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DEMAND FOR FOOD IN THE PHILIPPINES: RESPONSES TO PRICE AND INCOME CHANGES

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A member of the class of demand systems proposed by Blundell et al. (1993) is employed to inform the structure of food consumption responses in the Philippines. In general, it is found that the income elasticity of demand for cereal is about 0.1 and that this elasticity does not drop rapidly with the level of income as is often suggested in the literature. This response is consistent with expectations concerning conversion ratios of cereal consumption to calorie-intake and gains in body weight. Moreover, while food price responses vary from one income group to another, or between rural and urban areas, the variation is not as large as has commonly been presumed.

1. Introduction

Information about current food demand patterns and how they are likely to change as prices and incomes change is crucial to assessing the welfare and distributional impact of technological change, infrastructure development, and economic policies. Moreover, such information is useful in designing policies aimed at improving the access of the poor to food, especially during a period of macroeconomic adjustment. Structural adjustment reforms aimed at bringing the economy to a rapid, sustainable growth path often accompany changes which may have especially disruptive effects on the poor's welfare such as sharp increases in the prices of food and services. Such reforms are critical to get the Philippine economy moving and eventually keeping pace with the other Southeast Asian countries.

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Estimates of food demand responses to price and income changes vary widely, partly reflecting differences in estimation methodology, data, and commodity aggregation. Most of the previous studies used aggregate data (e.g., annual average consumption) and neglected information on time-varying household characteristics which may well be correlated with real total expenditure and relative price movements. In all cases, the possibility of interaction of total expenditure with individual characteristics is ignored; aggregation factors (e.g., proportion of total expenditure associated with family size, occupation, or employment status) are also excluded. Aggregate models that fail to account for these factors may give unstable parameters and thus may perform poorly in forecasting demand patterns (Blundell et al., 1993). Consequently, the parameter estimates may not be useful for the evaluation of aggregate consequences of public-policy experiments. As Blundell et al. have shown, this problem can be remedied by an inclusion of certain distributional measures—not at all easy to come out owing to paucity of time-series household surveys—in the aggregate model, but this has not been attempted in any of the previous studies on Philippine food demand system.

In this paper, we use individual household data collated from 1985 to 1991 to estimate food demand responses for the Philippines. The estimating model employed is a member of the class of demand systems proposed by Blundell et al., specifically the extended "almost ideal" demand system. Section 2 of the paper discusses the theoretical structure of the model. Section 3 discusses the estimation procedure and data sources. Section 4 presents estimation results. Section 5 compares these results with previous studies. Finally, Section 6 gives concluding remarks.

2. Theory and Model Structure

In theory, the following restrictions are expected to be satisfied by a system of demand equations: (a) homogeneity of degree zero in prices and income, (b) share-weighted sum of income elasticities equal to unity, and (c) symmetry and negative definiteness of compensated cross-price terms. Demand systems derived from constrained maximization of a specified utility function automatically

satisfy these restrictions. Such systems are, however, restrictive; their estimation may be quite complicated and clumsy to handle without the imposition (often unrealistic) of separability conditions on the utility function (see Deaton and Muellbauer, 1980b).

Some type of linear or quadratic expenditure system, for example, assumes either strong or weak separability between commodity groups in the utility function. For strong separability, this means that, in the case of food demand system, the utility derived from the consumption of, say, an inexpensive staple does not depend on the level of consumption of a more expensive, preferred staple. This is not a defensible assumption in areas where households suffer hunger (see, e.g., Bouis, 1990). For weak separability, the marginal rate of substitution between an inexpensive and expensive staple does not depend on the level of consumption of nonstaples. This assumption appears innocuous. However, where households have a desire for variety in their diet, or for tastes inherent in particular foods, or for both, then the marginal rate of substitution between the two staples depends very much on the level of consumption of nonstaples, thereby violating the assumption of weak separability.

The empirical attraction of imposing separability restrictions on the data is that it reduces substantially the number of demand parameters to be estimated. This is a justifiable remedy for data and computational constraints. For example, the linear expenditure system proposed by Stone (1954)—a logarithmic demand function—assumed zero cross-price elasticities for some pairs of goods, and, together with automatic imposition of homogeneity and symmetry restrictions, reduced considerably the parameters to be estimated to a manageable level. Where data permit, instead of imposing these restriction on the data, an alternative approach would be to test directly the assumption of separability (as well as the restrictions of consumer demand theory in general).

In recent years, the more popular approach to deriving a demand system is the so-called "duality approach." This approach involves a cost-minimization problem and, therefore, allows moving relatively easily from the cost function to demand functions. Moreover, given a correctly specified cost function, the approach guarantees the existence of corresponding preferences, even though the utility function need never be explicitly evaluated (Christensen et al., 1975; Deaton, 1986). This "flexible" property turns out to be very useful in applied work.

The familiar "almost ideal" (AI) demand system proposed by Deaton and Muelbauer (1980) is one class of flexible functional forms. The demand functions derived from it are first-order approximations to any demand system derived from utility-maximizing behavior. The model satisfies the axioms of choice exactly, aggregates perfectly over consumers without invoking parallel linear Engel curves, and is simple to estimate (thereby largely avoiding the need for nonlinear estimation). While the homogeneity and Slutsky symmetry restrictions of consumer demand theory can be easily imposed, the model allows the testing of these restrictions against the data through linear restrictions on fixed parameters.

However, because of the specificity of the cost function guaranteeing exact aggregation, the AI demand system may not permit non-linear expenditure terms and interactions between expenditure and household characteristics. In a number of studies (Swamy and Binswanger, 1983; Browning and Meghir, 1991; Blundell et al., 1993; Dickens et al., 1993), these effects have been shown to be empirically important. Moreover, while the theoretical structure of the AI demand model supports the conventional view that the demand for food always becomes more inelastic with respect to price as real income increases, such implication has not always been consistent with household behavior (Wohlgenant, 1984).

In this paper, we follow a two-stage budgeting framework in modelling household behavior. In the first stage, the household makes decisions on how much of the predetermined total income is to be allocated for food consumption conditional on various household characteristics. The relative amount consumed of food commodities depends on the consumption of the second group of goods (nonfood goods) which acts much like demographic or locational variables affecting both the allocation of total expenditures to food commodities as well as the marginal rate of substitution between them (see Browning and Meghir (1991) for a discussion of conditional demands and weak separability). In the second stage, the household allocates the amount, m_t^h, to individual items of the food group. Under (conditional) intertemporal weak separability, the allocation is done

without reference to prices or incomes outside the period (Blundell and Walker, 1986; Blundell et al., 1993). Letting q_{it}^h represent the consumption of good i in period t by household h, then the expenditure on good i, conditional on demographic and locational variables (denoted z_t^h) may be expressed as

$$(1) \qquad p_{it} q_{it}^h = f_i \, (p_t, m_t^h; z_t^h)$$

Using a member of the class of preferences described by Blundell et al. (1993), we specify individual preferences as a quadratic (or extended) "almost ideal" demand system. This is given by

$$(2) \qquad w_{it}^h = \alpha_{it}^h + \sum_j \gamma_{ij} \ln p_{jt} + \beta_{it}^h \ln (m_t^h / P_t^h) + \lambda_{it}^h \left(\ln (m_t^h / P_t^h)\right)^2$$

where the α_i^h, β_i^h, and λ_i^h parameters are allowed to vary with the household-h characteristics and other conditioning variables, and P is the household-specific Stone price index. The way the demographic and other conditioning variables influence the intercept and expenditure parameters can be written as

$$(3) \qquad \alpha_{it}^h = \alpha_o + \sum_k \alpha_{ik} z_{kt}^h + \sum_k \delta_k T_{kt}$$

$$(4) \qquad \beta_{it}^h = \beta_i + \sum_k \beta_{ik} z_{kt}^h + \sum_k \delta_k T_{kt}$$

$$(5) \qquad \lambda_{it}^h = \lambda_i + \sum_k \lambda_{ik} z_{kt}^h + \sum_k \delta_k T_{kt}$$

where T_{kt} are purely deterministic time-dependent variables (e.g., time trends).

Homogeneity of the demand system requires that $\Sigma_j \gamma_{ij}$ is equal to zero, for all i. Symmetry of the Slutsky matrix, on the other hand, requires that $\gamma_{ij} = \gamma_{ji}$. In adddition, for integrability, $\lambda_i / \beta_i = \delta$, i.e, the ratio of the coefficients on the expenditure and squared terms in expenditure must be the same for all commodities. The AI demand system of Deaton and Muellbauer imposes the further restriction that $\lambda_i = 0$. Finally, note that unrestricted estimation of

(2) satisfies automatically the adding-up restriction that the sum of the budget shares must not exceed unity.

For this model, the expenditure elasticity (η_i) and the uncompensated elasticity of good i with respect to the price of good j (ϵ_{ij}) are defined as

(6) $$\eta_i^h = (\beta_i^h + 2\lambda_i^h \ln m^h)/w_i^h + 1$$

(7) $$\epsilon_{ij}^h = (\gamma_{ij}/w_i^h) - (\beta_i^h + 2\lambda_i^h \ln m^h)(w_j^h/w_i^h) - k_{ij}$$

where $k_{ij} = 1$ if $i = j$ and $k_{ij} = 0$ if $i \neq j$.

3. Data and Estimation Procedure

Household data used for the analysis are primarily the *Family Income and Expenditures Survey* (FIES) of the National Statistics Office for 1985, 1988, and 1991. The surveys have a sample size of 16,961 households for 1985, 18,885 households for 1988, and 24,789 households for 1991. For our purposes, we have randomly selected a sub-sample representing one-fourth of the sample size for each of the surveys. To eliminate household outliers which may unduly influence the estimated parameters of the demand system, we have eliminated observations belonging to one percent of each tail of the sub-sample distribution based on per capita household heads expenditure. Furthermore, because the preference of household heads whose ages are over 65 years may be quite different from those who are still in the income-generating stage of their life cycle, only households whose heads are 15 to 65 years old are included in the data set. These adjustments have reduced the sample size for this study to 13,487 households.

Expenditures are classified into 7 groups: rice, corn, other cereals, fruits and vegetables, dairy and meat, other food items, and nonfood. The disaggregation is dictated by the importance of the identified commodity in food policy discussions and by computational limitation. Rice is the major staple for the majority of the population; corn is a staple for low-income households in the

Visayas and Mindanao regions. Both commodities have occupied a central place in food policy discussions in recent years.

In stage 1 of the analysis, the real food expenditure (net of consumption of non-household members) is regressed with real net normal income, conditioning variables, and the interaction of net normal income with some conditioning variables. Net normal income is defined as wage/salary and entrepreneurial incomes. It is assumed that measurement error in food expenditure is not correlated with this variable. In stage 2 of the analysis, the share equations are jointly estimated taking into account the endogeneity of the expenditure terms.

The FIES surveys record food expenditures over a period of one week, based on the respondent's recall. For households which have infrequent purchases for some food items but which have nevertheless consumed them during the period, this has led to entries of zero expenditures on some food items—apart from the possibility of misreporting and of certain households simply choosing not to consume some commodities. In the case of infrequent purchases, the reported expenditure is different from the theoretical concept of consumption. Accordingly, ordinary least-square (OLS) estimates of the share equations are biased (Keen, 1986). As in Blundell et al. (1993) and Pashardes (1993), our treatment of real food expenditure in (2) as endogenous removes this measurement error problem.

The problem with endogenous choice of food items is not dealt with in this paper. Empirically, at least given the data set, it is not possible to isolate zero expenditures arising from infrequent purchase and those arising from household decision choice.

The FIES data do not report separate information on food quantities and prices. It is therefore not possible to infer quality differences in the food consumption of households with different levels of income and to incorporate this information in the estimation (as suggested, for example, by Deaton, 1987, 1990).

Consumer prices for each province, year, and commodity are also obtained from the National Statistics Office. The provincial indices, however, do not make a distinction between rural and urban areas. Consumer price indices for some commodities (e.g., cereals) are expected to be higher in urban areas than in rural areas, and so the expenditure shares may be systematically related with the location of households. We have included appropriate dummy variables to capture the independent influence of location on the parameters of the demand system.

Because the budget shares must add up to one (adding-up restriction), the error terms across equations of the demand system are correlated. Thus, even in the absence of measurement error problem, OLS estimates of the share equations are inefficient (though consistent and unbiased). We have employed iterative seemingly unrelated regression (SURE/MLE) to the share equations after instrumenting the real food expenditure terms (including interaction terms). However, only n-1 equations are linearly independent and one equation must be dropped for estimation purposes. We have arbitrarily deleted the share equation for the catch-all "other food" group. Iterative SURE estimation is invariant to which budget share is deleted. With both iterative procedure and symmetry restrictions, the estimation converges to full information maximum likelihood methods (Johnston, 1984).

The variable definitions and selected statistics are given in Table 1. The pattern of per capita expenditure for the six food commodity items and the nonfood group is summarized in Table 2. The pattern is consistent with familiar Engel curves: declining share of staples and increasing (or constant) share of nonstaple food and nonfood in total expenditure as income increases. The decline in the share of staple is sharper in urban areas than in rural areas, partly reflecting the higher average income in the former. Moreover, the share of the "other food" group falls also more rapidly in urban areas than in rural areas. In both rural and urban areas, the share of dairy and meat tends to increase with income.

4. Estimation Results

Parameter estimates of the total real food expenditure function are given in Table 3. The price terms have the expected signs—food prices negatively affect real food expenditure while nonfood prices positively affect it—and are significantly different from zero at conventional significance levels. The income variable and its square

Table 1
Variable Definitions and Means

Variable	Definition	Mean	Standard Deviation	Minimum	Maximum
SRIC	Rice share in total food expenditure	0.266	0.164	0	0.799
SCOR	Corn share in total food expenditure	0.044	0.123	0	0.749
SCER	Share of other cereals in total food expenditure	0.048	0.044	0	0.598
SDME	Share of dairy and meat in total food expenditure	0.154	0.105	0	0.628
SFRU	Share of fruits and vegetables in total food expenditure	0.089	0.048	0	0.593
SOTH	Share of other food in total food expenditure	0.399	0.112	0	0.669
OTHP	ln(retail price, other food)	1.425	0.221	0.931	1.934
RICP	ln(retail price, rice) - OTHP	-0.156	0.129	-0.581	0.227
CORP	ln(retail price, corn) - OTHP	-0.053	0.136	-0.716	0.410
CERP	ln(retail price, other cereals) - OTHP	0.216	0.220	-0.500	0.914
DMEP	ln(retail price, dairy and meat) - OTHP	0.159	0.236	-0.385	1.283
FRUP	ln(retail price, fruits and vegetables) -OTHP	0.057	0.144	-0.516	0.483
NONP	ln(retail price, nonfood) - OTHP	0.155	0.134	-0.569	0.897
FOODEX	Food expenditure	20,434	16,178	968	232,000
TOTEX	Total expenditure	42,821	55,733	1,358	1,152,000
STONE	Stone price index, all household expenditures	1.489	0.228	1.016	2.087
STONE2	Stone price index, food	1.424	0.215	0.984	2.003
LNX	ln (FOODEX) - STONE2	8.279	0.593	5.318	10.870
LNX2	LNX squared	68.887	9.841	28.280	118.100
LNY	ln(TOTEX) - STONE	8.809	0.726	5.847	12.440
LNY2	LNY squared	78.120	13.090	34.190	154.800

Table 1 (continued)

Variable	Definition	Mean	Standard Deviation	Minimum	Maximum
CHO6	Children aged 0-6 years	0.990	1.130	0	6
CH714	Children aged 7-14 years	1.179	1.267	0	7
CH1524	Children aged 15-24 years	1.044	1.270	0	8
NREL	Non-relatives	0.104	0.523	0	10
SINGLE	Dummy, household head is single	0.031	0.173	0	1
MARRIED	Dummy, household head is married	0.849	0.358	0	1
MALE	Dummy, household head is male	0.873	0.333	0	1
AGE	Age of household head	42.791	11.147	15	65
AGESQ	AGE squared	1,955.400	983.160	225	4,225
EDUC1	Dummy, household head completed elementary	0.067	0.250	0	1
EDUC2	Dummy, household head attended high shcool	0.073	0.260	0	1
EDUC3	Dummy, household head attended college	0.028	0.260	0	1
EDUC4	Dummy, household head is college graduate	0.097	0.296	0	1
TOTEMP	Employed household members	1.632	1.032	0	9
URBAN	Dummy, urban area	0.532	0.499	0	1
AGRI	Agriculture dummy	0.394	0.489	0	1
MAN	Manufacturing dummy	0.083	0.276	0	1
OTHIND	Other-industry dummy	0.064	0.245	0	1
FIN	Finance dummy	0.028	0.143	0	1
TRADTRAN	Trade & transport dummy	0.159	0.366	0	1
CHO6Y	CH06 X LNY	8.686	9.942	0	59.95
CHO6Y2	CH06 X LNY2	76.639	88.754	0	599.00
CH714Y	CH714 X LNY	10.477	11.347	0	69.88
CH714Y2	CH714 X LNY2	93.608	103.040	0	697.60

Table 1 (continued)

Variable	Definition	Mean	Standard Deviation	Minimum	Maximum
CH1524Y	CH1524 X LNY	9.461	11.811	0	86.90
CH1524Y2	CH1524 X LNY2	86.284	111.550	0	944.00
NRELY	NREL X LNY	1.053	5.489	0	106.30
NRELY2	NREL X LNY2	10.758	58.977	0	1,254.00
URBANY	URBAN X LNY	4.758	4.494	0	12.44
URBANY2	URBAN X LNY2	42.832	41.397	0	154.80
CH06X	CHO6 X LNX	8.213	9.419	0	57.02
CH06X2	CH06 X LNX2	68.429	79.347	0	541.90
CH714X	CH714 X LNX	8.885	11.061	0	82.03
CH714X2	CH714 X LNX2	75.958	97.359	0	841.20
URBANX	URBAN X LNX	4.453	4.197	0	10.87
URBANX2	URBAN X LNX2	37.437	35.856	0	118.1
REG1	Ilocos Region dummy	0.067	0.251	0	1
REG2	Cagayan Valley dummy	0.048	0.213	0	1
REG3	Central Luzon dummy	0.103	0.304	0	1
REG4	Southern Tagalog dummy	0.140	0.347	0	1
REG5	Bicol Region dummy	0.059	0.235	0	1
REG6	Western Visayas dummy	0.082	0.274	0	1
REG7	Central Visayas dummy	0.072	0.258	0	1
REG8	Eastern Visayas dummy	0.049	0.216	0	1
REG9	Western Mindanao dummy	0.048	0.214	0	1
REG10	Northern Mindanao dummy	0.059	0.236	0	1
REG11	Southern Mindanao dummy	0.072	0.258	0	1
REG12	Central Mindanao dummy	0.050	0.218	0	1
YR88	1988 dummy	0.314	0.464	0	1
YR91	1991 dummy	0.407	0.491	0	1

Table 2
Expenditure Pattern

Year	Commodity	Urban First 25%	Urban Second 25%	Urban Third 25%	Urban Fourth 25%	Rural First 25%	Rural Second 25%	Rural Third 25%	Rural Fourth 25%
1985	Rice	22.07	18.07	12.49	4.34	22.67	24.74	21.85	13.51
	Corn	3.52	0.71	0.20	0.05	11.28	3.87	2.13	0.80
	Other Cereal	2.44	2.67	2.97	2.00	1.63	1.96	2.23	2.69
	Dairy Products & Meat	7.94	9.10	10.27	8.40	5.63	7.55	8.60	10.10
	Fruits	4.60	3.99	3.88	2.69	5.44	5.51	4.93	4.12
	Other Foods	23.23	23.53	21.99	13.72	22.79	22.88	22.85	20.42
	Nonfood	36.19	41.93	48.20	68.81	30.56	33.48	37.41	48.37
	TOTAL	100	100	100	100	100	100	100	100
1988	Rice	22.21	16.84	11.15	3.57	23.23	20.49	14.95	7.33
	Corn	5.07	1.06	0.34	0.06	7.61	2.01	0.97	0.17
	Other Cereal	2.07	2.87	3.03	2.01	2.21	2.63	2.61	2.64
	Dairy Products & Meat	5.70	8.65	10.56	8.68	5.01	7.08	8.78	9.84
	Fruits	5.79	5.50	5.01	2.99	5.64	5.26	5.05	4.01
	Other Foods	23.86	24.14	23.06	13.56	23.94	24.19	23.33	18.13
	Nonfood	35.30	40.94	46.84	69.13	32.36	38.35	44.31	57.89
	TOTAL	100	100	100	100	100	100	100	100
1991	Rice	20.76	16.15	10.02	4.50	21.14	19.14	14.14	6.14
	Corn	5.75	1.14	0.26	0.08	8.04	1.99	0.54	0.13
	Other Cereal	2.86	3.13	3.32	2.55	2.56	2.91	2.94	2.76
	Dairy Products & Meat	6.21	8.79	10.72	10.18	5.58	7.52	9.19	10.84
	Fruits	5.52	5.41	4.78	3.69	5.73	5.34	4.92	4.15
	Other Foods	24.15	23.84	22.23	17.15	23.77	24.55	23.63	18.38
	Nonfood	34.75	41.54	48.67	61.86	33.18	38.56	44.64	57.59
	TOTAL	100	100	100	100	100	100	100	100

Table 3 - Real Food Expenditure Function
(dependent variable = LNX)

Variable	Coefficient	t-ratio
Constant	1.76370	7.097
RICP	-0.07707	-2.402
CORP	-0.05354	-1.891
CERP	-0.05216	-3.351
DMEP	-0.03667	-2.831
FRUP	-0.12793	-4.748
NONP	0.34360	13.979
LNY	1.05650	16.838
LNY2	-0.03444	-8.663
CH06	0.28971	2.351
CH714	0.69567	27.330
SINGLE	-0.05013	-2.843
MARRIED	0.09068	10.111
MALE	-0.02058	-2.381
AGE	0.00369	1.895
AGESQ	-0.00003	-1.328
NREL	0.00901	1.420
EDUC1	-0.00416	-0.301
EDUC2	0.00238	0.174
EDUC3	0.03861	2.035
EDUC4	0.00456	0.455
URBAN	-0.45409	-1.635
TOTEMP	0.06921	24.849
AGRI	0.00312	0.439
MAN	-0.00678	-0.622
OTHIND	0.00336	0.278
FIN	0.01908	0.958
TRADRAN	0.00137	0.158
REGN1	-0.08019	-5.691
REGN2	-0.07449	-4.757
REGN3	-0.02501	-1.922
REGN4	-0.08185	-7.154
REGN5	-0.16982	-10.953
REGN6	-0.12900	-8.631

Table 3 (continued)

Variable	Coefficient	t-ratio
REGN7	-0.13966	-9.800
REGN8	-0.03354	-2.091
REGN9	-0.05465	-3.318
REGN10	-0.09725	-6.333
REGN11	-0.04793	-3.397
REGN12	-0.13924	-8.721
URBANY	0.13251	1.902
URBANY2	-0.00958	-2.203
CH06Y	-0.05474	-1.790
CH06Y2	0.00288	1.526
CH714Y	0.00013	23.580
CH714Y2	-0.01957	-24.556
YR88	-0.01359	-3.043
YR91	0.01140	1.118
	Adjusted R-Squared	0.709
	F[47, 13,439]	701.533

are also highly significant, suggesting nonlinear response of real food expenditure to real income changes. Also noteworthy is the significance of the interaction terms involving income, on the one hand, and urbanization and the number of children aged 7-14 years. Substantial significant differences in food expenditure also exist among regions and across households of different demographic characteristics. However, sectoral employment of the household head does not affect the allocation of real food expenditure vis-à-vis nonfood expenditure.

Evaluated at sample mean, the total food expenditure elasticity with respect to income is about 0.138. The estimate for rural areas is 0.171, while that for urban areas is 0.104. For the sample, the average real income in urban areas is 47 higher than in rural areas.

Parameter estimates of the food demand system are shown in Table 4. Nearly two-thirds of the price terms have coefficients significantly different from zero. All own-price terms, except for the equation on fruits and vegetables, and expenditure terms are

Table 4
Parameter Estimates of the Extended AI Demand System
(absolute t-ratios in parentheses)

Variable	Rice	Corn	Other Cereals	Dairy & Meat	Fruits & Vegetables
Constant	-3.1225	1.8157	0.2995	0.8941	0.5263
	(9.61)	(7.82)	(3.17)	(4.61)	(5.02)
RICP	-0.0103	-0.0095	-0.0039	-0.0426	0.0317
	(2.80)	(1.18)	(1.20)	(8.97)	(8.12)
CORP	-0.0095	-0.0060	-0.0040	-0.0276	-0.0147
	(1.18)	(7.30)	(1.48)	(7.88)	(4.33)
CERP	-0.0039	-0.0040	-0.0040	0.0194	-0.0006
	(1.20)	(1.48)	(2.21)	(12.82)	(0.36)
DMEP	-0.0426	-0.0276	0.0194	0.0261	-0.0114
	(8.97)	(7.88)	(12.82)	(7.66)	(6.47)
FRUP	0.0317	-0.0147	-0.0006	-0.0114	-0.0017
	(8.12)	(4.33)	(0.36)	(6.45)	(0.48)
LNX	0.9114	-0.3640	-0.0828	-0.2846	-0.1031
	(11.44)	(6.39)	(3.57)	(5.98)	(4.01)
LNX2	-0.0602	0.0176	0.0062	0.0238	0.0061
	(12.34)	(5.03)	(4.40)	(8.17)	(3.86)
CHO6	0.0056	0.0037	0.0009	0.0021	-0.0012
	(4.96)	(4.57)	(2.67)	(3.09)	(3.34)
CH714	0.0261	0.0113	-0.0030	-0.0204	-0.0024
	(25.48)	(15.43)	(10.17)	(33.29)	(7.40)
MALE	0.0066	0.0067	-0.0027	-0.0086	-0.0012
	(1.76)	(2.51)	(2.52)	(3.84)	(0.99)
URBAN	3.9367	-0.4817	-0.4172	-1.6099	-0.2690
	(10.01)	(1.72)	(3.66)	(6.88)	(2.13)
URBANX	-0.9171	0.0865	0.1038	0.3921	0.0628
	(9.64)	(1.27)	(3.74)	(6.90)	(2.05)
URBANX2	0.0529	-0.0035	-0.0064	-0.0236	0.0062
	(9.15)	(0.86)	(3.77)	(6.84)	(2.11)
AGRI	0.0169	-0.0005	-0.0016	-0.0150	-0.7482
	(6.53)	(0.28)	(2.15)	(9.74)	
YR88	-0.0389	-0.0007	0.0038	-0.0061	-4.7759
	(10.76)	(0.28)	(3.52)	(2.97)	
YR91	-0.0431	0.0023	0.0079	-0.0061	0.0273
	(12.41)	(0.94)	(7.46)	(3.10)	(12.10)
REGN7	-0.1691	0.1927	0.0046	-0.0139	-0.0127
	(33.72)	(53.44)	(3.11)	(4.63)	(8.65)
REGN10	-0.0298	0.0759	-0.0043	-0.0159	-0.0089
	(5.53)	(19.66)	(2.70)	(4.96)	(5.06)
REGN11	-0.0592	0.0566	0.0001	-0.0128	0.0060
	(12.02)	(16.10)	(0.10)	(4.37)	(3.75)

Note: Variables treated as endogenous in estimation: LNX, LNX2, URBANX, URBANX2.

significantly different from zero. Wald test (Chi-squared = 395.9) indicates the appropriateness of including the square of the real expenditure term in the specification of the demand system. The interaction terms involving the food expenditure and urbanization are also mostly significant, indicating the differential consumption response of rural and urban households to income changes. The demographic variables, namely the number of children below 15 years old and the sex of the household head, are also highly significant in practically all the equations. The educational dummies were not significant and dropped in the final estimation. The AGRI variable is significant in three of the five equations. Finally, the year and regional dummy variables have the expected signs and are significant in most of the share equations. The average per capita expenditure in 1988 and 1991 is higher than in the control year (1985, a year punctuated by a sharp fall in average per capita income), and this is expected to reduce the expenditure share of staples. The regional dummy variables capture the expectedly different consumption response in regions where corn is a staple for a significant proportion of the population.

The income and uncompensated (Marshallian) price elasticities, evaluated at sample means, are shown in Table 5. For ease of comparison with other studies (Section 4), we focus on estimates of income elasticities (not on food expenditure elasticities) obtained by multiplying the commodity demand elasticity with respect to food expenditure (Stage 2) and the total food expenditure elasticity (Stage 1). These estimates are presented in the last column of Table 5.

The own-price elasticities have the expected negative signs and are all close to unity. The absolute values of the uncompensated cross-price elasticities, the signs of which indicate whether the paired goods are substitutes (positive sign) or complements (negative sign), are considerably high for some pairs of food groups. The price of fruits and vegetables, for example, exerts a positively significant effect on the demand for rice. On the other hand, the demand for dairy and meat is negatively affected by the price of rice.

It is generally known that the demand for food is income inelastic. This is also borne out by our results. For all food groups, the income elasticity of demand is no greater than 0.3. Rice, the major staple, has an income elasticity of 0.08, while that for corn,

Table 5
Food Price and Expenditure Elasticities Based on the Extended AI Demand System

Commodity	Uncompensated Price Elasticity with Respect to the Price of						Elasticity with respect to Food Expenditure (Stage 2)	Income Elasticity a/
	Rice	Corn	Other Cereals	Dairy & Meat	Fruits & Vegetables	Other Food		
Rice	-0.931	-0.018	0.005	-0.098	0.155	0.292	0.595	0.082
Corn	0.138	-1.078	-0.027	-0.423	-0.216	1.937	-0.332	-0.046
Other Cereals	-0.192	-0.101	-1.102	0.341	-0.049	-0.311	1.415	0.195
Dairy & Meat	-0.466	-0.210	0.092	-0.940	-0.137	-0.051	1.714	0.236
Fruits & Vegetables	0.101	-0.208	-0.053	-0.278	-1.104	-0.425	1.967	0.271
Other Food	0.119	0.160	-0.012	0.109	0.002	-1.256	0.877	0.121

a/ Elasticity of demand with respect to food expenditure times total food expenditure elasticity with respect to income.

also a staple for some groups of the population, has a negative low-income elasticity (i.e., an inferior good). Other cereals, mainly wheat, as well as dairy and meat, and fruits and vegetables have (expectedly) higher income elasticities.

Bouis (1993) warns that consistency with observed relationship between calorie-intake and gains in body height (and weight) requires that the income elasticity of demand for cereals as a group would have to be 0.1 or below. Our estimate for cereals as a group (rice, corn, and coarse grains) is an income elasticity of 0.08, well within the range noted by Bouis.

Except for corn, own-price elasticities do not change much across income quartiles and between urban and rural areas (Table 6). This is significant considering that previous studies (see section 5 below) show low-income groups to be more sensitive to price changes than the rest of the population. In the case of corn (an inferior good), the reverse pattern is observed: higher response of high-income groups to a price change.

A more varied response is evident in the comparison of income elasticities by income groups. Income elasticities fall with increases in income, but the fall is moderate. The pattern is similar for both rural and urban areas. In rural areas, the major staple does not become an inferior good even though the fourth-quartile average income per capita is fivefold higher than that of the first quartile. In urban areas, where the average income difference (about tenfold) is even more marked, the income elasticity for rice hardly becomes negative. This suggests that even a very rapid increase in aggregate per capita income in the medium term is not likely to turn rice to an inferior good.

5. Comparison with Other Estimates

Differences in functional forms, commodity groupings, data sources and types (whether cross-section or time-series, or both), and estimation procedures are usual problems in any comparison of parameter estimates of food demand even for a single country. We briefly comment on some of these issues and explore their implications on elasticity estimates of food demand in the Philippines.

Table 6
Own-Price and Income Elasticities by Quartile Based on the Extend AI Demand System a/

	First 25%	Second 25%	Third 25%	Fourth 25%
Average Real Income				
Rural	1,034	1,653	2,516	5,524
Urban	1,303	2,337	3,830	9,465
Own-Price Elasticity: Rural				
Rice	-1.007	-0.927	-0.908	-0.829
Corn	-1.017	-1.114	-1.404	-2.422
Other Cereals	-1.122	-1.103	-1.092	-1.075
Dairy & Meat	-0.849	-0.925	-0.945	-0.964
Fruits & Vegetables	-1.011	-1.180	-1.181	-1.171
Other Food	-1.331	-1.194	-1.186	-1.173
Own-Price Elasticity: Urban				
Rice	-0.930	-0.916	-0.876	-0.781
Corn	-1.040	-1.200	-1.829	-3.238
Other Cereals	-1.111	-1.091	-1.075	-1.073
Dairy & Meat	-0.904	-0.939	-0.956	-0.966
Fruits & Vegetables	-1.181	-1.172	-1.177	-1.180
Other Food	-1.199	-1.188	-1.178	-1.163
Income Elasticity: Rural				
Rice	0.234	0.166	0.106	0.010
Corn	0.066	-0.310	-1.035	-1.273
Other Cereals	0.359	0.281	0.216	0.090
Dairy & Meat	0.530	0.369	0.258	0.098
Fruits & Vegetables	0.234	0.192	0.151	0.067
Other Food	0.247	0.219	0.179	0.077
Income Elasticity: Urban				
Rice	0.140	0.080	0.027	-0.002
Corn	0.084	-0.211	-0.568	-0.129
Other Cereals	0.326	0.201	0.106	0.013
Dairy & Meat	0.489	0.257	0.125	0.014
Fruits & Vegetables	0.639	0.406	0.229	0.028
Other Food	0.149	0.108	0.063	0.008

a/ Income elasticity is elasticity of demand with respect to food expenditure times total food expenditure elasticity with respect to income.

Table 7 (continued)

Source	Sample Period	Model	Data	Commodity	Uncompensated Own-Price Elasticity	Income Elasticity
Quisumbing et al. (1988)	1978 & 1980	Tobit Flexible Form (Single Equation)	Food and Nutrition Research Institute Survey	Rice	-1.19	5.25 b/
				Corn	-0.00	-1.87 b/
				Rice & Corn Products	-5.63	2.82 b/
				Other Cereals	-5.37	4.70 b/
				Fruits	-0.85	9.93 b/
				Vegetables	-1.19	9.39 b/
				Meat	-4.28	3.86 b/
				Poultry	-6.68	-0.72 b/
				Eggs	-6.81	5.70 b/
				Dairy Products	-3.46	3.06 b/
				Fish	-2.73	8.22 b/
World Bank (1991)	1961-88	LA/AIDS	FAO Food Balance Sheet	Rice	-0.20	0.37
				Corn	-0.27	0.01
				Wheat	-0.57	0.55
				Meat	-0.79	0.75
				Fish	-0.03	0.54
				Fruits & Vegetables	-0.11	0.81
Huang & David (1993)	1960-88	LA/AIDS	USDA Food Balance Sheet	Rice	-0.96	0.25
				Corn	-0.35	0.06
				Corn Grains	-0.24	0.10

a/ For survey rounds: 1960, 1965, 1971, and 1975
b/ Real food expenditures elasticity.

Table 8
Income and Own Price Elasticity By Income Quartile Based on the Bouis Food Demand System

Commodity	Urban				Rural			
	I	II	III	IV	I	II	III	IV
Income Elasticity								
Rice	0.05	0.10	-0.01	-0.09	0.27	0.11	0.09	0.03
Corn	-0.27	-0.42	-0.26	-0.06	-0.64	-0.27	-0.39	-0.32
Wheat	0.89	0.71	0.42	0.19	1.20	0.63	0.47	0.28
Other Cereals	1.27	1.04	0.61	0.37	1.59	1.14	0.92	0.58
Vegetables	0.52	0.47	0.29	0.25	0.06	0.31	0.20	0.20
Other Fruits & Vegetables	0.19	0.32	0.28	0.24	0.61	0.28	0.36	0.26
Pork	1.17	0.97	0.64	0.35	1.62	1.17	0.88	0.53
Beef	1.34	1.07	0.74	0.44	1.74	1.29	0.97	0.62
Poultry	1.36	1.07	0.75	0.45	1.71	1.28	1.06	0.62
Milk	1.24	1.11	0.76	0.46	1.69	1.27	0.92	0.63
Eggs	1.30	1.05	0.72	0.41	1.68	1.33	1.01	0.54
Fish (fresh)	1.20	0.99	0.71	0.43	1.61	1.27	0.98	0.57
Own-Price Elasticity								
Rice	-0.55	-0.60	-0.49	-0.45	-0.87	-0.52	-0.46	-0.45
Corn	-1.80	-1.31	-1.09	0.88	-2.19	-1.26	-1.09	-0.92
Wheat	-1.29	-1.14	-1.04	-0.92	-1.51	-1.22	-1.10	-0.98
Other Cereals	-1.06	-1.02	-1.01	-0.97	-1.11	-1.05	-1.00	-0.98
Vegetables	-1.31	-1.23	-1.19	-1.10	-1.53	-1.39	-1.29	-1.17
Other Fruits & Vegetables	-0.88	-0.88	-0.85	-0.86	-0.97	-0.83	-0.84	-0.81
Pork	-1.20	-1.13	-1.08	-1.02	-1.18	-1.14	-1.09	-1.04
Beef	-1.08	-1.07	-1.04	-1.02	-1.07	-1.08	-1.06	-1.03
Poultry	-1.06	-1.07	-1.04	-1.02	-1.08	-1.09	-1.04	-1.02
Eggs	-1.10	-1.08	-1.05	-1.03	-1.11	-1.07	-1.05	-1.04
Fish (fresh)	-1.11	-1.08	-1.04	-1.02	-1.11	-1.09	-1.06	-1.03

Source: Bouis (1991b).

Quisumbing (1988), imply more gains in weight than would be expected from the calorie-intake-body-weight relationship found in the nutrition literature.

An interesting innovation in the estimation of food demand systems is that suggested by Bouis (1990,1991c). In the Bouis system, utility functions (not utilities) for food characteristics—energy (calorie-intake), variety, and taste—are components of the overall utility function. Energy and variety enter the utility function in such a way that utility from one food depends on the amount consumed in other food items. Given an explicit specification of these functions, the model is capable of generating the entire matrix of price and income elasticities for a system of n foods and one nonfood from prior knowledge of just four elasticities in the $(n+1)$ by $(n+2)$ matrix of price and income elasticities.

The Bouis demand system has attractive properties. First, its data requirement is parsimonious. Since a relatively large array of food demand elasticities can be derived without resorting to direct econometric estimation, the usual problem with limited time-series (or cross-section) data is practically swept away. Second, it is theory-consistent; its implications are also consistent with observed behavior. Third, the framework can accommodate some frequently observed phenomena concerning differences in consumption responses across income groups. It can, for example, accommodate the observation that, in a society where calorie consumption is high enough even among low-income consumers, the pure responsiveness of the low-income groups is greater than that for the rest of the society. It can also generate the less frequently observed phenomenon of highest price responses for middle income groups (Bouis 1991c).

6. Conclusion

Information about food consumption patterns and how they are likely to change as incomes and relative prices change is crucial to food policy analysis. The efficiency and welfare implications of various policy alternatives can be sensitive to the assumed structure of food consumption responses by various population groups. Our estimates of food demand responses help inform such structure. In general, we find that the income elasticity of demand for cereal—aggregate of rice, corn, and coarse grains—is about 0.1 and that this elasticity does not drop very rapidly with the level of income as is often suggested in the literature. This response is consistent with expectations concerning conversion ratios of cereal consumption to calorie-intake and gains in body weight. Moreover, while food price responses vary from one income group to another, or between rural and urban areas, the variation is not as large as has commonly been presumed.

Data and estimation constraints stand in the way of estimation of highly disaggregated food demand systems. The Bouis food demand system promises to be a useful complement to direct estimation using household data, such as the one pursued in this paper. This system has generated elasticities that are reasonably close to ours. But since the Bouis system permits the computation of a relatively large array of food demand elasticities without resorting to direct estimation (or imposing unrealistic assumption about consumer preferences), it can provide much richer information about demand patterns.

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