projected change in per capita calorie consumption per day from 1978 to 1982, for various noncereal food groups by urban and rural populations.*

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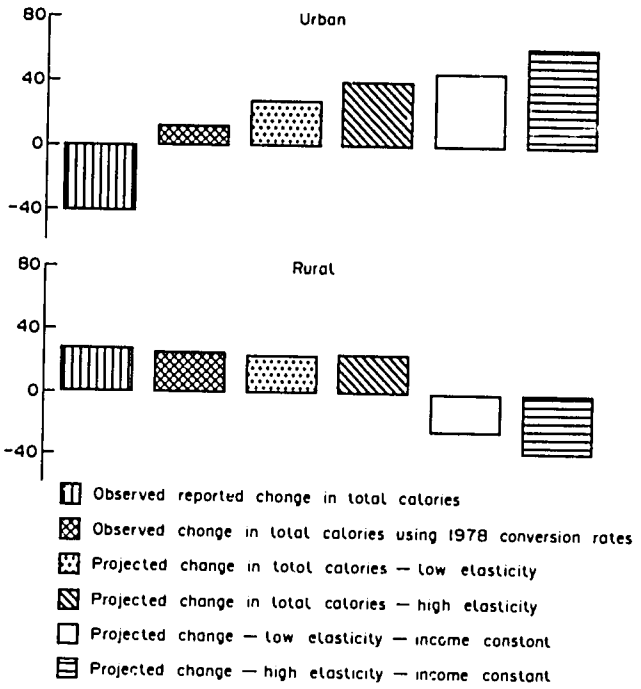

Figure 3. *Actual and projected change in per capita calorie consumption per day from 1978 to 1982, total for all food groups, by urban and rural populations.*

decreased subsistence cereal production, the consequent rise in cost implicit in greater dependence on food purchases in the market (paying retail instead of wholesale prices in terms of the characterization presented earlier), and higher input costs.

Figure 2 shows how savings from lower expenditures for cereals are spent on various nonfood items. The model successfully distinguishes between the large increase in calories for the rural group for the catch-all category of "all other noncereals," and the much smaller decrease for that category for the urban group. In general, the model does well in predicting rather small calorie changes for the remaining three food groups, with the glaring exception of the meat group for urban residents.

There is some tendency for the model to understate preferences for fish and meat and to overstate preferences for fruits and vegetables and for all other noncereals. Demand behavior for meats in particular is driven by demand behavior of higher income groups so that the uneven distribution of the change in income can account for this discrepancy. Table 8 indicates that the households in the highest 20% of the income distribution eat about half of the meat consumed in the Philippines, and that about three-fourths of the increase in meat consumption between 1978 and 1982 was accounted for by the upper one-third of the income distribution. This only serves to underscore the potential pitfalls of examining demand changes and their nutritional consequences at such an aggregate level as has been undertaken here, thus emphasizing the desirability of disaggregating by occupation group (especially for the rural population) *and* by income group.

(e) *Deriving estimates of calorie income elasticities*

Turning finally to changes in overall calorie availability, Figure 3 shows observed changes and predicted changes under two income scenarios, one an estimate of the actual change in income and another assuming no change in income. The appropriate comparison is between the model results and change in total calories calculated using the 1978 conversion rates, which show increases in total calorie consumption for both urban and rural populations, but rather small increases.[12]

Figure 3 shows that the model does quite well in predicting the relatively small changes in total calorie intakes that were observed between 1978 and 1982 for both the urban and rural groups. In

Table 8. *Meat consumption levels, by approximate income quintile, for the Philippines, 1978 and 1982*

Approximate income quintile	Absolute percentage of total sample 1978	1982	Cumulative percentage of total sample 1978	1982	Meat consumption in grams per day 1978	1982	Change
1	21.2	15.1	21.2	15.1	9	14	+5
2	23.3	21.7	44.5	36.8	19	20	+1
3	24.1	28.0	68.6	64.8	27	35	+8
4	13.4	19.3	82.0	84.1	38	55	+17
5	18.0	15.9	100.0	100.0	76	103	+27

Source: FNRI (1981 and 1984).

the case of the rural group, the model did a reasonably good job of predicting changes in the consumption levels of each of the seven food groups, so that it was a foregone conclusion that predicted and observed change in total calories would be similar. In the case of the urban group, however, overestimates of calories consumed from corn and all other noncereals and an underestimate of calories consumed from meat netted out to give an accurate projection of total change in calories. This is not just coincidence. As pointed out before, total calorie intake (bulk) is included as an explicit argument in the utility function used to derive the demand matrices.

To obtain estimates of the elasticities of calorie intakes with respect to income implicit in the demand matrices presented in Table 5, total calorie intakes were reestimated assuming no change in income. For the urban group with a 7.5% increase in income, the change in calorie intakes went from +27.5 to +45.9 (see Table 7), or percentage increase of 1.0% (18 divided by 1,857). Dividing 1.0% by 7.5% gives an elasticity of 0.13. For the rural group with a 10% decrease in income, the change in calorie intakes went from +23.3 to −24.9, or a percentage decrease of 2.6% (−48 divided by 1,820). Dividing −2.6% by −10.0% gives an elasticity of 0.26.

The elasticity is higher for rural groups for two reasons. First, *ceteris paribus*, rural incomes are lower and calorie intakes lower so that the marginal utility from increases in bulk is higher. Second, activity levels of rural households can be expected to be higher than those of urban households. Even if calorie intakes for urban and rural populations were equal, marginal utility from increases in bulk would still be higher for rural groups.[13]

(f) *Summary*

In conclusion, the proposed demand system provides a useful framework for understanding the reactions of urban and rural consumers to changes in prices and incomes from 1978 to 1982. The calorie intakes of low-income urban consumers were insulated from a decline in income by a substantial decrease in real cereal prices. Because the income elasticities of total calorie intakes are especially low for urban consumers, from a nutritional point of view consumers did not take full advantage of the decrease in cereal prices. Rural incomes increased modestly and aggregate real food prices fell, resulting in a small increase in calorie intakes for the rural sector. However, because much of the cereal consumption in rural areas is derived from subsistence production and input costs did not decline, rural producers as consumers were in a sense insulated from the real cereal price decline, consumption of cereals decreased, and consumption increased for foods which are relatively expensive sources of calories.

Rapid rural-to-urban migration, presumably induced in large part by the higher incomes that could be earned in urban areas, led to a substantial decline in real urban wages. Lower wages in urban areas explain how calorie intakes could have fallen at the same time as cereal prices fell. The net result for the poor, then, was that much of the potential nutritional benefit of falling cereal prices was negated by population growth, which led to reduced wages and incomes.

6. IMPLICATIONS FOR NUTRITION POLICY UNDER ECONOMIC RECOVERY

What has happened to nutrition since 1982? After a decade of steadily improving rice productivity and falling cereal prices, real cereal prices leveled off in 1982 and remained virtually con-

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stant through 1988. Real gross domestic product *declined* by 9% from 1982 to 1986 (CRC, 1988). Assuming a population growth rate of 2.6% per year, gross domestic product on a per capita basis fell by 20%. If real wages fell during an economic expansion, it is not unreasonable to expect that wages would fall even faster during an economic contraction which immediately followed the expansion. It is clear, then, that nutrition must have declined and declined significantly; measuring the extent of the decline awaits the next nationwide nutritional survey.[14]

If, from a nutritional point of view, it is somewhat disappointing that calorie intakes do not increase rapidly with increases in income, the obverse result at least is that calorie intakes should not decline rapidly as income goes down. Assuming a maximum aggregate calorie income elasticity of 0.2, this would indicate a modest 4% drop in calorie consumption (measured at the mean of the data) as income declined by 20%.

This aggregate figure of 4% is somewhat deceptive in that there is the possibility that the incidence of declining income has fallen disproportionately on lower-income groups (given the evidence presented of falling wages). Table 1 shows that the calorie intakes of the bottom 40% of the income distribution were already well below recommended levels even at the peak of the economic expansion. Table 1 does not take into account possible maldistribution of calories among household members, on average or at the margin (for example, see Bouis and Haddad, forthcoming, Chapter 8). *Any* decline in calorie intakes could have serious consequences for particular individuals in these low-income households. An examination of Tables 1 and 2 shows how modest increases in calorie intakes between 1978 and 1982 (below 4%) for the bottom 60% of the income distribution are correlated with a significant reduction in the incidence of young children falling below 75% of standard weight-for-age.

Finally, what conclusions are suggested for policies to improve nutrition during the economic recovery? First, in a labor-surplus economy such as the Philippines undergoing rapid population growth, the experience of the 1970s shows that there will continue to be strong pressure on real wages to fall over the long run, even during periods of economic expansion. Since 1982, real retail rice prices have remained constant at their lowest point since independence, roughly 50% below price peaks which occurred in the mid-1960s when the Philippines reached its land constraint before the introduction of modern varieties, and again in the early 1970s when poor weather and pest infestation struck, world rice prices were at unusually high levels, and imports were difficult to secure (see Bouis, 1982, Chapter 2).

Given the slowdown in productivity gains in the rice sector in recent years, continued population growth, and limited government resources for purchases of imports to bring cereal prices down even further, it is very unlikely that cereal prices will decline in the medium run to compensate the poor for lower wages, as occurred in the 1970s. Rather, lower production of rice and corn on a per capita basis may cause prices to rise, if policies are not implemented to improve cereal productivity. Lower real wages coupled with constant or rising cereal prices will mean that the incidence of malnutrition can be expected to increase, even if there is moderate growth in the aggregate economy and apart from whatever decline in nutrition has taken place since 1982.

Second, the above conclusion suggests that any strategy for economic recovery needs to be particularly sensitive to the already precarious plight of the poor. Economic readjustment policies will ultimately determine how the repayment of the foreign debt will be shared among various income and occupation groups. A strategy that keeps food prices from rising will tend to minimize the share that is paid by the poor. Investments in increased corn productivity in particular would meet such distributional goals, and at the same time would contribute to overall economic growth (see Rosegrant *et al.*, 1987; Bouis and Haddad, forthcoming). If real food prices should rise, targeted food subsidies will need to be considered to prevent a worsening nutritional situation.[15]

Third, the low calorie-income elasticities suggest the possibility that there may be some scope for improving nutrition through a reallocation of food expenditures away from higher-priced calorie sources to less expensive calorie sources. If this cannot be done for those at the very bottom of the income distribution, it should be done at least for those in the middle of the income distribution, whose calorie intakes, on average, are significantly below recommended levels (see Table 1). This proposition assumes that calories are the primary nutrient constraining better nutrition, that families are not fully aware that individual household members could improve their nutritional status by consuming more calories, and that families could be convinced (for example, through a cost-effective government program) to alter their expenditure and food consumption behavior. All of these assumptions would need to be thoroughly tested through microlevel household studies.

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NOTES

1. Four major crops — rice, corn, coconuts, and sugar — account for 90% of area harvested (Bouis, 1982).

2. Because the cutoff points defining various income groups are different for the 1978 and 1982 surveys, comparisons are only approximate and need to be treated with some caution. As outlined in the notes to Table 1, data for some income groups were aggregated to facilitate comparison.

3. A decline in the incidence of young children below 85% of standard weight-for-height was also statistically significant, but the only available disaggregation was by age of the child.

4. The sense of the term "preferred" as it is used here is an empirical one, simply that it has a higher income elasticity than the inexpensive staple. In the context of the Philippines, corn, a relatively inexpensive staple, is often referred to as an "inferior" staple in that consumption is observed to decline with income, as rice consumption (the preferred staple) increases. The preference patterns of particular individuals may, of course, deviate from this cultural norm.

5. See Quisumbing (1987 and 1988) for demand estimates derived from the FNRI survey data through direct econometric estimation using the household-level observations, from which the published mean consumption levels in Table 3 were computed. Published data are available for estimating food demand matrices by the three broad regions, Luzon, Visayas, and Mindanao, *or* by income group. As will become evident from the analysis to follow, the most interesting breakdown for this particular time period is between urban and rural populations. An additional reason for not deriving demand matrices by income group was that income groups were defined differently in the 1982 survey, which makes comparisons between the 1978 and 1982 surveys difficult (see the notes at the bottom of Table 1).

6. The aggregate own-price elasticity of −0.6, which is used as a base here, is higher than estimates obtained by other authors, which tend to range from −0.2 to −0.4. Note also the negative income elasticity for rice for the urban group. Application of the characteristic demand system does not guarantee that any set of four prespecified elasticities will be consistent with such restrictions as positive shadow prices for bulk and variety, or utility maximization. A positive income elasticity for rice for the urban data tended to violate such restrictions.

7. This suggests that the national aggregate own-price elasticity for rice (a weighted average of −0.40 and −0.65) may be somewhat lower than −0.6, although not substantially lower.

8. While landlessness is becoming an increasingly important problem in the Philippines, a large majority of rural households have access to some land, so that the characterization which is described in the text is not untypical. Data cited in Philippine Institute for Development Studies (1987; Table 11, p. II.19) for the bottom 30% of the national income distribution (where representation of persons without access to land would be disproportionately high) show that for rural occupations (farmer owners; farmer part-owners; farmer tenants; fishermen, laborers, and related workers; loggers and other forestry workers; miners, quarrymen, and related workers), only 17% do not have access to land (that is, are not farm owners, part-owners, or tenants).

A random sample of households in a predominantly rural southern Philippine province (see Bouis and Haddad, forthcoming, Chapter 3), shows that only 7% of households had no access to land, using these same occupation categories. Using all occupation categories (including transportation related jobs, skilled workers, professionals, and so on), only 26% of households could not be categorized as either farm owner or farm tenant. Moreover, detailed surveys of a stratified sample of farm owner and tenant households showed that all households produced some rice or corn for subsistence consumption, even those that were predominantly engaged in noncereal, cash crop production. Some households that characterized themselves as landless laborers or as engaged in nonagricultural occupations (included in the 26% landless cited above) had small plots of land on which they produced either rice or corn.

9. Nominal fertilizer prices rose faster than nominal rice prices, and interest rates rose (PIDS, 1987, Table 17, p. V.87).

10. The urban series was unfortunately discontinued after 1980 when the indicated trend became an embarrassment to the Marcos administration.

11. Alternative simulations were run, which assumed zero income change for both urban and rural groups, so that the sensitivity of predicted calorie consumption levels to these income growth assumptions could be checked. These results are reported in Table 7 and discussed later in the paper.

12. As shown in Table 7, a comparison of the calorie intakes reported by the FNRI shows a 41 calorie (−3.2%) decline for the urban population between the two surveys and a 28 calorie (1.6%) increase for the rural population. Both the 1978 and 1982 FNRI publications provided sufficient information that calorie conversion rates for the disaggregate food groups could be computed, but only for the sample as whole; that is, separate conversion rates for urban and rural groups could not be derived. Multiplying these total sample conversion rates by the 1978 urban and rural consumption levels for the disaggregate food groups gave a slight underestimate for the urban population and a slight overestimate for the rural population (this is shown in Table 7). Applying the same conversion

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rates to the 1982 *rural* data again gave a reasonable approximation of total calorie intake and, more importantly, an almost identical change in calorie intakes between the two surveys (+25 as compared with +28). Unfortunately, for the *urban* data, these conversion rates indicated a 12 calorie increase between the two surveys, as opposed to a reported decrease of 41 calories.

While this is not a large discrepancy in percentage terms, it raises the conceptual issue of whether substitution among foods within the disaggregate food groups, caused by changes in prices and income, led to a significant change in the calorie content of the individual food groups themselves. In other words, should the calorie conversion rates be treated as endogenous, and are changes in these conversion rates important enough empirically that they should be considered in the analysis? While in a theoretical sense, it cannot be denied that such substitution takes place within food groups and that calorie conversion rates change, it is also evident that at a sufficient level of disaggregation of food groups, such substitution becomes empirically irrelevant. Calorie conversion rates for 17 disaggregate food groups were used in the calculations just discussed, which is thought to be sufficient disaggregation to minimize this problem.

Comparing calorie conversion rates across the survey rounds for the 17 food groups, most conversion rates changed only a few percentage points, some increasing, others decreasing. A notable exception was the calorie conversion rate for milk and milk products, which fell by nearly 80%. This alone can account for the discrepancy in reported and calculated change in calorie intakes for the urban population between the two surveys. Such a large decrease in the calorie conversion rate would appear to be related to a definitional change or technical correction, rather than a real phenomenon. While this bears further investigation, for the purposes of this paper, the appropriate comparison for validating the model is to use total calorie intakes calculated by multiplying the observed consumption levels by the 1978 conversion rates.

13. Note in Table 1, comparing 1978 calorie intakes across urban and rural populations in the same income groups (that is, controlling for income), that rural calorie intakes are consistently higher than urban calorie intakes. The one exception is the highest income group (which does not control for income). Average urban incomes for this highest income group are likely much higher than average rural incomes.

14. See Quisumbing (1985) for a survey of what data are available for assessing the impact of the economic crisis on nutrition. These sketchy data suggest a deteriorating nutritional situation.

15. See Quisumbing (1987) for a discussion of the comparative costs and benefits of various policy alternatives to improve nutrition, including targeted food subsidies.

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APPENDIX: MATHEMATICAL FORMULATION FOR FOOD DEMAND MODEL BASED ON DEMAND FOR CHARACTERISTICS

Utility is a function of bulk, variety, and tastes (characteristics of quantities of food consumed) and of nonfood purchases. Total utility gained from these three characteristics and from nonfoods is the weighted sum of the individual utilities that these four items generate.

$$U = w_b U_b(B) + w_v U_v(V) + \sum_{i=1}^{n} w_{ti} U_{ti}(q_i) + w_{nf} U_{nf}(q_{nf}) \quad (1)$$

where:

- U = total utility from all food and nonfood goods,
- q = quantity of a good,
- i = 1, . . ., n are the n foods consumed,
- B = a measure of bulk in the diet,
- V = a measure of variety in the diet,
- U_b = utility derived from bulk,
- U_v = utility derived from variety,
- $U_{ti}(q_i)$ = utility derived from the taste of q units of good i,
- $U_{nf}(q_{nf})$ = utility derived from q units of the nonfood good,
- w_b = weight placed on utility from bulk,
- w_v = weight placed on utility from variety,
- w_{ti} = weight placed on taste from individual food i,
- w_{nf} = weight placed on utility from the nonfood good.

Utility from bulk

$$B = \sum_{i=1}^{n} z_i q_i \quad (2)$$

where

- z_i = factor converting quantity of the ith food into bulk.

Calories are used as proxies for the z_is in the empirical work presented in the paper. B is total calories consumed per adult equivalent.

$$U_b(B) = b_1 + b_2 B + b_3 B^2 \quad (3)$$

where $b_2 > 0$ and $b_3 < 0$

At low levels of total bulk, each additional unit of bulk increases utility, but at a decreasing rate. The functional form chosen, however, allows for marginal decreases in utility from additional units of bulk at sufficiently high intakes of bulk.

$$B_i = w_b (b_2 z_i + 2b_3 B z_i) > 0 \text{ for low-income groups} \quad (4)$$

where $B_i = \dfrac{\partial U}{\partial U_b(B)} \quad \dfrac{\partial U_b(B)}{\partial q_i}$

$$B_{ij} = 2 w_b b_3 z_i z_j < 0 \quad (5)$$

where $B_{ij} = \dfrac{\partial B_i}{\partial q_j}$

Analogous notation will be used below for V_i, V_{ij}, T_i, and T_{ij}.

Utility from taste

$$U_{ti}(q_i) = \log(q_i) \quad (6)$$

$$T_i = w_{ti}(1/q_i) > 0 \quad (7)$$

$$T_{ii} = -w_{ti}(1/q_i)^2 < 0 \quad (8)$$

$$T_{ij} = 0 \quad (9)$$

Each additional unit of taste of good i, no matter what the quantity, adds additional utility, but at a decreasing rate. The first derivative is positive and the second derivative negative, then, which is similar to bulk for low-income groups. However, for taste the "across food" second derivative is zero.

Utility from variety

$$U_v(V) = M/T \tag{10}$$

where:

M = nonstaple kilograms of food consumed per adult equivalent,

T = total kilograms of food consumed per adult equivalent,

$$V_i = -w_v M/T^2 < 0 \qquad \text{for } i \leq s \tag{11}$$

$$V_i = w_v(1/T)\,(1 - [M/T]) > 0 \text{ for } s < i < n$$

where $i = 1, \ldots, s$ are staple foods.

Each additional unit of a staple good reduces utility from variety and each additional unit of a nonstaple good increases utility from variety.

$$V_{ij} = 2M/T^3 > 0 \qquad \text{for } i,j \leq s \tag{12}$$

$$V_{ij} = (w_v/T^3)\,[2M - T] \qquad \text{for } i \leq s \text{ and } s < j < n$$

$$V_{ij} = (2w_v/T^3)\,[M - T] < 0 \qquad \text{for } s < i,j < n$$

For all three sets of i and j, $V_{ij} = V_{ji}$.

Solving the model

For any food i:

$$P_i = \frac{\dfrac{\partial U}{\partial U_b}}{\lambda}\left[\frac{\partial U_b}{\partial B}\,\frac{\partial B}{\partial q_i}\right] + \frac{\dfrac{\partial U}{\partial U_v}}{\lambda}\left[\frac{\partial U_v}{\partial V}\,\frac{\partial V}{\partial q_i}\right] + \frac{\dfrac{\partial U}{\partial U_T}}{\lambda}\left[\frac{\partial U_T}{\partial T}\,\frac{\partial T}{\partial q_i}\right] \quad i = 1, \ldots, n \tag{13}$$

where

P_i = price of quantity i,

λ = Lagrangian multiplier derived from the budget constraint.

There are n equations associated with (13), which for the first food, a staple, gives:

$$P_1 = \frac{w_b}{\lambda}\left[b_2 z_1 + 2b_3 z_1 B\right] + \frac{w_v}{\lambda}\left[-M/T^2\right] + \frac{w_{t1}}{\lambda}\left[\frac{1}{q_1}\right] \tag{14}$$

Shadow prices for bulk and variety are given by the product of the coefficient outside the brackets times the first derivative inside the brackets, for the first and second terms in (14), respectively. Generally, shadow prices will decrease with increased comsumption as the first derivative declines. However, the marginal utility of income, λ, declines with income, tending to raise the shadow price.

Elasticity estimates do not depend on λ, but on the flexibility of the marginal utility of income, ϕ, a term which involves λ and which is used in the Frisch technique for estimating demand elasticities (see Pinstrup-Andersen *et al.*, 1976). Thus, there are $(n+5)$ unknowns associated with the n equations represented by (13), specifically ϕ, w_b, w_v, b_2, b_3, and the n w_{ti}s. An additional equation for the nonfood good (which includes ϕ as an unknown) gives a total of $(n+1)$ equations. Prior specification of four elasticities identifies the four "extra" parameters.

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