HOUSEHOLD FOOD DEMAND IN A DEVELOPING COUNTRY: ESTIMATION OF AN EXTENDED ALMOST IDEAL DEMAND SYSTEM APPROACH

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Chronic food production deficits since the early 1970s have prompted policy makers of Burkina Faso (in West Africa) to emphasize technological research with the goal to increase the production of the most consumed locally-grown cereals: sorghum and millet. Meanwhile, urban consumers appear to be developing preferences for imported rice and wheat due to their relatively low prices and greater convenience (Delgado and Miller; Roth and Abbott). Because the urban population constitutes a major prospective market for any rural surplus production that would result from technological advances, the disposal of such surplus depends in part on the preferences of urban consumers.

The major objective of this project was to estimate demand relationships among food groups in Ouagadougou, Burkina, using household budgets and then to use these demand results to forecast future consumption levels under alternative price, income, education, and related demographic scenarios. These consumption levels were compared with anticipated domestically produced cereal levels to determine potential self-sufficiency levels for the country (see Savadogo and Brandt). This paper is less ambitious due to length limitations and concentrates solely on the demand relationships. In order to identify the patterns of household food consumption, a demand system was specified with prices, income and household demographics including size and sex-age composition, formal education, urbanization, and other characteristics. The Almost Ideal Demand System (AIDS) was extended to include these factors in estimating household demand for food. Because time series of consumption, prices, income and other data were unavailable a cross section of households was surveyed to generate data with which to conduct the analysis.

MODEL SPECIFICATION

The AIDS model introduced by Deaton and Muellbauer was used to model household behavior for several reasons. It is theoretically consistent with the postulate that households maximize utility and is considered flexible enough to encompass broad ranges of behavior. Recent studies by other investigators testifies to its usefulness (Blanciforti and Green; Barewal and Goddard; Capps, Tedford, and Havlicek). The basic AIDS model hypothesizes that the portion of total expenditure that accrues to a particular commodity (or budget share) is related to prices and income as follows:

$$(1) \quad w_i = a_i + b_i \log (M/P^*) + \sum_j c_{ij} \log p_j \qquad i=1,\ldots,n$$

where w_i is the average budget share of commodity i, M is total nominal expenditure on all goods, p_j is the price of the jth good, and P^* is a price index. The a_i represents the average value of the budget share in the absence of price and income effect. The b_i and c_{ij} represent the effects on the expenditure share of a one percent change in real income or the price of good j. Positive (negative) b_i indicates greater (less) than unitary elasticity. A positive (negative) c_{ii} indicates inelastic (elastic) own price response. A positive (negative) c_{ij} suggests substitutability (complementarity) between goods.

Because household data are used to estimate the models, variables other than income and prices play an important role in shaping consumption patterns. Empirical work has identified that household size and composition, education, urbanization, and occupation constitute important determinants of consumption patterns (Prais and Houthakker; McCracken and Brandt; Kinsey; Capps, et al.). Household demographics are incorporated into this demand analysis through "scaling", which implies replacing the market price p by scaled prices, where the scale is a function of household characteristics (see Barten; Gorman; and

Ray for detailed discussion). The extended AIDS then (after several steps) becomes:

$$(2)\quad w_i = a_i + b_i \log (M/P) + \sum_j c_{ij} \log p_j + (\sum_j c_{ij} - b_i) \log k(Q)$$

where P^* has been replaced by Stone's index P, k(Q) is the scale, related to adult equivalents. The scale is assumed to be commodity independent, a restrictive assumption (necessary to reduce the econometric problems associated with simultaneity) that implies an additional adult has the same impact on consumption of baby food and meat. As goods are aggregated into broader groups (as in this study), this restrictiveness is of lesser concern.

A common specification of k(Q) is a log-linear form such that $k = \prod_{r=1}^{R} q_r^{d_r}$, where q represents the demographic characteristics and d are unknown parameters. Substituting this expression for k(Q) and adding a disturbance term completes the equation:

$$(3)\quad w_{iht} = a_i + b_i \log m_{ht} + \sum_j c_{ij} \log p_{jt} + \sum_r d_{ir} \log q_{rh} + u_{iht}$$

$$i=1,\ldots,n \qquad h=1,\ldots,h \qquad t=1,\ldots,T$$

where i, h, and t index the commodity, household, and time period, m = M/P is real income, and u is the random error.

DATA

The data used to implement the model were generated through a weekly consumer and market survey in Ouagadougou from September 1982 to August 1983. Sixty-five households were randomly selected from a larger group of 500 households which were selected to reflect income and population distribution within the city based on national census data. In addition to quantities purchased and expenditures, the households provided demographic and income information.

The households were analyzed by three income groups. Sample household characteristics by income category are provided in Table 1. The lowest income group includes those families with less than 30,000 CFA ($75) monthly income. A middle income household receives monthly income between 30,000 CFA and 85,000 CFA. The upper income group comprises households with more than 85,000 CFA per month. The lower income group is associated with more children, a lower percentage of male heads of households, older heads, greater time living in the city, and far less education of the head than either of the other two groups. Conversely, the highest income group has more adults per household and greater education, characteristics which are likely to be associated with increased income. Other characteristics are described in greater detail in Savadogo and Brandt.

A disaggregation of the expenditure data into various food and one non-food categories suggests that higher income households tend to spend more than lower income households on both food and non-food items. However, the ratio of expenditures (high income expenditure/low income expenditure) is only 1.5 for food but 3 for non-food. Table 1 suggests that the survey households spend about 73 of their total expenditures on food. However, the lower and middle income groups spend a substantially greater (smaller) portion of their share on the less (more) expensive cereals (meat) than does the higher income group.

ESTIMATION AND RESULTS

In order to account for variations in expenditure by income groups, intercept and income slope shifters were added to equation (3). Although originally the intent was to investigate the effects of differences in sociological, economic, and demographic characteristics on the demand for a large variety of foods (particularly individual cereals), the paucity of sample observations reduced the analysis to five food and one non-food groups. These

TABLE 1 HOUSEHOLD CHARACTERISTICS BY INCOME GROUP, OUAGADOUGOU, BURKINA FASO, 1983

	Sample Mean	Income Category[a]		
		Low	Middle	High
Number of Households	65	19	29	17
Average Household Size	8.68	8.16	8.93	8.82
Children 12 or Younger	3.25	3.37	3.38	2.88
Proportion of Male Heads (%)	87.6	73.7	96.6	88.2
Average Age of Head (years)	45.0	48.1	44.9	41.5
Urbanization[b]	53	14	25	14
Single, Widowed, or Divorced	12	5	4	3
Education, Head of Household				
0- 6 years	48	18	23	7
7-13 years	11	1	4	6
14+ years	6	0	2	4
Average School Education (years)	4.4	.8	4.0	9.1
Expenditures on Food (%)	73.0	78.7	71.7	68.4
Expenditures on Cereal (%)	20.1	24.3	21.8	12.3
Expenditures on Meat (%)	14.1	13.5	12.4	17.8

[a]Income categories include: Low, < 30,000 CFA ($75); Middle, 30,000-85,000 CFA; and High, > 85,000 CFA per month.

[b]Urbanization denotes the number of years the head of household has resided in the city.

included: (1) domestic cereals (sorghum, millet, corn), (2) imported cereals (wheat, rice), (3) meats, (4) vegetables, (5) other food, and (6) non-food. The dependent variables (budget shares) were defined as the ratio of the expenditure on each product group to the total household expenditure.

Price data were available for the five food groups; however, price data were not collected for the non-food items. Reported monthly data for the non-food items were constant and as such would not explain variation in expenditures. However, the omission of non-food prices on the food equations (which are of primary interest in this analysis) is likely to be small. Total household expenditures appear to be a better measure than take-home income, particularly for non-durables such as food products. Total expenditure is also consistent with the adding up criterion.

Although the model was a set of disturbance-related equations (because of adding up), estimation by generalized least squares on the entire system would not improve on single equation OLS since the same explanatory variables were repeated in each equation (Theil). This is true in the absence of cross-equation restrictions, such as symmetry. In the context of AIDS, testing for or imposing the symmetry restriction is valid only when the theoretical price index (P^* in equation 1) is used, not when an approximation index (Stone's index P) is used (Deaton and Muellbauer). Since the theoretical P^* was not used in this study, symmetry restrictions were not tested nor imposed.

Two potential problems arise with the use of OLS regressions of household data. Errors may be heteroskedastic because data relate to different households with differing characteristics (e.g., income). The use of budget shares (i.e., expenditures on the commodity divided by total expenditure) is likely to lessen the problem of heteroskedasticity. Second, the use of monthly expenditures may result in negatively serially-correlated error terms, since the expectation is

for an above average allocation to a commodity in a given month induces a below average allocation the following month. The presence of serial correlation was tested using the Durbin-Watson procedure. The results of the test on the pooled household data led to the rejection of the hypothesis of serial correlation.

The results of the AIDS estimation are presented in Table 2. The explanatory variables are a logarithmic form (except for the dummy variables). Since the dependent variables are budget shares resulting in occasionally very small explanatory coefficients, the original coefficients are multiplied by 100. The F values are large and significant at the one percent level; the R^2 results are mixed -- low for cereals, relatively high for meat, vegetables, and non-food. The high correlation in non-food budget share and income and the relative lack of variability in both series account for much of the high R^2 in this equation.

Of the 90 non-intercept coefficients in the table, 38 are significant at the five percent level, four more at the 10 percent level of significance. Ten of the meat equation coefficients are significantly different from zero, including the own price. For domestic cereals, only six coefficients are statistically significant. The cross price effects between the cereal groups reflect complementarity but are not significant. While this was unexpected and undesired from a policy analysis perspective, the results are perhaps not so surprising when the very low month-to-month and market-to-market variability in prices as measured by the low coefficients of variation (less than 10 percent for domestic and five percent for imported cereals) is taken into account. Separate F-tests for the statistical significance of group price effects on expenditure allocations confirmed their importance and the potential model mis-specification if price data were excluded from the analysis.

TABLE 2 COEFFICIENT ESTIMATES BASED ON THE ALMOST IDEAL DEMAND SYSTEM[a]

Explanatory Variables	Dependent Variables[b]					
	DOMCER	IMPCER	Meat	Vegetables	Other Food	Nonfood
PDOMCER	-6.5	-9.9	2.2	3.4	12.0	-1.3
	(-.98)	(-1.52)	(.62)	(.92)	(2.37)	(-.26)
PIMPCER	-9.2	-12.5	3.1	.8	7.1	10.8
	(-1.42)	(-2.01)	(.87)	(.23)	(1.44)	(2.25)
PMEAT	10.8	-.8	-5.3	-4.5	6.4	-6.5
	(3.43)	(-.26)	(-3.12)	(-2.56)	(2.68)	(-2.81)
PVEGET	6.5	3.8	-3.3	-2.4	2.3	-6.9
	(2.79)	(1.67)	(-2.57)	(-1.83)	(1.30)	(-4.02)
POTHFOOD	12.7	5.4	-4.7	-6.1	-1.1	-6.2
	(5.01)	(2.21)	(-3.40)	(-4.33)	(-.57)	(-3.30)
Income	1.3	-1.3	-2.9	-4.5	-2.5	10.1
	(2.03)	(-2.05)	(-8.10)	(-13.14)	(-5.04)	(20.96)
DY2	-1.5	.9	.5	.3	-.3	.1
	(-1.93)	(1.19)	(1.26)	(.80)	(-.58)	(.10)
DY3	-1.1	2.3	-1.1	-.01	.01	-.01
	(-1.45)	(3.00)	(-2.51)	(-.13)	(.02)	(-.01)
Children	-.5	1.7	1.4	-1.1	.2	-2.4
	(-.64)	(2.13)	(3.20)	(-3.12)	(.33)	(-4.00)
Adults	.6	.6	1.1	.4	-.2	-2.7
	(.67)	(.72)	(2.27)	(.87)	(-.24)	(-3.93)
EDUC	-.6	.2	.3	-.2	.8	-.4
	(-1.33)	(.46)	(1.11)	(-.96)	(2.21)	(-1.16)
MARSTAT	3.0	-.01	-2.1	1.2	.7	-2.8
	(2.52)	(-.01)	(-3.14)	(1.72)	(.80)	(-3.20)
URBAN	-2.6	-.2	2.4	-.3	-.2	.9
	(-3.01)	(-.19)	(5.02)	(-.64)	(-.24)	(1.34)
Intercept	-107.7	71.4	77.7	109.9	-104.7	51.4
	(-2.23)	(1.56)	(3.00)	(4.16)	(-2.92)	(1.47)
D2	6.5	-6.6	-1.4	-2.1	3.9	-.3
	(1.49)	(-1.57)	(-.58)	(-.87)	(1.20)	(-.10)
D3	-1.7	-18.6	15.1	2.3	1.3	1.6
	(-.37)	(-4.15)	(5.95)	(.90)	(.38)	(.46)
F	8.95	3.60	43.35	69.77	13.00	196.76
R^2	.15	.07	.48	.58	.20	.79

[a]Coefficients presented are 100 times their original values; t-values are in parentheses.

[b]Dependent variables are represented as budget shares. DOMCER includes those cereals largely produced domestically (sorghum, millet, and corn), IMPCER includes those cereals largely imported (wheat and rice).

Table 2 reflects the consumption response to income by group. All income coefficients are significant verifying the importance of income variability in explaining household consumption differences. Rising income shifts consumption sharply away from sorghum-millet (DOMCER) to wheat-rice (IMPCER).

The demographic variables appear significant in explaining household budget allocation. The effects of children are significant at 5 percent for imported cereals, meat, vegetables, and non-food equations. The effects of adults are significant for the meat and non-food equations. For example, increasing the number of adults by 10 percent entails an increase by 6 percent in the budget share of both traditional (domestic) and new-type (imported) cereals. In contrast, a 10 percent increase in the number of children reduces the budget share of traditional cereals by 5 percent and a statistically significant increase by 17 percent in the share of imported cereals. Discussions with members of the surveyed households suggested that children had a stronger preference for rice than for sorghum and that heads of households typically attempted to meet those preferences when economically possible.

Household head education (EDUC) and income tended to be highly correlated within the household and probably accounts for the general insignificance of the education variable in most demand equations.

When per capita income is held constant and an increase in household size leads to a less than proportionate increase in consumption, economies of size in consumption are said to be present. Table 3 reports the household size elasticities. These elasticities are income compensated, measuring the effect of an additional household member on consumption per capita. The results suggest economies of scale in consumption associated with large households at all income levels. The elasticities are small but positive for imported cereals but relatively large for domestic cereals. They are negative for vegetables,

TABLE 3 HOUSEHOLD SIZE ELASTICITIES BY INCOME GROUP

Goods	Sample Mean	Income Level		
		Low	Middle	High
DOMCER	.28	.22	.23	.66
IMPCER	.08	.06	.08	.10
MEAT	-.05	-.05	-.06	-.04
VEGETABLES	-.29	-.25	-.31	-.29
OTHER FOOD	-.14	-.14	-.14	-.14

TABLE 4 MARGINAL BUDGET SHARES BY INCOME GROUP

Goods	Sample Mean	Income Level		
		Low	Middle	High
	----------Marginal Budget Shares----------			
DOMCER	.09	.12	.10	.02
IMPCER	.12	.13	.12	.11
MEAT	.11	.11	.10	.14
VEGETABLES	.14	.16	.13	.14
OTHER FOOD	.18	.17	.18	.17
TOTAL FOOD	.64	.69	.63	.58
NON-FOOD	.37	.31	.37	.42

meat, and other food, indicating that households at all income levels would substitute away from these commodities toward less expensive food items (cereals) when a member is added.

The marginal budget share (MBS) measures the net allocation of an additional unit of income to a particular commodity. For staple foods such as cereals (especially domestic), the MBS should decline as income increases. The results in Table 4 show the net differences between low and high income groups and suggest that the MBS for domestic cereals declines dramatically with higher income, imported cereals less so. The MBS for meat, a relatively expensive food item, increases with income as expected. Similarly, higher income is associated with increased marginal spending on non-foods.

DISCUSSION

This study has estimated an urban household demand model to explain the patterns of household consumption as a function of economic and socio-demographic variables. The results of the analysis suggested that prices, income, household composition, education, and marital status were jointly important in explaining household expenditures allocations. Both local and imported cereals responded positively to an income increase. However, incremental income changes would lead low income households to consume more locally-produced cereals than high income households; the latter would consume more wheat and rice than the former.

Wheat and rice enter Burkina Faso either as commercially imported cereals or as food aid (e.g., PL-480). Because of distribution channel bottlenecks, the imported commodities tend to be largely allocated to the urban centers and generally at subsidized (below international market) prices. As a result, the consumption of the preferred cereals (relative to sorghum and millet) tends to be higher than if free market prices prevailed.

Burkina Faso has embarked on a training program for rural producers to increase the production potential for traditional cereals. Elsewhere we have shown that self-sufficiency is possible under several demand and supply scenarios where income and technology shift consumption and production (Savadogo and Brandt). However, the prevailing grain price policy of the government is not compatible with self-sufficiency production goals. Wheat and rice are underpriced relative to sorghum or millet, as evidenced by their in-country comparison with international prices. As a consequence, the consumption of wheat and rice is promoted at the expense of the local cereals. Increased production of local cereals in the face of an unfavorable price climate would lead to sharply depressed farm prices and a disincentive to adopt any supply shifting technologies.

The results of this analysis suggest that governmental intervention in the form of selling wheat and rice above (not below as is currently the case) their acquisition values could create a favorable price situation for producers of traditional grain. The revenues raised by the government could be used to finance programs in the traditional cereals sector. In order to increase the probability of success of such price policy, accompanying measures tending to increase the preparation and consumption convenience of the traditional cereals could be implemented. The results suggest that a redistribution of income from high (typically urban) to low (generally rural) income consumers would increase aggregate consumption of locally produced cereals, a desired governmental objective.

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