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Food and Nutritional Adequacy in Ghana

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CORNELL FOOD AND NUTRITION POLICY PROGRAM

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ABBREVIATIONS

AIDS	Almost Ideal Demand System
FAO	Food and Agriculture Organization
GLSS	Ghana Living Standards Survey
PAMSCAD	Programme of Actions to Mitigate the Social Costs of Adjustment
PPMED	Policy Planning, Monitoring, and Evaluation Department (Ministry of Agriculture)
WHO	World Health Organization

FOREWORD

This paper is the fourth in a series on food security in Ghana, and follows from Working Papers 2, 10, and 26. It presents findings on patterns and levels of food consumption and food acquisition behavior and shows the implications of these findings for nutritional adequacy as measured in terms of calorie intake. In addition, the paper includes an interesting discussion of the limitations of, and problems with, cross-sectional survey data in this regard. While the results include few surprises, they once again show the importance of a careful food price and consumption analysis before embarking on programs designed to protect vulnerable groups. For example, the high degree of substitution between commodities is noted and offered as evidence of the ability of the poor to cope with price changes. Even so, there are limits to how far government can intervene through price policy to raise nutrition levels. In particular, a reduction in the price of cassava will most directly contribute to improved calorie intake; but cassava is one commodity over which the government has, and can have, only limited influence in terms of price. Similarly, while lowering maize prices will contribute only to small increases in calorie intake, the opposite is true for expensive sources of calories, such as rice.

This information can aid policymakers' understanding of how price-oriented adjustment policies will affect food security and nutrition. At the same time, the results provide considerable insight into the scope for, and appropriate design of, programs targeted to vulnerable groups. These important issues are key components of the work being performed by CFNPP to analyze the impact of economic reform in Africa on the poor. This work in Ghana is financed under a Cooperative Agreement with the Africa Bureau and Ghana Mission of the U.S. Agency for International Development, with additional support from the World Bank.

Washington, DC
May 1992

David E. Sahn
Deputy Director, CFNPP

1. INTRODUCTION

Levels of food availability, household, as well as aggregate levels, are often considered as a measure of household welfare. This idea reflects both the view that food availability is an important determinant of malnutrition of members of the community or the household as well as the fact that this measure correlates with other potential indicators of poverty. Indeed, often the income or expenditure needed to purchase a given amount of food is used to define poverty lines and, subsequently, to compare poverty across regions and over time.[1] While both reasons for focusing on food availability are not without theoretical and empirical challenges,[2] the staying power of calorie availability in policy discussions attests to its value as a merit good in the minds — and decisions — of policymakers.

Comparatively little, however, is known about the levels of food available to the households in Ghana. Nor, as is discussed further below, are even the aggregate measures of production and net availability known precisely. This clearly has a bearing on the design of food policies, as well as of specific measures to alleviate poverty. Among the latter is the Programme of Actions to Mitigate the Social Costs of Adjustment (PAMSCAD). With a few exceptions, the components of this program are not targeted to a group of newly poor, in part because there are no easily identifiable groups in this category. The program, nevertheless, devotes considerable resources toward poverty alleviation, including food-oriented nutrition interventions such as supplementary feeding.

This study analyzes the first year's data of the Ghana Living Standards Survey (GLSS) in order to indicate levels and composition of the energy sources in different regions of Ghana and to place these observations in the context of food and nutrition policy in Ghana. Moreover, particular attention is devoted to the possibilities and limitations of the data, inasmuch as the format of the information is similar to a number of other surveys proposed or being undertaken in sub-Saharan Africa. It is hoped that the approach used for analysis in this paper, then, has some general relevance to these studies, as well as specific relevance to policy design in Ghana.

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1 Such a measure is often used in Asian countries, although one of the few applications for sub-Saharan Africa is based on 1974/75 data from Ghana (Kyereme and Thorbecke 1987).

2 See, for example, Srinivasan (1981) and Behrman, Deolalikar, and Wolfe (1988). For an example of the correlation of poverty measures, see Glewwe and van der Gaag (1990).

We do not specifically focus on nutrition, but on food consumption as an input into a wide set of issues subsumed under food security (Alderman 1992). Governments desire information on food consumption patterns to address both broad questions of food policy and more specific nutritional concerns. The information presented here on variations of consumption patterns across income groups and how these patterns respond to changes in income and prices then may be considered inputs into a range of welfare policies, one of which is nutrition. It is often recognized, however, that nutrition depends on a range of factors, including curative and preventative health, in addition to household food availability (Alderman and Garcia 1992; Schultz 1984). Thus, a secondary objective of this study is to modify the analysis reported in Alderman (1990) to indicate whether broad food policies aimed at increasing household calorie consumption can be expected to reduce levels of malnutrition observed in the country.

2. UTILIZATION OF THE GHANA LIVING STANDARDS SURVEY FOR ANALYSIS OF FOOD QUANTITIES

The GLSS is designed to link data on household production and consumption with other indicators of household and individual welfare, including nutrition, health, and fertility. In order to achieve this comprehensive perspective, there is some need to sacrifice depth in various subsections for breadth of the overall survey. Consequently, other types of information desirable for the specific goal of this study — the analysis of diets and dietary adequacy — are not directly or completely available in the GLSS questionnaire.

Most significantly, the survey collected data only on the value, not on the quantities, of foods either purchased or consumed from home production. This might seem a binding constraint for a study that seeks to compare calorie consumption across households and regions. The survey, however, contains information on prices that, with a number of assumptions, can be used to derive food quantities and, subsequently, calorie availability. This section discusses in detail those assumptions as well as the tests for accuracy and sensitivity that were used to assess the usefulness of the data.

Since expenditures are, by definition, price times quantity, it should be relatively simple to convert the expenditure data to quantities. Behrman and Deolalikar (1987), however, argue that even in rural communities, households tend to shift to higher-priced commodities as their incomes rise.[3] If so, then dividing household expenditures by average prices would exaggerate the quantities consumed by the well-off and underestimate those consumed by poorer households who tend to purchase lower-priced grades of any commodity.

For a number of reasons, however, this issue is not likely to introduce a major bias in estimates from the GLSS. A priori, one would expect the quality effect to be more significant for shifts between commodities — say, from gari to rice or beans to meat — than within a narrowly defined commodity group. This would imply that the average cost of the kilocalories consumed would increase fairly significantly with income, but not the cost of individual components. The GLSS data are adequate for measuring any changes in the commodity composition of the diet. Moreover, a significant proportion of the food consumed in Ghana is from home production. The imputed price of this home production should not change as incomes rise, unless households shift their production patterns and their choices with income — a reversal of generally assumed causality.

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3 Alderman (forthcoming) indicates that at least one other interpretation is consistent with the results that Behrman and Deolalikar use to support this hypothesis.

Furthermore, the available direct evidence on changes in commodity-specific prices as incomes rise indicates that this effect is generally small. Deaton (1987), for example, finds this to be the case for moderately aggregated groups in Côte d'Ivoire. Data from a survey of 600 households in the Upper East and Brong-Ahafo conducted in 1990 indicate that the prices paid for specific commodities rise only slightly as incomes rise. For example, the quality elasticity for maize (defined as the coefficient of the logarithm of total per capita household expenditures when the logarithm of price is regressed on expenditures) was 0.085 with a t-statistic of 1.34.[4] The elasticity for sorghum was of similar magnitude, while that for millet was negligible. Only for rice, for which imports make up a portion of the market, was the quality elasticity greater than 0.1. As discussed below, rice, with a quality elasticity of 0.2, contributes a minor share of total calories. It does not, then, appear likely that a serious bias will be introduced if average community (cluster) prices, which take into account regional as well as sectoral differences, are used to calculate food quantities.

The prices that are available with the GLSS come from a separate module conducted at the cluster level at the time of the household survey. Field staff were asked to make three purchases of specific commodities recording the price paid. The purchases were subsequently weighed, giving a unit price. As always, there are missing prices as well as occasional wide variations between unit prices recorded for a single market. The former can be handled by using information from the nearest market. Similarly, one can get the price of rice — omitted from the community questionnaire — from an alternative source. Still, one would like to know how sensitive various food security measures are to the assumptions used.

This is illustrated in Tables 1 and 2. The former shows the mean and median of per capita calorie consumption calculated under three price assumptions, but using the same household data and calorie conversions matrix.[5] The actual GLSS prices are derived from the community survey while the smoothed prices are predicted in the regression of observed prices on dummy variables for month and locale. The Policy Planning, Monitoring, and Evaluation Department (PPMED) of the Ministry of Agriculture prices come from monthly averages of weekly market prices recorded by the Ministry of Agriculture. While in principle both wholesale and retail prices are available for dozens of markets nationwide, in practice a limited number of market series were available, as prices had to be recorded and units reconciled by hand.

As can be noted in Table 1, there is no large discrepancy between calories derived from the smoothed and the actual GLSS prices, although there is between

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4 The elasticity drops to 0.066 when one includes a dummy variable for purchases smaller than a basin. For various commodities, such small purchases — themselves correlated with income — can bring the unit cost up 20 to 30 percent.

5 Eyeson and Ankrah (1975) was used wherever possible.

Table 1 —Ghana: Daily Per Capita Calorie Availabilities by Quintile Under Three Alternative Price Regimes

Item	Rural			Urban		
	Smoothed GLSS Prices	Actual GLSS Prices	PPMED Prices	Smoothed GLSS Prices	Actual GLSS Prices	PPMED Prices
Quintile 1						
Mean	2,158	2,211	1,929	1,654	1,748	1,604
Median	1,744	1,737	1,481	1,365	1,494	1,331
Standard deviation	1,618	1,758	1,572	1,359	1,421	1,325
Number of households	517	517	517	87	87	87
Below minimum daily requirement (%)	57	56	65	70	69	75
Below 85% of minimum daily requirment (%)	47	47	55	63	63	66
Quintile 2						
Mean	2,682	2,798	2,371	1,912	1,930	1,787
Median	2,291	2,374	2,036	1,481	1,560	1,499
Standard deviation	1,703	1,974	1,612	1,318	1,236	1,072
Number of households	474	474	474	131	131	131
Below minimum daily requirement (%)	40	39	50	66	63	65
Below 85% of minimum daily requirement (%)	30	30	38	57	57	58
Quintile 3						
Mean	3,012	3,094	2,743	2,197	2,265	2,178
Median	2,676	2,736	2,488	1,798	1,792	1,877
Standard deviation	1,729	1,921	1,501	1,446	1,526	1,418
Number of households	423	423	423	182	182	182
Below minimum daily requirement (%)	31	32	35	55	55	55
Below 85% of minimum daily requirement (%)	23	23	26	43	43	46
Quintile 4						
Mean	3,457	3,663	3,374	2,552	2,630	2,533
Median	3,095	3,180	3,026	2,009	2,038	2,052
Standard deviation	1,766	2,088	1,777	1,815	1,876	1,734
Number of households	306	306	306	299	299	299
Below minimum daily requirement (%)	23	23	26	49	49	48
Below 85% of minimum daily requirement (%)	17	17	17	38	38	37

(continued)

Table 1 (continued)

Item	Rural Smoothed GLSS Prices	Rural Actual GLSS Prices	Rural PPMED Prices	Urban Smoothed GLSS Prices	Urban Actual GLSS Prices	Urban PPMED Prices
Quintile 5						
Mean	4,815	4,834	4,947	3,440	3,445	3,409
Median	4,660	4,867	4,595	2,938	2,846	2,916
Standard deviation	2,233	2,603	2,563	2,066	2,130	2,095
Number of households	143	143	143	461	461	461
Below minimum daily requirement (%)	13	16	13	32	32	32
Below 85% of minimum daily requirement (%)	10	10	11	23	23	24
National						
Mean	2,903	3,001	2,695	2,709	2,751	2,671
Median	2,450	2,458	2,238	2,172	2,197	2,181
Standard deviation	1,879	2,105	1,875	1,901	1,943	1,877
Number of households	1,863	1,863	1,863	1,160	1,160	1,160
Below minimum daily requirement (%)	38	38	44	46	46	47
Below 85% of minimum daily requirement (%)	29	29	34	37	37	37

Source: GLSS (1987-1988).

Note: Calories are derived from marginal food expenditures between enumerator visits. Ranks based on predicted per capita marginal expenditures. Ranks are based on a nationwide ordering; consequently, the urban population is concentrated in the upper quantiles. Requirements based upon household composition, assuming moderate activity levels equivalent to 1.6 times basal metabolic rates (WHO 1984).

Table 2 —Ghana: Quantities Produced, Marketed, and Purchased

Crop	Produced	Marketed	Purchased	Estimated Production	
				1987 Production	1988 Production
	Thousands of Metric Tons				
Cassava	2,216.6	552.4	791.4	2,725.8	2,287.5
Yams	926.1	463.6	148.2	1,185.4	961.6
Cocoyams	488.5	122.0	57.8	1,011.8	907.0
Plantain	1,279.4	730.3	221.8	1,077.6	1,135.0
Maize	888.7	319.8	326.4	597.7	750.9
Millet and sorghum	305.2	32.8	24.4	379.0	370.0
Rice	129.7	84.1	117.1	80.7	84.0

Sources: GLSS (1987-1988); PPMED.

Notes: Estimated from household survey data on agricultural sales, and consumption out of stocks, together with household food budget data. Pooled survey figures were blown up by the ratio of the 1987/88 national population to the GLSS sample size.

either of these and the PPMED prices.[6] The PPMED prices lead to lower estimates of calorie consumption, especially for rural areas. There is, however, very little difference in the estimates for urban households. It is likely that the markets for which prices were available from the Ministry of Agriculture are somewhat further down the marketing chain than those used by the majority of households in the rural sample. If prices are higher at these final stages in the marketing process, the PPMED prices are higher than the sampled households actually face.[7] An upward bias on the prices would lead to a downward bias on consumption. The urban areas, on the other hand, correspond closely to the data points used by the PPMED and, therefore, there is no appreciable difference in the estimates derived from the various sources.

One notes that the reported calorie consumption in Table 1 appears high, especially in the top expenditure brackets. Even the average for the country far exceeds the values derived from food balance tables. The World Bank (1990), for example, reports that Ghana had only 1,759 calories per capita per day in 1986 — that is, after agriculture had recovered from the earlier drought. This was the fourth lowest level in the world. The vast difference between such estimates and those here requires scrutiny lest all conclusions from the data be called into question.

The estimates in Table 1 differ from most other estimates of food consumption in Ghana in that they are based on a household survey rather than aggregate data. Calories from the GLSS data reflect household availability (purchase plus retained production), while balance sheets are calculated from total production plus net trade and taking into account usage for seed and for animals as well as losses in storage. In general, the former approach is found to exceed the latter. Pinckney (1989), for example, compares four household surveys from Pakistan with data from balance sheets and finds that the survey data exceeded the corresponding balance sheets by 8 to 27 percent. The calories estimated from GLSS data may be slightly higher than actual intake, as they do not account for spoilage and inedible portions of roots and tubers. If, however, this share is a small constant proportion, little will be gained by modifying purchases and production reported for household use by an arbitrary coefficient.

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6 Retail prices were derived from the more accurate PPMED wholesale series using a 10 percent markup assumption for all commodities except rice, for which 20 percent was used. While these markups might appear small, they represent only the difference in market levels at the same place and time. Therefore, no storage or transport should be included. A larger markup is not only unwarranted by available data, but would lead to wider, rather than smaller, discrepancies.

7 This is not an indication that markets fail to function in Ghana, but only that there are significant costs to transport and storage. In fact, most evidence points to smoothly functioning markets in Ghana (Alderman and Shively 1991).

Table 2 indicates the aggregation of production and marketing data derived from the GLSS using the 1988 population, assuming that the percentage of households in urban areas was the same observed in the 1984 census.[8]

GLSS estimates of the production of maize exceed national production figures for 1988. Cassava, on the other hand, is appreciably lower in the estimates based on the GLSS than in national production figures. The other estimates of production are basically consistent between the two sources.

Another means of indicating the overall reliability of the GLSS data is to compare marketing and purchase data. Not only are these estimates from different portions of the questionnaires, they differ in that the data on marketed quantities do not require the division of prices in order to derive quantities.

The aggregation of maize is less than national production figures for 1988, although it exceeds 1987 harvest levels by a considerable amount; it is quite close to the average, which may reflect changes in inventories. While sorghum and millet consumption levels are lower than production figures, the difference does not actually exceed domestic availability if one subtracts an estimate of the amount of sorghum used for brewing. Reported rice consumption exceeds production, but is reasonably close to production plus imports (imports were 37,000 tons in 1987 and 48,000 tons the following year).[9] Consumption of yams, plantains, and cocoyams in the survey, however, differ markedly from production.

This reasoning, however, does not explain why some estimates, such as of yam consumption, in the survey do not match with the estimates of national production. The distribution of calories from fufu might have underestimated the share to foods other than cassava, but the total for this category was comparatively small. Table 2 indicates the levels of production, amounts marketed, and amounts purchased on the national level as implied by the GLSS. Production, of course, is largely consumed at home and, therefore, errors in production are not independent from errors in consumption. The purchase data, on the other hand, is derived from a different portion of the questionnaire — and often from different individuals — than the production and marketing data. One gains an impression from these tables whether the data are internally consistent.

Several points are worth noting from Table 2. First, the largest discrepancies between marketings and purchases are for roots and starchy tubers, particularly yams and plantains. Marketing and purchases of grains, by contrast, are in far closer accord. This is not surprising, as standardized units of

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8 Average values are based on the sum of production and marketing divided by the total number of individuals surveyed from the sector. This should be more accurate than estimates derived using the average of household production and marketing divided by household size. The latter treats small households equally with larger ones.

9 Food for work and other food aid added an average of 30,000 tons a year to these commercial imports.

measure prevail throughout the country for grains, but not for roots and tubers. Moreover, the divergences for millet and sorghum, and for rice, while not large, are expected: reported purchases of the former ought to be smaller than sales, while rice purchases should exceed domestic marketed surplus by the amount of imports, for reasons already mentioned.

The large divergences between marketings and purchases of root and tuber crops are more difficult to explain. Sample errors, such as an under- or overrepresentation of net consuming regions relative to producing regions, can account for some differences between purchases and marketing or between sample estimates of production and Ministry of Agriculture estimates of the same. It is unlikely, however, that more than a small share of the difference between GLSS production estimates and Ministry of Agriculture figures can be explained in this manner.

The differences between GLSS data and other statistics are not sufficient to account for the discrepancy between calorie consumption as reported in Food and Agriculture Organization (FAO) or World Development statistics and that calculated from the survey. Note, however, that leaving aside storage loss and planting requirements, the caloric value of the grains, roots, and tubers produced in Ghana in 1987/88 are equivalent to the *total* calorie availability reported in the World Development Report. Only with extreme estimates of storage loss — estimates that are not validated by field surveys (Alderman and Shively 1991) — does the level of food production in Ghana imply the low food consumption in the World Development Report.[10]

The comparisons reported above pertain to food availability as observed in the two weeks between the first and second survey visits. In this report, this consumption is referred to as marginal consumption to distinguish it from the annual (or normal) food consumption reported in a different set of questions. Table 3 indicates that there are only slight differences in the average calories as calculated using the different questions, with the annual data giving an estimate of average calories between 3.0 (urban) and 5.2 percent higher than the marginal. Moreover, there are no marked differences in the shares to specific foods, hence, no major systematic differences in the two sources of information. There are conceptual advantages to the marginal data; the shorter recall corresponds to the prices recorded while the annual expenditures give no indication of how consumption responds to intrayear price fluctuations. Consequently, except where noted, the remainder of the study focuses on these marginal expenditures.

Before proceeding to this discussion, it is useful to present a few points about the calculations of calories from these expenditures. While most expenditures are converted using smoothed GLSS prices, a few prices were

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[10] The following year's World Development Report (World Bank 1991) reports per capita calories for 1988 as 2,209. Given a 6 percent population growth in the two years, this figure implies either a change in methodology in the period, or greater changes in production and imports than recorded by PPMED.

Table 3 —Ghana: Calorie Share Means For Major Food Groups and Staples Estimated with Average and Marginal Expenditures Under Smoothed GLSS Prices

	Rural (n=1,865)		Urban (n=1,161)	
Item	Average	Marginal	Average	Marginal
Cereals	0.314	0.317	0.345	0.339
Maize	0.157	0.155	0.138	0.126
Millet and sorghum	0.079	0.076	0.019	0.017
Rice	0.026	0.032	0.057	0.065
Kenkey, banku, akpler, tuo zaafi	0.039	0.039	0.083	0.082
Roots and tubers	0.514	0.502	0.390	0.387
Cassava	0.280	0.267	0.169	0.160
Gari and other cassava products[a]	0.045	0.050	0.086	0.092
Yams[a]	0.039	0.040	0.040	0.042
Cocoyams	0.054	0.056	0.030	0.030
Plantain[a]	0.093	0.090	0.065	0.063
Meats and fish	0.061	0.064	0.094	0.095
Fish	0.055	0.056	0.082	0.083
Red meats	0.005	0.006	0.009	0.010
Poultry	0.002	0.002	0.002	0.002
Dairy products and eggs	0.001	0.001	0.002	0.002
Oils and fats	0.045	0.045	0.078	0.079
Other[b]	0.065	0.072	0.092	0.098
Mean per capita daily calorie intake	3,046	2,906	2,774	2,712
Median per capita daily calorie intake	2,600	2,451	2,372	2,176

Source: GLSS (1987-1988).

[a] Fufu calories were arbitrarily apportioned 50 percent to cassava, 25 percent each to yam and to plantain.

[b] Consists of calories represented by sugar and groundnuts only. Not comparable to "Other" category in tables giving food expenditures or budget shares.

Notes: Marginal based on 14-day recall; average based on normative monthly consumption behavior recalled from previous 12 months. Shares calculated over the subset of foods given in the table.

unavailable. As noted, regional prices were used to convert rice expenditures to quantities. Similarly, the average prices for fufu and kenkey observed in 1990 were converted to 1987/88 prices to handle the omission of prices for those key foods. Consumption of home-produced foods presents a particular problem; recall is only reported on an annual basis. The data do reveal the number of months in a year the household relies on home production, but not whether these months are included in the period of the survey. It was necessary, therefore, to presume that a household that purchased a particular food in the last two weeks did not also consume it from their own production in the period. For those who had no recent purchase, monthly drawdown of stocks was presumed constant over the number of months a household reported relying on this production.

The coefficient of variation for the calorie availability in Table 1 is high. This reflects the difficulty of recording purchases and home consumption in a culture that does not have uniform marketing units for weight or volume. It is tempting to clean the data so that the levels conform to expectations of reasonable levels of intakes. To a fair degree, however, this temptation was resisted at this stage, with one exception. A natural misinterpretation was likely with the flexible recall period used for the survey. It is likely that a number of households reported the number of purchases (or times of consumption) within a period and then reported the quantity used per *period* rather than per *purchase* (time consumed). For example, a respondent may report consumption of maize three times a day and then report the amount consumed daily rather than per meal. A conservative filter was used to identify such cases: households that reported over 8,000 calories per capita per day *and* implicit yields calculated from home consumption which exceeded three times the national average *and* which reported a frequency of use in whatever period was recalled that was greater than one, were flagged. It was assumed that these households had confused the question in the manner discussed above and the recall for the commodity in question was adjusted accordingly. Households that, even after this filter, were reporting more than 11,000, or fewer than 300, calories per capita per day, were deleted from the data set.[11]

[11] While only a few households were flagged with these criteria, the changes also led to changes in the equations used to predict per capita expenditures and, hence, to quartile ranking based upon them. The tables in this study differ slightly from an earlier report based on the same data (Alderman 1990).

3. HOUSEHOLD CALORIE AVAILABILITY IN GHANA

Although the national average for calorie availability in Table 1 is comparatively high, calorie availability is skewed toward the highest income groups; for many households, food availability is less than calorie requirements. For example, 38 percent of urban households do not purchase or retain enough food from production to meet 85 percent of energy requirements for moderate activity levels. These requirements follow WHO (1984) and are based on age, gender, and body size of each family member. They cannot, however, account for differences in activity, that is, energy expenditures.[12] While the lower energy availability for urban households *at comparative income levels* may reflect lower activity levels, it also is likely to reflect demand factors as well. Indeed, one justification for deriving quintiles from a national ranking and then desegregating to urban and rural populations is that the quintile groupings in both sectors will have comparable expenditures. This does, of course, imply that the urban poorest quintile is not a fifth of the *urban* population, although the sum of the rural and urban will be 20 percent. Urban households generally have higher food prices relative to nonfood. Moreover, they often have more obligations for rent and cash outlay for transport and fuel than do rural counterparts. On the other hand, the average urban resident is slightly larger than his or her rural counterpart and will, therefore, require more food, assuming the same level of activity.

As is discussed further below, the high levels of consumption in the upper two quintiles are both implausible and lead to a strong income elasticity for food. Looking further, one notes that while mean levels are comparatively high, the median values are less surprising. Given that negative purchases cannot exist, the data are skewed, with extreme positive values bringing up the mean. This should be borne in mind in the analysis that follows.

The concern, however, is not merely one of methodology; the table implies a large expected increase of food as incomes rise. From the perspective of national consumption, if this is the case, production will need to expand at a rapid pace to keep up with expected economic gains as well as certain population growth. From a poverty alleviation standpoint, such a strong relationship implies that any calorie gap that exists will decline rapidly if incomes of the poor can be raised through economic development or income transfers. Conversely, it also implies that changes in real income due to unanticipated price increases

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12 This is one of the two basic drawbacks of calorie requirements; they are literally normative in that they assume a "normal" activity level. Moreover, there is a fair amount of controversy regarding adaptation to low calorie intakes (see Beaton [1983] and [1989]).

or loss of earning power will translate into substantial reductions in food availability at the household level.

Are there any reasons to question the relationship observed across quintiles in Table 1? It should be noted that the quintiles are based on predicted per capita expenditures rather than observed expenditures. This reduces the likelihood that high expenditures and high calorie availability reflect the same error structure. Bouis and Haddad (forthcoming) argue that, in addition to the issue of error correlation, which is addressed using the predicted expenditures, a systematic bias occurs in reported food availability at the household level because gifts and wages in kind may be correlated with income. Since the special concern with household energy availability arises from the assumption that it is a measure of household nutrition, such food used for social obligations should be distinct from the food consumed by the household. The GLSS questionnaire, however, did try to confine recall to foods "consumed by the household," in the case of purchases, and "eaten," in the case of stock drawdown. Moreover, while gifts and the provision of food to friends and relatives are part of the social fabric, wages in kind are not common, nor is wage labor, for cash or kind, prevalent in most agricultural communities.[13] Without denying the validity of Bouis and Haddad's observation for some communities, it is not likely to be the main explanation for observed patterns of food and incomes.

Table 4, however, indicates another possible explanation for the pattern in Table 1. One notes a strong inverse relationship between household size and average calorie consumption at most expenditure levels. The exceptions are cells with too few observations for confidence. While there are some structural reasons for this pattern — large households likely contain more children and, therefore, have lower average requirements — the high levels in the lower left cells in each region may also reflect a bias in the data. If the number of household members are underestimated (overestimated), both per capita incomes and calorie intakes will be biased upward (downward). Instrumental variables, the usual method of avoiding the problem of bias, are not likely to help in this case, since household size and composition variables are generally included in the instrumenting equations. The coefficients of a number of these composition variables are negative in equations in per capita terms, hence, they lead to a bias in the direction indicated above. An alternative approach would be to create predicted expenditures rather than per capita expenditures. In such an approach the coefficients of composition variables are universally positive. The bias to the calories estimates would still occur, however, if the predicted variable were then to be divided by household size or some measure of adult equivalents derived from sample data.

Note also that there is a surprisingly, perhaps implausibly, large number of households having only one member; 12.9 percent of the households in the rural sample, and 18.7 percent of the urban households report having a single member.

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[13] Only 85 *individuals* in the entire GLSS (urban and rural) sample reported receiving agricultural wages. It is, however, conceivable that the GLSS sample frame undersampled migrant laborers.

Table 4 —Ghana: Mean Daily Per Capita Calorie Availabilities, by Quintile and Size of Household

Quintile	Rural 1 Person	Rural 2 People	Rural 3-5 People	Rural 6-10 People	Rural >10 People	Urban 1 Person	Urban 2 People	Urban 3-5 People	Urban 6-10 People	Urban >10 People
1	2,657	2,559	2,152	2,209	1,978	—	—	2,028	1,652	1,537
	(n=6)	(n=12)	(n=142)	(n=274)	(n=86)	—	—	(n=10)	(n=46)	(n=31)
2	3,281	2,974	2,818	2,358	2,321	—	1,199	2,250	1,806	1,975
	(n=27)	(n=31)	(n=233)	(n=171)	(n=14)	—	(n=3)	(n=33)	(n=89)	(n=6)
3	4,285	3,381	2,811	2,579	2,327	3,232	2,967	2,441	1,766	3,396
	(n=58)	(n=60)	(n=193)	(n=106)	(n=7)	(n=7)	(n=6)	(n=83)	(n=84)	(n=3)
4	3,954	4,197	3,136	3,125	6,687	3,956	3,618	2,311	2,103	3,866
	(n=68)	(n=39)	(n=147)	(n=53)	(n=1)	(n=31)	(n=28)	(n=161)	(n=78)	(n=1)
5	5,309	4,697	4,092	2,687	3,038	4,124	3,971	2,592	2,682	—
	(n=82)	(n=17)	(n=38)	(n=6)	(n=1)	(n=179)	(n=85)	(n=174)	(n=25)	—
Column Averages	4,387 (n=241)	3,580 (n=159)	2,817 (n=753)	2,399 (n=610)	2,097 (n=109)	4,071 (n=217)	3,773 (n=122)	2,430 (n=461)	1,914 (n=322)	1,794 (n=41)

Source: GLSS (1987-1988).

Notes: Calories are estimated from 14-day recall of food consumption (expenditures plus value of own production consumed) and smoothed GLSS cluster prices. Households were ranked over the entire sample on the basis of predicted per capita expenditures.

While two-person households are actually less common than single-individual households in the sample, nearly 10 percent fall in the two-person category as well.[14]

This type of potential nonsampling error would reflect the difficulties inherent in defining the household, as well as errors in recall and errors in data entry, and may be widespread despite efforts to reduce its likelihood. Even the functional definition of a household in terms of eating meals together — itself not necessarily reflecting production or income pooling units — contains some ambiguity in that different meals may be shared amongst different individuals. To be sure, no extensive survey can be free of such errors. Our concern here, however, is that the error introduces a potentially systematic bias. This possibility will be discussed further in the analysis below.

Tables 5 and 6 present additional descriptive statistics on calorie availability in Ghana. As indicated in the former, the rural savannah zone has a higher average estimated calorie availability than other zones. Both the median and the number of households reporting low energy availability in the region, however, are more in keeping with the consistently higher levels of malnutrition in this region. Differences in consumption patterns across regions are presented in Table 6. One notes, for example, that the share of millet and sorghum in the mean diet of the rural savannah region exceeds the share to *all* cereals in the other regions. Moreover, the savannah *also* has the highest share to both maize and rice among the rural population. Logically, of course, the region has a smaller share to roots and tubers, although it is the only zone with an appreciable share to yams.[15]

The collective share of roots and tubers in the Ghanian diet is surprising not only because it exceeds grains, but because roots and tubers are assumed to become comparatively unimportant as incomes rise and as a population urbanizes. The comparatively large share of calories from roots and tubers in urban areas, then, is an exception to the trend towards wheat and rice observed in other parts of Africa. Moreover, it implies a more extensive marketing infrastructure than is often assumed, given that such crops are bulky and perishable. Poleman (1961) noted such marketing in 1957 for urban Ghana with surprise. Little, however, appears to have changed in urban dietary habits in the ensuing years.

The shares to calories do not, of course, correspond to budget shares (see Appendix Table 4) since foods that are relatively expensive sources of calories would have higher budget shares than calorie shares. While this is particularly true for meats and poultry, it is surprising that the cheapest calories in the

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[14] The 20 to 30 percent range of households with two or fewer members contrasts markedly with a sample of 600 households drawn from Brong-Ahafo and Upper East in 1990. Only 6.2 percent of that sample were one- or two-person households (Alderman 1992).

[15] The surprisingly high food availability for this zone reported in the GLSS would be higher still if yams are systematically underestimated.

Table 5 —Ghana: Daily Per Capita Calorie Availabilities and Requirements, by Agroecological Zone

Item	Rural	Urban
Coastal zone		
Daily per capita calories:		
Mean	2,954	2,837
Median	2,502	2,263
Standard deviation	1,941	1,939
Mean minimum requirement	2,020	2,116
Number of households:		
Total	512	667
Below minimum (%)	36	43
Below 85% of minimum (%)	29	34
Forest zone		
Daily per capita calories:		
Mean	2,837	2,468
Median	2,454	1,959
Standard deviation	1,710	1,721
Mean minimum requirement	1,998	2,074
Number of households:		
Total	924	385
Below minimum (%)	35	52
Below 85% of minimum (%)	27	42
Savannah zone		
Daily per capita calories:		
Mean	2,983	2,783
Median	2,232	2,103
Standard deviation	2,137	2,188
Mean minimum requirement	2,016	2,074
Number of households:		
Total	427	108
Below minimum (%)	45	45
Below 85% of minimum (%)	36	39

Source: GLSS (1987-1988).

Notes: Calorie intakes are derived from 14-day recall food expenditures and smoothed, cluster-specific GLSS prices. Requirements based upon household composition, assuming average activity levels equivalent to 1.6 times basal metabolic rate.

Table 6 —Ghana: Calorie Share Means For Major Food Groups and Staples by Agroecological Zone Estimated with Marginal Expenditures Under Smoothed GLSS Prices

Item	Rural			Urban			
	Coastal (n=513)	Forest (n=930)	Savannah (n=429)	Accra City (n=327)	Non-Accra Coast (n=341)	Forest (n=388)	Savannah (n=108)
Cereals	0.267	0.197	0.637	0.388	0.325	0.265	0.504
Maize	0.145	0.114	0.256	0.109	0.133	0.109	0.221
Millet and sorghum	0.001	0.001	0.329	0.002	0.001	0.001	0.165
Rice	0.023	0.034	0.036	0.076	0.061	0.057	0.071
Kenkey, banku, akpler, and tuo zaafi	0.076	0.033	0.009	0.121	0.088	0.061	0.049
Roots and tubers	0.509	0.619	0.241	0.312	0.392	0.474	0.228
Cassava	0.317	0.316	0.101	0.106	0.178	0.204	0.113
Gari and other cassava products[a]	0.106	0.028	0.025	0.114	0.119	0.058	0.059
Yams[a]	0.015	0.032	0.086	0.042	0.025	0.043	0.089
Cocoyams	0.025	0.093	0.014	0.008	0.017	0.068	0.007
Plantain[a]	0.045	0.149	0.015	0.042	0.054	0.102	0.021
Meats and fish	0.081	0.067	0.036	0.114	0.096	0.091	0.046
Fish	0.075	0.059	0.028	0.099	0.090	0.079	0.032
Red meats	0.003	0.007	0.006	0.012	0.005	0.011	0.013
Poultry	0.002	0.002	0.001	0.003	0.001	0.001	0.002
Dairy products and eggs	0.001	0.001	0.003	0.003	0.002	0.002	0.001
Oils and fats	0.057	0.046	0.027	0.086	0.087	0.071	0.055
Other[b]	0.086	0.070	0.059	0.097	0.098	0.096	0.106
Mean daily per capita calorie availability	2,950	2,849	2,976	2,984	2,696	2,476	2,783

Source: GLSS (1987-1988).

Note: Based on 14-day recall.

[a] Fufu expenditures were arbitrarily apportioned 50 percent to cassava, 25 percent each to yam and to plaintain. Sweet potato expenditures were combined with yams.

[b] Consists of calories represented by sugar and groundnuts only. Not comparable to "Other" category in expenditure shares.

savannah are not from millet, even though millet predominates in the diet in the most densely populated region (Upper East).

Table 7 indicates the price of the cheapest source of food in three different markets — representing the three main agroecological zones — over the decade.[16] The table indicates that the cheapest source of calories varies over time as well as over the three representative markets; five different commodities appear in the table, four in Techiman alone. The cheapest calorie source can cost as little as 43 percent of the composite price of staples in the diet, although the average price of the cheapest source is approximately two-thirds of the composite price and may be as much as 75 percent. It is also noteworthy that millet does not appear as the cheapest source in any period.

Table 7 also reports the cost per 1,000 kilocalories for the representative diet[17] in 1985 cedis for these markets at various times in the decade. These dietary costs are based on weights derived from the calorie shares to basic staples in the individual markets. The table indicates the general variability of prices and serves as a caveat for the interpretation of any single year's data. There is an extreme price rise in 1983 as well as an increase in 1987, prior to the survey but within the annual recall period. Moreover, the cost of calories differs greatly in the different markets, with the rank ordering of markets changing over time.

Table 8 indicates some of the regional and intercrop differences in the cost of food energy at the time of the GLSS. In addition, the table shows the quarterly price cycle for maize, the price of which is generally the most variable over seasons (Alderman and Shively 1991). Rice and bread, commodities that are imported and, hence, reflect the world prices, are particularly expensive, a fact that likely explains the small contributions of these commodities to total caloric intake.

Table 9 presents the average cost of 1,000 calories in the *total* diet in the different quarters of the survey, rather than for specific commodities. The average cost of the diet is much higher in this table than in Table 7, as it includes all foods in the diets including vegetables, meat, fish, and other sources of calories that are expensive, but that provide other nutrients as well as variety. Clearly, the diet is more expensive in the urban area due to differences in commodity mixes as well as higher prices for most food items. As a point of reference, the minimum wage in 1986 was 120 cedis per day, or roughly the average cost of 2,500 to 3,000 calories. Less than 10 percent of all individuals who reported a wage in the 1987-1988 GLSS indicated that their wage was below the legal minimum. Similarly, 15 percent of the small subset of those

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16 The methodology for constructing the time series is discussed in Alderman and Shively (1991).

17 Given the ages across the population in the 1987-1988 GLSS, the average Ghanaian requires approximately 2,050 kilocalories a day, estimated from WHO/FAO energy requirements for a moderately active population.

Table 7 —Ghana: Price per 1,000 Kilocalories

Year	Month	Representative Diet			Cheapest Source		
		Bolgatanga	Cape Coast	Techiman	Bolgatanga	Cape Coast	Techiman
		December 1987 Cedis					
1981	6	28.02	18.64	16.45	19.21 (sorghum)	10.86 (cassava)	7.92 (cassava)
1981	12	14.40	14.55	12.34	10.70 (maize)	8.69 (cassava)	7.78 (cocoyam)
1983	6	61.22	—	43.92	43.36 (sorghum)	90.32 (maize)	22.39 (cassava)
1983	12	31.65	—	27.90	20.75 (maize)	27.23 (maize)	17.36 (maize)
1985	6	20.75	13.29	11.51	12.14 (sorghum)	9.60 (gari)	6.77 (cassava)
1985	12	15.11	13.63	8.39	7.72 (sorghum)	8.20 (cassava)	4.45 (cassava)
1987	6	23.99	25.83	24.39	12.22 (sorghum)	20.20 (cassava)	15.32 (sorghum)
1987	12	21.78	22.18	18.13	14.44 (sorghum)	19.25 (maize)	9.48 (cocoyam)
1989	6	17.65	14.55	15.70	10.03 (maize)	9.68 (cassava)	6.81 (maize)
1989	12	11.83	12.22	10.35	8.35 (maize)	7.92 (cassava)	6.89 (maize)

Source: GLSS (1987-1988).

Note: "—" means not available due to one or more component prices missing.

Table 8 —Ghana: Price of 1,000 Calories Obtained from Various Staples, by Agroecological Zone

Staple Food	Coastal	Forest	Savannah
Maize			
4th Quarter 1987	16.6	15.9	13.1
1st Quarter 1988	20.9	20.2	17.5
2nd Quarter 1988	24.9	25.8	23.0
3rd Quarter 1988	20.4	18.5	15.7
Rice	72.3	86.0	75.1
Millet and sorghum	32.3	30.9	24.6
Cassava	16.6	16.3	21.2
Gari	30.0	32.4	30.5
Yam	56.3	52.6	41.7
Bread	77.9	84.5	85.0
Plantain	40.4	30.9	44.2

Source: GLSS (1987-1988).

Table 9 —Ghana: Price of 1,000 Calories

	Total Diet	
	Rural	Urban
4th Quarter 1987[a]	38.2	52.1
1st Quarter 1988	44.8	59.2
2nd Quarter 1988	[illegible]5.5	69.1
3rd Quarter 1989	38.2	60.3

Source: GLSS (1987-1988).

[a] Includes some observations from September 1987.

Note: Price is calculated as the ratio of total food expenditures to total calories, summed over all households in each cell.

individuals who reported receiving a wage for agricultural labor did not get at least the minimum wage.

Table 9 also indicates some seasonality in the average cost of calories with the third quarter of 1988 — after the early maize harvest — being the time of lowest cost in rural areas. In urban areas, however, the price (in nominal terms) was lowest in the fourth quarter of 1987. One cannot, of course, say much about seasonality with a single year's data, but it is not unlikely that the postharvest price drop would be delayed slightly in urban areas.

Tables 10 and 11 indicate calorie sources by expenditure quintile. To a degree, many of the patterns represent the fact that the poorest quintiles have a higher proportion of households from the savannah than do the more affluent quintiles. Thus, the share to maize is over twice as high for both the urban and rural poor as for the highest quintiles. Similarly, consumption of millet and sorghum is inconsequential for the top 60 percent of the income distribution.[18] On the other hand, the pattern with meat and fish, oils, and sugar reflect a global tendency for these items to play a greater role in the diet as incomes rise. Similarly, the positive correlation of the role of prepared foods (kenkey, banku, and akpler, as well as gari and other cassava products) with income is a pattern that mirrors worldwide evidence. The large calorie share to cassava and other root crops among the rural affluent and the urban middle class, however, challenges conventional wisdom for two reasons. It is often assumed that one shifts from roots to cereals to animal products as incomes rise. There is no such tendency in rural Ghana and only a comparatively weak one in urban areas. Moreover, as root crops are far more bulky and perishable than grains, it is relatively difficult to transport them to urban consumers. The important role such commodities play in the Ghanaian diet, then, challenges the common assumption that the food marketing chain in Ghana is underdeveloped.

RELATIONSHIP OF CALORIES AND INCOME

A number of recent studies on the demand for calories have narrowed the range of expectations of the responsiveness of household calorie consumption to income changes as typically measured in terms of income or expenditure elasticities (Alderman 1992; Behrman, Deolalikar, and Wolfe 1988). Given the income disparities found in most populations — as well as in most data sets from which estimates are derived — an overall income elasticity larger than 0.15 to 0.20 would not be in keeping with known distributions of food intakes. Upper income groups often have incomes 5 to 10 times that of the poorest groups in the population, while on physiological grounds the ratio of calorie intakes cannot be more than two or three to one. It is important, however, to note that the increase in energy intakes as incomes rise might be compressed into the lower end

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[18] However, the sharp decline of consumption of millet and sorghum as incomes rise is not likely to indicate a candidate for a self-targeting food subsidy; relatively little millet is marketed.

Table 10 — Ghana: Rural Calorie Share Means For Major Food Groups and Staples by Per Capita Expenditure Quintile Estimated with Marginal Expenditures Under Smoothed GLSS Prices

Item	Quintile				
	1 (n=520)	2 (n=476)	3 (n=424)	4 (n=308)	5 (n=144)
Cereals	0.445	0.310	0.265	0.228	0.220
Maize	0.199	0.164	0.138	0.115	0.098
Millet and sorghum	0.182	0.060	0.038	0.009	0.008
Rice	0.029	0.032	0.029	0.039	0.032
Kenkey, banku, akpler, and tuo zaafi	0.026	0.042	0.044	0.045	0.050
Roots and tubers	0.423	0.519	0.543	0.547	0.515
Cassava	0.238	0.266	0.288	0.286	0.275
Gari and other cassava products[a]	0.031	0.039	0.064	0.056	0.086
Yams[a]	0.047	0.043	0.033	0.035	0.034
Cocoyams	0.042	0.068	0.061	0.062	0.044
Plantain[a]	0.066	0.104	0.096	0.108	0.075
Meats and fish	0.043	0.057	0.068	0.084	0.105
Fish	0.037	0.050	0.061	0.074	0.093
Red meats	0.005	0.005	0.005	0.008	0.009
Poultry	0.002	0.002	0.002	0.002	0.003
Dairy products and eggs	0.000	0.001	0.001	0.002	0.002
Oils and fats	0.032	0.040	0.051	0.054	0.063
Other[b]	0.056	0.073	0.072	0.086	0.095
Mean daily per capita calorie availability	2,169	2,674	3,027	3,461	4,791

Source: GLSS (1987-88).

[a] Fufu expenditures were arbitrarily apportioned 50 percent to cassava, 25 percent each to yam and to plantain. Sweet potato expenditures were combined with yams.

[b] Consists of calories represented by sugar and groundnuts only. Not comparable to "Other" category in expenditure shares.

Note: Quintile ranks are based on predicted per capita value of household food and nonfood consumption. Shares estimated from 14-day recall.

Table 11 —Ghana: Urban Calorie Share Means For Major Food Groups and Staples by Per Capita Expenditure Quintile Estimated with Marginal Expenditures Under Smoothed GLSS Prices

	Quintile				
Item	1 (n=87)	2 (n=131)	3 (n=183)	4 (n=299)	5 (n=463)
Cereals	0.377	0.370	0.318	0.309	0.352
Maize	0.185	0.197	0.164	0.122	0.083
Millet and sorghum	0.062	0.039	0.008	0.017	0.005
Rice	0.057	0.055	0.054	0.058	0.078
Kenkey, banku, akpler, and tuo zaafi	0.054	0.057	0.061	0.066	0.114
Roots and tubers	0.444	0.399	0.419	0.413	0.345
Cassava	0.212	0.191	0.179	0.188	0.117
Gari and other cassava products[a]	0.070	0.066	0.092	0.082	0.110
Yams[a]	0.032	0.031	0.040	0.040	0.048
Cocoyams	0.056	0.041	0.040	0.035	0.015
Plantain[a]	0.072	0.071	0.068	0.067	0.055
Meats and fish	0.057	0.068	0.084	0.101	0.109
Fish	0.050	0.060	0.073	0.090	0.096
Red meats	0.006	0.007	0.009	0.009	0.011
Poultry	0.002	0.001	0.001	0.002	0.002
Dairy products and eggs	0.001	0.001	0.001	0.002	0.004
Oils and fats	0.042	0.063	0.083	0.080	0.087
Other[b]	0.079	0.099	0.109	0.096	0.103
Mean daily per capita calorie availability	1,654	1,912	2,194	2,555	3,442

Source: GLSS (1987-1988).

[a] Fufu expenditures were arbitrarily apportioned 50 percent to cassava, 25 percent each to yam and to plantain. Sweet potato expenditures were combined with yams.

[b] Consists of calories represented by sugar and groundnuts only. Not comparable to "Other" category in expenditure shares.

Note: Quintile ranks based on predicted per capita value of household food and nonfood consumption, estimated from 14-day recall.

of the range of incomes, so that a low population response may be making a far stronger response among the poorest households.

Regressions of household calorie availability on expenditures using the GLSS data indicate that the expenditure elasticity in Ghana is on the high end of the range reported in the literature. While it is well known that repeated estimates with the same data set violate the assumption of independent samples, which underlies much of classical statistical sampling theory, there is also a need to verify that any results reported are robust to variations in model specification. Consequently, alternative estimates were studied in order to assess the robustness of the high calorie elasticities under alternative functional forms. As indicated in Table 12, the elasticity at the mean does not vary appreciably over functional forms. Since elasticities rarely differ at the mean and since the elasticities are sufficiently high even at this mean, there is little need to explore the lower tail. A more important set of variants looks at the potential distortion that might be due to the under-reporting of household members discussed above. A number of regressions summarized in Table 12, then, were run in terms of total household calories regressed on total household (not per capita) expenditures. Moreover, regressions were run that limited observations to those households with three or more family members. Note that these variations also have comparatively little effect on the magnitude of calorie elasticities at the mean.

A more fundamental problem is the number of extreme values of reported calorie availability. Fully one quarter of the sample consume less than 1,000 calories per capita per day or more than 5,000 calories, even after the data have been filtered in the manner reported above. When these observations are removed from the sample — a truncation that admittedly alters the statistical properties of the parameters reported — the expenditure elasticities drop markedly. This implies that the physiologically implausible observations on calorie availability are *not* randomly distributed over predicted expenditures, even though the use of predicted expenditures in the regressions is intended to free them of any potential positive correlation of errors introduced when the food items that comprise the calorie availability also are major components of total expenditures. This not only makes a caveat necessary for any statement about the magnitude of the relationship of calorie availability to expenditures from the sample, it calls into question any parametric model using expenditures calculated with the data set.[19]

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19 As mentioned above, any aggregate of household expenditures contains the errors in reporting food levels; the extreme calorie levels are less likely due to errors in prices than to recall of expenditures and imputed expenditures. Income estimates are also not unbiased. Not only is there a difficulty using transitory income in regression analysis, there are various likely systematic biases in reported income. For example, households in Greater Accra, the region with the highest levels of total expenditures, report an average income that was *lower* than that reported in the rural savannah zone.

Table 12 —Ghana: Alternative Estimates of Income Elasticities for Calories, Estimated at Mean Values

Specification	Rural		Urban	
	Calories Per capita	Total Calories	Calories Per Capita	Total Calories
1) Double logarithm[a]	0.572	0.576	0.427	0.432
2) Double logarithm[a], including square of household size	0.631	0.666	0.493	0.497
3) Double logarithm[a], with square of expenditure	0.638	0.678	0.491	0.509
4) Log-log inverse[a]	0.553	0.602	0.396	0.457
5) Log-log inverse[a] with square of logarithm of expenditure	0.589	0.614	0.426	0.469
6) Semilogarithm[a]	0.572	0.498	0.455	0.539
7) As 2)[b], excluding households with one or two individuals	0.652	0.674	0.513	0.488
8) Expenditure percentile median calories regressed on percentile average expenditures	0.667	—	0.571	—
9) As 4)[c], excluding households with per capita calories less than 1,000 or greater than 5,000	0.280	0.298	0.297	0.293

Source: Estimated from GLSS (1987-1988).

[a] The estimates are based on 1,876 rural households and 1,164 urban households.

[b] The estimates are based on 1,473 rural households and 824 urban households.

[c] The estimates are based on 1,519 rural households and 1,004 urban households.

There is no solution to this problem that does not have an arbitrary element. If one rejects the observations outside the range indicated above, one could equally argue to reject observations above, say, 4,000 calories a day. Nor is the sample truncation criterion obvious from the perspective of the independent variables; the average per capita expenditure in the truncated portion of the sample differs by only 1 percent from that in the full sample. Indeed, the average daily calorie intake of those households excluded differs by less than 10 percent from the average of those included. This reflects, of course, the double truncation, hence, the bimodal distribution of the intakes; households falling below the lower truncation point have average predicted expenditures significantly below the population mean while those above the 5,000 calorie cutoff are, on the average, more affluent than the overall population. Nevertheless, this information does not provide a means of identifying a sample-truncation criterion: it merely shifts the arbitrary selection from the left-hand side of the equation to the right.[20]

The procedure used here is also ad hoc, but it does exclude fewer observations from consideration. For those households that have estimated calorie availabilities outside the range under consideration, the annual observations are substituted for the marginal recall. The errors in these estimates, however, are not independent of each other, not only because the same individual often reports both sets of expenditure information but also because only one estimate of consumption out of retained production is used for both methods of calculating food availability. Nevertheless, for a number of cases in which the recall period was confused or in which a principal component of consumption was omitted, the alternative observations form a more accurate estimate of food availability. The results of regressions using these observations are reported below.

In the regressions in Table 13, expenditures are entered as the inverse of the logarithm of predicted per capita expenditures, while the dependent variable is the logarithm of per capita calories. This particular functional form is chosen because it has been shown to accommodate a flattening of the calorie-expenditure curve as total expenditures increase (Strauss and Thomas 1989). In actuality, however, there is no strong reason to use, or not to use, any particular functional form; there was little curvature in the data set and, therefore, no particular need to place special emphasis on the curvature.

RELATIONSHIP OF CALORIES AND PRICES

In a number of countries, price movements appear to have an appreciable impact on the amount of calories consumed (Behrman, Deolalikar, and Wolfe 1988). While this may appear intuitive, it should be recalled that when there is appreciable substitution between food commodities, the price elasticity for

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[20] A possible approach is a spline, or piecewise, regression in which one concentrates on a center portion, which is possibly less contaminated by faulty data. The nodes for such a procedure, however, remain somewhat arbitrary.

Table 13 —Ghana: Regression Results for the Relationship Between Calories, Expenditures, and Prices

	Rural				Urban			
	Model 1		Model 2		Model 1		Model 2	
Variable	Parameter Estimate	Standard Error	Parameter Estimate	Standard Error	Parameter Estimate	Standard Error	Parameter Estimate	Standard Error
Intercept	16.31	0.79	13.20	0.97	14.35	1.29	14.69	1.48
Inverse of log expenditures[a]	-70.15	5.88	-68.67	5.83	-52.91	8.17	-52.32	8.18
Log of household size	-0.47	0.08	-0.44	0.08	-0.20	-0.09	-0.19	0.09
Square of log household size	0.13	0.03	0.12	0.03	0.05	0.04	0.04	0.04
Share of females - 0-5 years	-0.22	0.14	-0.25	0.14	-0.39	0.16	-0.38	0.16
Share of females - 5-10 years	-0.11	0.16	-0.14	0.16	-0.31	0.17	-0.31	0.17
Share of females - 10-20 years	-0.04	0.11	-0.03	0.12	-0.176	0.14	-0.16	0.14
Share of females - > 65 years	-0.08	0.15	-0.10	0.15	0.12	0.18	0.13	0.18
Share of males - 0-5 years	-0.14	0.14	-0.16	0.14	-0.33	0.16	-0.32	0.16
Share of males - 5-10 years	-0.05	0.15	-0.06	0.15	-0.23	0.17	-0.22	0.17
Share of males - 10-20 years	-0.08	0.13	-0.10	0.13	-0.35	0.14	-0.34	0.14
Share of males - 20-65 years	-0.32	0.10	-0.33	0.10	-0.164	0.10	-0.14	0.10
Share of males - > 65 years	-0.40	0.14	-0.40	0.14	0.04	0.20	0.02	0.20
Forest zone dummy	0.04	0.04	0.05	0.04	0.20[b]	0.05	0.04	0.05
Savannah zone dummy	0.08	0.06	3.80	0.79	0.05	0.09	3.29	1.33
Accra dummy	—	—	—	—	-0.05	0.07	-0.05	0.07
Kumasi dummy	—	—	—	—	-0.07	0.10	-0.05	0.10
Semiurban dummy	-0.15	0.03	-0.14	0.03	—	—	—	—
Land (acres)	0.03[b]	0.02[b]	0.03[b]	0.02[b]	0.13[b]	0.08[b]	0.12[b]	0.08[b]
2nd quarter dummy	0.12	0.06	0.05	0.06	-0.11	0.07	-0.12	0.08
3rd quarter dummy	-0.11	0.08	-0.09	0.08	-0.02	0.09	0.02	0.11
4th quarter dummy	-0.02	0.05	0.04	0.05	-0.05	0.06	-0.03	0.07
Log of maize price[a]	-0.60	0.16	-0.63	0.16	-0.42[b]	0.19	0.15	0.21
Log of cassava price[a]	0.26	0.09	0.31	0.10	-0.18	0.23	-0.39	0.24
Log of yam price[a]	0.14	0.13	0.41	0.14	-0.35	0.22	-0.32	0.23
Log of plantain price[a]	-0.12	0.07	-0.18	0.08	0.14	0.10	0.17	0.12
Log of rice price[a]	—	—	0.40	0.11	—	—	-0.12	0.11
Log of millet & sorghum price[a]	—	—	-0.82	0.17	—	—	-0.73	0.30
Female head dummy	-0.09	0.04	-0.08	0.04	0.03	0.05	0.04	0.05
N	1,872		1,872		1,164		1,164	
Corrected R^2	0.213		0.226		0.231		0.234	

Source: Estimated from GLSS (1987-1988).

[a] Predicted variable. Predicted prices reflect the smoothing procedures discussed above.

[b] x 10^2.

Note: Dependent variable is the natural logarithm of per capita calories per day. Millet and sorghum price is interacted with savannah zone dummy.

individual foods may be fairly high in absolute value, yet the net impact of price and cross-price responses could be low. Indeed, there are examples in which an increase in the price of one food leads to an overall *increase* in calorie intake as consumers add more of one or more low-priced commodities in their diet than they reduce consumption of a good with rising prices (Pitt 1983).

Although there is a strong correlation between food prices and levels of malnutrition in Ghana over the 1980s, it is not possible to use such time series to separate the effects of rising food prices from falling incomes; a famine may be what Sen (1981) calls an entitlement failure as much as a food shortage. That is, rising malnutrition may be caused directly by crop failure and declining income rather than through high food prices.

Table 13 (Model 1) indicates that consumers do reduce (increase) their total food availability as maize prices increase (decrease); the maize price elasticity for calories in rural areas is -0.60. As indicated above, this response can be considered the long-run net impact of price and cross-price effects. In this model the impact of plantain price is also negative and statistically significant. The inclusion of sorghum prices[21] in Model 2 does not change the other price response although the dummy variable for the savannah zone increases in magnitude.

Although it is not indicated in Table 13 for brevity, some of the coefficients of the price variables vary when the dummy variables for zones or regions change. For example, if Model 2 is run without any variables for agroecological zone, the millet/sorghum price variable is not significant, while the yams price response is essentially the same as in Model 1. When the ecological zone variables are replaced with nine variables for regions, the apparent price response for yams becomes positive, although the coefficient on plantains is negative. The maize price response, however, does not vary over these alternatives.

While much of this paper indicates flaws in the first-year GLSS data, pointing to redesign as the real solution to the problems raised, this variability of the price response does not fall in that category. Prices vary spatially as well as temporally. Some of the spatial differences correlate with differences in tastes. Indeed, prices — or differences in supply that influence prices — may be the long-run causes of these regional patterns.[22] The inclusion of zone-wise or regional dummy variables removes much of this long-run response. While this issue is addressed further in the next section, for the

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21 This price is interacted with the dummy variable for the savannah agroecological zone. In effect, it constrains the price response to zero outside the zone.

22 Deaton (1987) discusses the long- and short-run price responses from an economist's perspective (see also Alderman 1988). Harris and Ross (1987) present an anthropological perspective on the same issue.

purposes of the study of the net impact of prices on calorie availability, it is useful to disaggregate the calorie response by agroecological zone.

Table 14 presents such disaggregations. Price responses differ by region. In the coastal area, increases in the price of maize lead to a decline in household availability of calories (not significant).[23] Changes in cassava prices have the largest net impact in the forest zone. In the savannah, on the other hand, consumers appear to be responsive to changes in millet and sorghum prices as well as maize prices. Price collinearity, however, is evident in the variables in that zone; if a separate regression is run for the urban savannah zone, the maize price parameter is -2.6 and the other price parameters appear to be greater than 3.0. There are too few observations and too little price variation to reliably estimate price response for the urban savannah zone with the GLSS first-year data alone. In all regions, an increase in rice prices would lead to a net increase in calories due to commodity substitutions.

Finally, one should note that there are no strong effects among the variables for household composition. These variables measure the difference (in logarithms) of per capita consumption attributable to changes in the proportion of the total household in nine age and gender groups. One group, adult females, is omitted as the sum of these variables cannot total one. The composition coefficients, then, can be considered as proportional changes in per capita consumption as a difference from the base group. The negative coefficients on the share of young children is in keeping with their smaller size, but the fact that a number of the other coefficients — including adult males — are also negative is surprising. Again, the explanation may lay in nonsampling error, including any confusion of food prepared at home for sale with food for consumption and possibly the omission of meals taken outside the home.

Although many of the composition variables are not statistically significant, the household size and size squared variables are. Holding per capita expenditures constant, per capita calorie availability declines as one goes from a one or two person household to a larger household and then increases. The decline may be due to difficulties with enumerating household size as discussed above. The increase may reflect scale economies over all aspects of expenditures; larger households have more real income than a smaller household with comparable per capita incomes.[24]

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[23] When yam prices are included in the regressions for the urban coastal zone, that price is apparently significant with a price elasticity of -0.94. Given the small share of yams in either budgets or calories in that subsample, as well as the fact that the inclusion of yams leads to a threefold increase in the coefficient of maize price and a doubling of the standard error, this price was excluded from this model.

[24] In a log linear regression of total calories on total household expenditures, the coefficient of household size is 0.35, indicating a less than proportional increase in calories as family size increases, holding composition constant.

Table 14 — Ghana: Regression Results for the Relationship Between Calories, Expenditures, and Prices, by Agroecological Zone

	Coastal				Forest		Savannah	
	Rural		Urban					
Variable	Parameter Estimate	Standard Error	Parameter Estimate	Standard Error	Parameter Estimate	Standard Error	Parameter Estimate	Standard Error
Intercept	13.31	2.94	14.34	2.43	15.67	1.50	18.54	1.66
Inverse of log expenditures[a]	-69.63	14.50	-77.03	12.03	-65.81	7.47	-67.31	13.85
Log of household size	-0.21	0.15	-0.63	0.14	-0.43	0.09	-0.45	0.19
Square of log household size	0.07	0.06	0.21	0.06	0.11	0.03	0.12	0.06
Share of females - 0-5 years	-0.56	0.27	-0.27	0.23	-0.25	0.16	-0.14	0.34
Share of females - 5-10 years	-0.49	0.30	-0.22	0.26	-0.18	0.17	0.22	0.39
Share of females - 10-20 years	-0.16	0.23	-0.01	0.18	0.07	0.13	-0.61	0.28
Share of females - > 65 years	-0.25	0.22	-0.16	0.26	0.09	0.18	0.52	0.65
Share of males - 0-5 years	-0.20	0.24	-0.22	0.24	-0.14	0.16	-0.37	0.34
Share of males - 5-10 years	-0.07	0.30	0.16	0.25	-0.29	0.17	-0.24	0.35
Share of males - 10-20 years	-0.44	0.23	-0.22	0.20	-0.09	0.13	-0.37	0.31
Share of males - 20-65 years	-0.24	0.18	-0.36	0.14	-0.27	0.11	-0.33	0.26
Share of males - > 65 years	-0.33	0.25	0.05	0.31	-0.34	0.15	-0.29	0.50
Accra dummy	—	—	0.01	0.08	—	—	—	—
Kumasi dummy	—	—	—	—	-0.05	0.11	—	—
Urban dummy	—	—	—	—	-0.20	0.06	-0.51	0.11
Semiurban dummy	-0.21	0.07	—	—	-0.03	0.04	-0.36	0.11
Land (acres)	0.03[b]	0.04[b]	—	—	0.03[b]	0.02[b]	0.06	0.07[b]
2nd quarter dummy	-0.21	0.11	0.17	0.10	-0.09	0.08	0.08	0.15
3rd quarter dummy	-0.22	0.17	0.14	0.13	-0.17	0.09	-0.41	0.21
4th quarter dummy	0.01	0.10	0.15	0.09	-0.01	0.06	-0.15	0.12
Log of cassava price[a]	0.09	0.33	0.13	0.32	-0.47	0.18	0.51	0.18
Log of yam price[a]	0.40	0.32	—	—	0.10	0.17	1.02	0.39
Log of plantain price[a]	0.07	0.20	-0.36	0.18	-0.03	0.09	—	—
Log of maize price[a]	-0.48	0.32	-0.12	0.21	-0.26	0.18	-1.67	0.47
Log of rice price[a]	0.28	0.32	0.43	0.34	0.20	0.11	0.60	0.20
Log of millet & sorghum price[a]	—	—	—	—	—	—	-1.31	0.39
Female head dummy	-0.06	0.09	-0.02	0.07	0.01	0.04	-0.14	0.11
N	513		668		1,316		536	
Corrected R^2	0.221		0.245		0.256		0.244	

Source: Estimated from GLSS (1987-1988).

[a] Instrumental variable.

[b] x 10^2.

Note: Dependent variable is the natural logarithm of per capita calories per day.

Contrary to the commonly held view that households headed by women allocate more resources to food, the coefficient of the dummy variable for female-headed households is negative and marginally significant in the pooled rural area regressions. Given that the data include a vector of variables for household composition, this is unlikely to reflect different dependency ratios in households with no adult male. The data do not allow testing of whether this result indicates a difference in demand indirectly caused by differences in the energy intensity of labor patterns, or whether it reflects time allocation constraints. Such results do, however, indicate a need for further research on intrahousehold allocation and gender-specific control of resources.

CALORIES AND NUTRITIONAL STATUS

Most governments have food security objectives that are broader than nutritional considerations. Similarly, as mentioned above, nutrition results from a complex process; food availability at the household level is only one aspect of the total pathway. Nevertheless, there is an obvious interest in delineating the response of nutrition to food policy, including those policies that influence calorie availability. In order to measure this response, production functions for children's standardized heights and weights were run in a simultaneous system with calorie demand. The models used followed those already explored for Ghana in Alderman (1990).[25] Predicted household calorie availability did not have a significant explanatory effect for nutritional status of children, although a number of other variables such as predicted illness, parents' heights, mother's education, and household size had expected signs and were generally significant. Similarly, when predicted expenditures were included in a conditional production function, that variable was significant, although the variable for household calorie availability was negative in both the height-for-age and weight-for-height equations, and significant in the latter.

Such results are not unique to Ghana (Alderman and Garcia 1992). They are, nonetheless, surprising. The most obvious explanation is that household calorie availability is an inadequate measure of either dietary quality or intrahousehold distribution, or both. The former explanation may account for the positive impact of income apart from the indirect influence on calorie availability in the simultaneous system. Similarly, household food availability does not indicate frequency of meals or caloric density of the diet, both of which are known to influence the nutrition of young children, especially when root crops are a major source of food energy.

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[25] In particular, we adapted Models (3) and (5) from Tables 6 and 7. For more details, see the cited reference.

4. COMMODITY DEMAND

While the price responses discussed above give the net impact on calorie availability of various price shifts, there is also a need to determine the level of price response for specific commodities. A few such estimates exist for Ghana. For example, Asante, Asuming-Brempong, and Bruce (1989) report estimates based on time-series data. The price elasticities in that study are, in general, plausible in magnitude, although the own-price response of sorghum indicates that consumers of that commodity are rather extraordinarily price responsive. The income elasticities reported, however, are surprisingly low. Maize, for example, has a negative income elasticity. Although this income response differs from that estimated using the GLSS, part of the difference is that the latter are based on cross-sectional data, which often have results that exceed those of time-series estimates.

Another set of demand parameters was reported by Haessel (1976), again using time-series data. That study required extensive commodity aggregation in order to deal with difficulties in estimation that were encountered. The only plausible results reported were for three groups of commodities — rice, roots and tubers, and other cereals. The studies of Haessel and Asante et al. are in general agreement regarding the comparatively large price responsiveness of consumers in Ghana, but Haessel finds income responses more than twice the magnitude of any reported by Asante et al.

Any comparison of two sets of estimates from two different data sets cannot hope to resolve the relative reliability of either without additional information.[26] However, as the Asante et al. study is based on average prices in a country for which regional and seasonal variability is large, it is useful to explore the GLSS data to indicate the range of price responses. Moreover, while the Asante et al. study is able to report on sorghum and millet consumption separately (this is not possible with the GLSS data), it does not indicate any price or cross-price response for root crops.

The approach used here attempts to make a virtue of necessity. As mentioned above, the survey collects information on usual purchases in the previous year as well as marginal purchases in the previous two weeks, but only reports annual consumption out of own-produced stocks. One would want, however, to distinguish between short-run responses to price movement — for example, seasonal shifts between yams and cassava — and long-run price effects that influence regional

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[26] Unless, of course, there is an obvious methodological error. This is not the case for the Asante study.

patterns.[27] The method employed must also deal with sample truncation imposed by zero values of consumption. That is, household demand consists of the decision of whether to buy, as well as how much; typically, cross-sectional household consumption survey data will contain many zeroes, reflecting the fact that not every household consumes something in every category. This is a common issue in demand analysis that is typically dealt with either by the use of Tobit regressions (Tobin 1958) or — as below — with Heckman's (1979) two stage technique for sample truncation. The advantage of the Heckman procedure over the Tobit procedure stems from the fact that the Tobit is a special case of the more general Heckman correction and has been shown to be restrictive (Haines, Guilkey, and Popkin 1988).

The first step is to regress the incidence of consuming a commodity at least once during the year using a probit regression. Conditional on a positive response and employing a statistical correction for the sample truncation, one then studies the level of the quantity consumed. In the discussion below, the probit equation will be also called the entry relationship, while the conditional estimates will be denoted as intensification. The price included at this stage measures the long-run price (spatial difference) using the December/January smoothed prices. The survey was undertaken throughout the year and, therefore, the recorded prices from the cluster price questionnaire are not necessarily those used to determine annual consumption, nor do they permit a direct comparison across regions.

Given that the price variation used at this stage of the analysis is cross-sectional, price elasticities from the estimates should be considered long-run responses. As such, they are useful for calculating the impact of welfare on, say, changes in trade policy or public finance as well as for estimating the impact of changes in production and of marketing costs. They do not, however, indicate how households substitute between goods in response to short-run fluctuations of prices such as unexpected seasonal unavailability or gluts.

In order to explore such short-run responses with the limited price variation available, the annual and marginal responses were treated as separate observations and utilized in a panel data set. The incidence of a household consuming a commodity in the current period, given that they consume it at all during the year, is regressed on the difference of this period's price and the annual average price.[28] The regressions also include the number of months between the survey period and the most recent harvest period, plus this variable interacted with landholding in per capita terms. Incomes and household composition variables are not included as the method is essentially a quasifixed effects approach in which the variables are all in terms of the differences between current observations and the household's yearly average. Likewise,

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27 This issue is touched upon in Deaton (1987).

28 Since the concern is with changes over time rather than levels, PPMED prices are used as they allow more regional temporal variance than the GLSS actual or smoothed prices.

permanent income does not change; hence the different between the current period and the average level is zero for all observations. For this reason, as well, it is not necessary to include a correction for sample selection that accounts for the probability of purchase at some time in the year; this is also constant over the year.

Marginal consumption is only accurately observed, however, for those households who make a market purchase in the current period.[29] It is necessary, therefore, to account for the selection in current market purchases, using the same variables as in the other selection process. For these households, the quantity purchased is regressed on the same price and monthly variables as in the selection model as well as the variable used for the correction for sample truncation. Under the reasonable assumption that in a given locale purchasers face the same prices and have the same preference ordering as households that consume from their own production — an assumption that is consistent with separable (recursive) models of farm households — the parameters of the estimates for market purchases can be used as estimates for all consumers.

With either the long-run or the short-run model, the total elasticities must be constructed as a weighted combination of the elasticities from the entry and intensification decisions, i.e., those derived from the probit and conditional estimates. Average consumption can be defined as the probability of consumption times the level of consumption conditional on it being greater than zero (McDonald and Moffit 1980). Given this definition and the fact that both components of the product are functions of income or prices or both, the total derivative is:

$$\frac{\partial Q}{\partial X} = F(Z)\left[\frac{\partial Q^{*}}{\partial X}\right] + E(Q^{*})\left[\frac{\partial F(Z)}{\partial X}\right] \tag{1}$$

where Q is average consumption, Q^* is consumption conditional on a positive value, X is the independent variable (either income or price), and $F(Z)$ the cumulative normal function of the probability of purchase. This latter is the basis for the probit estimation. In words, this equation states that the total change in demand is composed of the change in the quantity of those households that consume, weighted by the probability of being in that group, plus the change in that probability weighted by the expected value of consumption conditional on its being above zero. In practice, due to the nonlinearity of the probit estimators, the arc derivatives are estimated using simulations based on the estimated parameters and the value of the variables for each household.

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[29] As discussed earlier, the survey did not record stock drawdown between enumerator visits.

As is indicated in Table 15, virtually every household in Ghana consumes maize at any given time, so that the approach outlined above can be simplified to ordinary least square (OLS) procedures for that commodity. Note that even 72 percent of the households who produce maize reported purchasing the commodity or some processed form of it during the two weeks between interviews. This reflects the fact that even maize producers purchase prepared products such as kenkey and banku regularly. The percentage of maize producers who buy maize *grain* is much smaller. Cassava is the second most commonly consumed item, with little seasonality in the frequency of consumption. With this commodity as well, the majority of producers claim to be purchasers, perhaps reflecting the processing of gari, fufu, and other products.[30] At the other end of the spectrum, millet and sorghum combined are the least commonly consumed staples, with home production accounting for the dominant share of total consumption. Millet producers are unlikely to purchase the crop during the year; neither are cocoyam producers. In general, however, producers appear to purchase on the market throughout the year, and subsistence farmers seem to be unaffected by changes in market circumstances.

Tables 16 and 17 present the entry and intensification equations, respectively, for long-run demand, while Tables 18 and 19 do the same for short-run demand. Note that the probability of consumption during some time in the year increases with income for all commodities except the millet and sorghum group. This is even true if a probit is run for maize, even though 96 percent of the households consume the product. While diversity of consumption is often assumed to be a function of income, given that these equations cover the entire year, it is surprising that this seems to hold for the number of staples in the Ghanaian diet.[31] It is less surprising — indeed, expected — that the logarithm of expenditure is positive and significant in most of the equations for quantities consumed.

An increase in the long-run own price of a commodity reduces entry for five of the seven commodities and is not significant in another. The positive price response in the rice equation is, of course, inconsistent with theory, but it should be recalled that rice prices are not recorded in the GLSS cluster data. The regional prices used in this study do not indicate rural-urban price differentials, nor do they distinguish imported from domestic rice, although these markets are clearly distinct in Ghana (Alderman 1990).[32]

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30 With both maize and cassava products, there is a possibility that households that produce the raw material also reported the processed form which they themselves produced. The regressions in this section reduce (but do not eliminate) such double counting insofar as they do not include fufu, tuo zaafi, banku, or akpler.

31 As in other estimates, predicted expenditures are used to instrument income.

32 Most estimates were also run without rice prices to ensure that these prices do not affect the other results of interest.

Table 15 —Ghana: Percentage of Households Consuming Major Crops

Food	Consumed Last Period[a]	Consumed During the Year	Purchased Last Period	Purchased During the Year	Percentage of Households That Produce a Crop and — Purchased Last Year	Purchased During the Year
Rice	59.2	85.4	53.5	81.0	23.8	42.9
Maize[b]	94.4	96.9	75.1	86.7	71.7	81.1
Millet and sorghum	12.6	14.4	2.5	5.7	17.8	30.0
Cassava[c]	90.8	93.7	58.0	75.9	51.1	69.5
Yam	56.6	76.6	32.0	66.1	27.9	51.6
Cocoyam	47.4	59.4	15.2	31.2	9.3	20.6
Plantain	66.3	74.5	37.6	59.2	27.6	44.5

Source: GLSS (1987-1988).

[a] Period between enumerator visits —typically 14 days.

[b] Includes kenkey, banku, akpler.

[c] Includes fufu, gari.

Table 16 —Ghana: Probit Results Predicting the Probability of Consuming Staples During the Previous 12 Months

Variable	Maize	Rice	Millet, Sorghum	Cassava	Yams	Cocoyam	Plantain
Intercept	13.649 (3.714)	-9.633 (2.189)	-5.978 (3.366)	-2.874 (2.683)	1.084 (2.368)	14.283 (2.706)	5.984 (2.736)
Land per capita (acres)	0.051 (0.018)	-0.007 (0.011)	0.011 (0.017)	0.034 (0.015)	-0.010 (0.011)	0.012 (0.010)	-0.008 (0.012)
Log of per capita expenditures[a]	0.426 (0.158)	0.497 (0.097)	-0.516 (0.149)	0.724 (0.144)	0.768 (0.094)	0.488 (0.086)	0.920 (0.103)
Household size	0.308 (0.083)	0.367 (0.052)	0.010 (0.082)	0.619 (0.076)	0.487 (0.049)	0.428 (0.046)	0.601 (0.055)
Dummy variables:							
Urban	-0.110 (0.141)	0.250 (0.089)	-0.307 (0.126)	0.218 (0.135)	0.077 (0.086)	0.300 (0.088)	0.460 (0.091)
Semiurban	-0.015 (0.135)	0.163 (0.078)	-0.539 (0.146)	0.086 (0.121)	0.213 (0.076)	0.138 (0.073)	0.385 (0.087)
Forest zone	0.071 (0.130)	0.126 (0.075)	-0.234 (0.129)	0.144 (0.135)	0.520 (0.068)	0.750 (0.068)	1.107 (0.082)
Savannah zone	-0.757 (0.183)	-0.062 (0.128)	1.180 (0.153)	-1.055 (0.165)	0.209 (0.123)	-0.665 (0.117)	-0.599 (0.119)
Accra	0.146 (0.231)	0.360 (0.157)	0.175 (0.190)	-0.356 (0.199)	0.110 (0.130)	0.226 (0.115)	0.489 (0.142)
Kumasi	0.440 (0.330)	0.177 (0.240)	-0.834 (0.351)	-0.832 (0.276)	0.406 (0.229)	-0.353 (0.223)	-0.197 (0.240)
Log of retail prices:							
Maize[a]	-1.776 (0.466)	-0.221 (0.275)	0.709 (0.467)	0.013 (0.520)	-1.348 (0.359)	-1.171 (0.293)	-0.657 (0.305)
Rice[a]	-1.589 (0.389)	1.034 (0.230)	0.798 (0.329)	-0.242 (0.330)	-0.473 (0.224)	-1.443 (0.231)	-1.263 (0.282)
Millet and sorghum[a]	—	—	-1.252 (0.348)	—	—	—	—
Cassava[a]	-0.383 (0.261)	0.124 (0.181)	2.752 (0.340)	-0.813 (0.255)	0.531 (0.233)	-1.216 (0.248)	-2.507 (0.291)
Yam[a]	—	—	—	-0.037 (0.429)	-0.823 (0.289)	—	—
Cocoyam[a]	—	—	—	—	—	-1.088 (0.202)	—
Plantain[a]	—	—	—	—	—	—	0.146 (0.129)
N	3,040	3,040	3,040	3,040	3,040	3,040	3,040

Source: GLSS (1987-1988).

[a] Predicted variable.

Notes: Dependent variable is a dummy variable, which is unity when consumption is reported in previous 12 months. Standard error in parentheses. Price variables are natural logarithms of predicted December/January GLSS cluster retail prices (cedis per kilogram).

Table 17 —Ghana: Long-Run Conditional Consumption, Two Alternative Specifications

Variable	Maize		Rice		Millet and Sorghum		Cassava		Yams		Cocoyam		Plantain	
	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
Intercept	4.465 (1.971)	-1.728 (2.329)	-19.053 (3.831)	-14.171 (5.254)	3.616 (3.694)	0.042 (4.002)	6.782 (1.635)	7.676 (1.725)	6.069 (2.066)	0.799 (2.271)	6.867 (3.961)	-0.516 (5.111)	5.243 (2.887)	4.866 (3.094)
Per capita expenditures[a] (in logarithms)	0.083 (0.081)	-0.175 (0.083)	1.005 (0.162)	0.811 (0.219)	0.026 (0.243)	-0.178 (0.292)	0.367 (0.072)	0.411 (0.081)	0.445 (0.115)	0.906 (0.199)	-0.264 (0.120)	-0.129 (0.184)	-0.014 (0.098)	0.381 (0.148)
Long-run cluster retail prices (in logarithms):														
Maize[a]	-1.107 (0.242)	-0.076 (0.308)	0.714 (0.268)	1.081 (0.282)	3.641 (1.406)	3.099 (1.427)	-0.163 (0.240)	-0.253 (0.248)	-0.840 (0.385)	-0.964 (0.460)	-0.563 (0.411)	0.276 (0.539)	0.422 (0.322)	0.534 (0.360)
Rice[a]	0.220 (0.204)	1.203 (0.250)	0.594 (0.371)	0.151 (0.481)	-1.583 (0.844)	-0.499 (1.046)	-0.147 (0.155)	-0.240 (0.166)	-0.608 (0.217)	-0.390 (0.221)	0.291 (0.310)	0.787 (0.489)	-0.621 (0.258)	-1.013 (0.318)
Millet and sorghum[a]	—	—	—	—	-0.360 (0.911)	-1.083 (1.022)	—	—	—	—	—	—	—	—
Cassava[a]	0.525 (0.173)	0.671 (0.171)	0.756 (0.161)	0.298 (0.197)	-1.119 (0.560)	-0.097 (0.869)	-1.400 (0.206)	-1.504 (0.225)	0.404 (0.207)	0.169 (0.273)	1.126 (0.407)	0.751 (0.563)	0.946 (0.330)	-0.347 (0.473)
Yam[a]	—	—	—	—	—	—	0.072 (0.204)	0.010 (0.210)	-0.493 (0.285)	-0.700 (0.324)	—	—	—	—
Cocoyam[a]	—	—	—	—	—	—	—	—	—	—	-0.342 (0.240)	-0.143 (0.309)	—	—
Plantain[a]	—	—	—	—	—	—	—	—	—	—	—	—	-0.474 (0.108)	-0.341 (0.109)
Household size	-0.039 (0.046)	-0.209 (0.049)	0.098 (0.113)	-0.077 (0.156)	-0.415 (0.133)	-0.417 (0.132)	-0.002 (0.041)	0.042 (0.053)	-0.336 (0.070)	-0.082 (0.125)	-0.683 (0.069)	-0.666 (0.143)	-0.531 (0.055)	-0.292 (0.093)
Dummy variables:														
Urban	-0.022 (0.064)	0.041 (0.067)	0.686 (0.108)	0.613 (0.135)	0.216 (0.200)	0.055 (0.218)	-0.396 (0.060)	-0.356 (0.062)	-0.357 (0.080)	-0.190 (0.083)	-0.750 (0.117)	-0.636 (0.131)	-0.642 (0.087)	-0.348 (0.111)
Semiurban	-0.173 (0.063)	-0.127 (0.062)	0.197 (0.093)	0.118 (0.104)	0.007 (0.265)	-0.179 (0.294)	-0.082 (0.055)	-0.068 (0.056)	-0.107 (0.081)	0.018 (0.088)	-0.408 (0.095)	-0.396 (0.098)	-0.207 (0.079)	-0.044 (0.094)

(continued)

Table 17 (continued)

Variable	Maize		Rice		Millet and Sorghum		Cassava		Yams		Cocoyam		Plantain	
	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
Forest zone	—	-0.544 (0.057)	—	0.040 (0.085)	—	0.762 (0.371)	—	-0.018 (0.050)	—	0.482 (0.151)	—	0.432 (0.253)	—	0.712 (0.155)
Savannah zone	—	0.409 (0.134)	—	0.502 (0.121)	—	1.874 (0.917)	—	-0.232 (0.142)	—	0.952 (0.129)	—	1.257 (0.314)	—	0.181 (0.224)
Accra	0.310 (0.096)	0.123 (0.098)	0.361 (0.124)	0.378 (0.149)	-0.681 (0.372)	0.322 (0.535)	-0.136 (0.085)	-0.167 (0.089)	-0.142 (0.112)	0.192 (0.124)	-1.022 (0.165)	-0.726 (0.179)	-0.725 (0.130)	-0.322 (0.157)
Kumasi	0.070 (0.179)	0.150 (0.184)	-0.190 (0.208)	-0.266 (0.209)	-0.269 (0.911)	-0.375 (0.925)	0.186 (0.149)	0.183 (0.155)	0.279 (0.210)	0.364 (0.212)	0.560 (0.320)	0.258 (0.327)	-0.097 (0.247)	-0.284 (0.248)
Inverse mills ratio	0.433 (0.489)	-3.277 (0.693)	2.624 (0.832)	1.055 (1.198)	-1.730 (0.201)	-0.727 (0.691)	-1.409 (0.212)	-0.944 (0.382)	-1.294 (0.278)	-0.364 (0.590)	-2.203 (0.154)	-2.329 (0.608)	-2.169 (0.129)	-1.094 (0.399)
N	2,932	2,932	2,595	2,595	438	438	2,810	2,810	2,380	2,380	1,806	1,806	2,264	2,264
Corrected R^2	0.041	0.079	0.167	0.172	0.440	0.448	0.215	0.215	0.129	0.148	0.272	0.293	0.221	0.233

Source: Estimated from GLSS (1987-1988).

[a] Predicted variable.

Notes: Regression is conditional upon consuming some amount of the commodity at some time in previous 12 months. The dependent variable is the natural logarithm of per capita quantity consumed during the year (in kilograms). Price variables are natural logarithms of predicted December/January GLSS cluster retail prices (cedis per kilogram) except for rice, which was obtained from the Ministry of Agriculture. Standard errors in parentheses.

Table 18 —Ghana: Probit Results Predicting the Probability of Consuming Staples in the Previous Two Weeks (Quasifixed Effects)

	Parameter Estimate						
Variables	Maize	Rice	Millet, Sorghum	Cassava	Yams	Cocoyam	Plantain
Intercept	1.945 (0.080)	0.631 (0.049)	1.352 (0.145)	1.430 (0.064)	0.731 (0.057)	1.069 (0.067)	1.533 (0.071)
Own price	-0.289 (0.112)	-0.358 (0.211)	-1.013 (0.437)	0.319 (0.092)	-0.236 (0.075)	-0.517 (0.190)	0.010 (0.105)
Cassava price	0.365 (0.101)	-0.089 (0.089)	0.542[b] (0.346)	0.024[b] (0.113)	0.123 (0.093)	0.483 (0.135)	-0.374 (0.134)
Months from harvest	-0.106 (0.011)	0.034 (0.008)	-0.126 (0.022)	-0.065 (0.009)	-0.083 (0.009)	-0.109 (0.011)	-0.106 (0.011)
Land x months from harvest[a]	0.075 (0.103)	0.124 (0.059)	0.978 (0.289)	0.047 (0.047)	0.045 (0.040)	0.919 (0.282)	0.658 (0.328)
N	2,932	2,595	438	2,810	2,380	1,806	2,264

Source: Estimated from GLSS (1987-1988).

[a] x 10^{-3}.

[b] Cross-price with maize.

Note: Asymptotic standard errors are in parentheses.

Table 19 —Ghana: Quasifixed Effects Results Conditional on Purchase

	Log of Own Price	Log of Cassava Price	Inverse Mills Ratio
Maize			
Parameter estimate	0.267	-0.944	-2.104
Standard error	0.110	0.119	0.148
Rice			
Parameter estimate	-2.110	0.464	1.813
Standard error	0.183	0.090	0.048
Millet and sorghum			
Parameter estimate	1.878	-0.701[a]	-0.400
Standard error	1.607	1.032	0.672
Cassava			
Parameter estimate	-0.527	-0.221[a]	-0.948
Standard error	0.144	0.117	0.132
Yams			
Parameter estimate	-0.101	-0.072	0.894
Standard error	0.086	0.113	0.047
Cocoyam			
Parameter estimate	-2.042	-0.569	0.994
Standard error	0.326	0.214	0.096
Plantain			
Parameter estimate	-0.205	-0.518	0.213
Standard error	0.096	0.125	0.107

Source: Estimated from GLSS (1987-1988).

[a] Cross-price with maize.

Price parameters vary somewhat in the equations indicating *intensification* (conditional demand), depending upon whether the equations include dummy variables for agroecological zones. Clearly, long-run prices should reflect the resource base as well as differ according to where one lives along the marketing chain — that is, whether one lives in an urban or rural locale. The zone and urban dummy variables, then, are relatively collinear with prices. Indeed, price parameters were rarely significant in models that included dummy variables for all regions, in part because they dominated the equations used to smooth prices. Unless there is a plausible reason to assume that demand differs over ecological zones — other than that which is mediated by the long-run price — the more parsimonious model should give a better indication of the price response.

Table 20 reports expenditure and own-price elasticities tabulated from the regression results. Cross-price elasticities of all commodities with maize, rice, and cassava are also included. The expenditure elasticities are generally lower than those reported in Alderman (1992) even though the data source is the same.[33] Most noteworthy, the maize elasticity is much lower in the current study. If, however, additional dummy variables are included in the maize equations — a technique which approaches the cluster fixed effects used in the earlier paper — the expenditure elasticity for maize increases. The millet elasticity also changes quite substantially, although for those households that do consume the commodity, the conditional amount is not income responsive.

The magnitude of the long-run price elasticities is comparatively large. This is not likely an artifact of the two-step estimation technique; OLS estimates of the maize own-price elasticity, for example, are even larger in absolute value. Under the interpretation that these are long-run elasticities, the results indicate that much of the regional diversity in local diets is directly attributable to price differences, including urban-rural differences. The magnitude of these results also implies that the Ghanaian diet is malleable, at least in the long run.

This is also indicated with the cross-price responses of various commodities with cassava price. Many of these are positive. While the magnitudes are high, they are consistent with the large, own-price elasticity for cassava. The response of cassava to maize price is, however, not only unexpected as it indicates complementarity, it is not consistent with the positive cross response of maize with cassava.

To a degree, the estimates of short-run price response are hindered by limited price variance. Maize consumption is virtually unresponsive to price changes in the short run. While there is an apparently positive elasticity for maize in Table 20, it is small and not robust; other specifications lead to an

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33 There are some small differences in the predicted expenditures as well as a regrouping of the root crop variables. In Alderman (1992), fufu expenditures were assigned to cassava, yams, and plantains in a 50:25:25 distribution. These estimates, on the other hand, assign fufu exclusively to cassava. These changes all have very small impacts at the mean.

Table 20 —Ghana: Estimated Elasticities of Demand

	Long-Run					Short-Run		
Crop	**Per Capita Expenditures**	**Own Price**	**Maize Price**	**Cassava Price**	**Rice Price**	**Own Price**	**Maize Price**	**Cassava Price**
Maize	0.183	-1.533	—	0.411	0.747	0.092	—	-0.661
Maize (OLS)	0.423	-1.924	—	-0.617	-1.084	—	—	—
Rice	1.031	0.861	0.531	0.689	—	-1.750	—	0.224
Millet	-0.194	-0.526	0.808	0.957	2.871	0.397	—	-0.002
Cassava	0.696	-1.709	-0.144	—	-1.292	—	-0.145	-0.163
Yams	0.878	-0.969	-1.621	0.684	-1.753	-0.338	—	0.102
Cocoyams	0.265	-1.153	-1.358	-0.395	-3.964	-1.909	—	0.076
Plantain	0.640	-0.248	-0.161	-1.158	-4.811	-0.163	—	-0.716

Source: Estimated from GLSS (1987-1988).

equally small negative elasticity. Other commodities indicate greater response to short-run price changes. Since these regressions are based on differences in average and current consumption regressed on the differences in prices for that region, they do not represent inter-regional patterns or other determinants of demand not subject to policy interventions. They do, however, indicate households' reaction to unanticipated price shocks.

DEMAND ESTIMATE USING THE ALMOST IDEAL DEMAND SYSTEM

A number of the parameters in Table 20 are either larger in absolute value than expected or have unanticipated signs. Therefore, it is useful to offer an alternative approach using a more conventional demand system. One that has proven flexible and adaptable to cross-sectional data without counterintuitive assumptions is the Almost Ideal Demand System (AIDS) introduced by Deaton and Muellbauer (1980). While the AIDS model is nonlinear in its parameters, a simplified linear form has been used with success in empirical applications.

An additional difficulty in using a systems approach to estimate demand relations with microdata is the problem of zero consumption values. Adapting the well-known single equation methods of correcting for sample censoring mentioned in the previ ous section, to simultaneous systems of equations is theoretically nontrivial. Lee's (1978) extension of the Amemiya generalized two-step estimator to simultaneous-equation models with censored endogenous variables is perhaps the easiest to implement, as it is analogous to Heckman's two-step method.[34] That is, it uses probit regressions to estimate the probability of consuming each commodity, and uses a transformation of the estimated probability to correct for the binding non-negativity constraints in the demand system. Heien and Wessels (1990) provide an empirical application of Lee's method using U.S. household consumption data.

The demand equations in the AIDS model with censored dependent variables are:

$$w_i = \alpha_i + \sum_{i=1}^{n} \gamma_{ij} \, lnP_j + \beta ln \left[\frac{X}{\Pi}\right] + \delta M_i \qquad (2)$$

where w_i is the budget share of the ith commodity, P_j is the price of the *jth* commodity, X is total expenditure, and M_i the inverse Mills ratio from the probit equation estimating the probability of having nonzero consumption of the *ith* commodity. The variable Π is a price index. While in the nonlinear version of the AIDS model, Π is iteratively solved from the estimated parameters of the

[34] Nelson and Olson (1978), Wales and Woodland (1983), Deaton and Irish (1984), and Lee and Pitt (1986) have also written on this topic.

system, in the linear approximation of the AIDS demand system the price index is taken to be the share-weighted sum of the logarithms of market prices:

$$\ln \Pi = \Sigma w_i \ln P_i. \tag{3}$$

The parameters to be estimated are denoted by α, γ, β, and δ. In principal one can impose both homogeneity and Slutsky symmetry by the judicious placement of linear restrictions on the parameters of the system. The GLSS data, however, contain limited information on nonfood prices. Consequently, it is necessary to omit the prices of nonfood items and assume homogeneity without either testing or formally imposing the condition. This reduces the efficiency of estimation relative to a full information system, and introduces an unknown bias proportional to the correlation of nonfood and food prices. Symmetry, however, can be imposed using cross-equation restrictions. We include six commodity groups in the system: maize, rice, millet and sorghum, cassava, other roots and tubers, and all other foods. Nonfoods are implicitly included as well using the adding-up property of budgets and homogeneity. This grouping, however, is dropped from the estimation; given the other six equations, plus expenditures, the seventh equation is redundant, and including it would render the covariance matrix of the disturbances singular.

Clearly the use of a theoretically consistent demand system provides an advantage over the previous approach; for example, by allowing the imposition of symmetry. On the other hand, it does not easily allow one to distinguish long-run from short-run parameters. As mentioned, however, the main reason for introducing this alternative is to indicate the robustness of previously reported results. As can be noted in Table 21, compensated own-price parameters derived from the AIDS system are comparatively large in absolute value. This is consistent with the long-run estimates indicated in Table 20. There are, however, a few unexpected cross-price terms, including the complementary relationship between maize, and millet and sorghum implied by the negative cross-price elasticities. Similarly, cassava and maize appear to be complements in this data set. The response here may be considered to be a long-run response, and hence a reflection of regional ecological patterns.

As indicated in Appendix Tables 1 through 3, the results are not particularly sensitive to alternative assumptions. Removal of the correction for zero consumption, for example, does not change the results appreciably (Appendix Table 1). Although not illustrated, the results also do not change qualitatively if symmetry restrictions are not imposed. The inclusion of quarterly dummy variables (Appendix Table 2) reduces the maize price responsiveness, but does not change the relationship of millet and sorghum or of cassava. Similarly, disaggregation of the data does not change the apparent complementarity. For example, Appendix Table 3 indicates the results for the savannah subsample.

Table 21 —Ghana: Income and Price Elasticities of Demand for Food Using a Complete Demand System, National Estimates

				Compensated Price Elasticities with Respect to the Price					
Commodity	Proportion of Households Using	Budget Share	Expenditure Elasticity	Maize	Rice	Millet and Sorghum	Cassava	Other Roots and Tubers	All Other Foods
Maize[a]	0.944	0.087	0.347	-0.981	0.108	-0.446	-0.573	0.109	0.502
Rice	0.592	0.024	0.821	0.384	-1.144	0.297	0.292	-0.036	-1.375
Millet and sorghum	0.126	0.029	0.218	-1.345	0.252	-0.731	0.411	1.444	2.205
Cassava[b]	0.908	0.087	0.650	-0.572	0.082	0.136	-1.512	0.311	0.678
Other roots and tubers[c]	0.879	0.086	0.847	0.110	-0.010	0.483	0.316	-1.377	-0.220
All other foods[d]	0.999	0.343	1.161	0.127	-0.098	0.185	0.172	-0.055	-0.981

Source: Estimated from GLSS (1987-1988).

[a] Includes maize cob, grain, dough or flour, kenkey, banku, akpler, and tuo zaafi.

[b] Includes raw cassava, gari, fufu, tapioca, dough, and other processed forms.

[c] Includes yam, cocoyam, plantain, and banana.

[d] Includes fruit, vegetables, meat, fish, poultry, dairy products, egg, oils, fats, sugar, groundnuts, and all other foods.

Notes: Elasticities derived from a seven-equation linear AIDS demand system, the seventh equation of which (nonfoods) was dropped for purposes of estimation. Slutsky symmetry and adding-up properties were imposed. In light of the degree of disaggregation of the model, and hence the high proportion of zero consumption values for most commodities, corrections were made for binding non-negativity constraints in all but the last equation.

5. CONCLUSIONS

The conclusions of this study fall into two broad categories: those pertaining to food consumption patterns in Ghana and those pertaining to field and data collection methodology. Regarding the former, a few generalizations can be made on price response although the estimates are hindered by limited systematic price variance within any agroecological zone.

Despite extensive substitution between commodities, calorie availability at the household level responds to grain prices. This is particularly true in the savannah zone where prices of millet and sorghum as well as maize are important. Elsewhere as well the net impact of a maize price increase is a decline in household calories, but at a smaller rate.

Increases in cassava prices are most likely to lead to reductions of calories available in the forest regions. Note that the price of calories from cassava is not only nearly always lower than grains but is also less seasonal, in keeping with its year-round availability. While there is little likelihood that the government can directly influence the price of cassava through market stabilization or price subsidies, programs that reduce the cost of transport, or the amount of spoilage, will have a significant effect on the calorie availability at the household level. Similarly, improvements in cassava production or — to be less optimistic — increases in pest infestations will have a comparatively large effect on food energy availability. Such results can contribute to the establishment of agricultural research priorities in a manner similar to the estimates of the net-price and cross-price effects on nutrition suggested by Pinstrup-Andersen, Londono, and Hoover (1976).

A number of cases indicate that a price increase will lead to an increase of calorie availability. This is the case with rice and with yams in the savannah. These foods are relatively expensive sources of food energy (Table 8). Hence, when these prices increase, households substitute into cheaper calorie sources. It is plausible that this may lead to a net increase of calories.[35]

The comparatively large net effects of food prices on energy availability are somewhat surprising in light of the diverse Ghanaian diet and the price effects documented in the food demand studies above. Diversity of diet means

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35 It should be noted that since large numbers of rural savannah households are producers and storers of one or more of these commodities, such price responses may reflect short-run wealth effects via the impact of price changes on stored produce, in addition to substitution effects. Renkow (1990) presents similar results for some semiarid regions of India.

that households have the option of substituting between commodities as their relative costs shift. The fact that Ghanaian consumers take advantage of this is confirmed by the price elasticities from the long-run and short-run demand regressions (reported in Table 20) as well as those derived from the Almost Ideal Demand System (Table 21). These regressions indicate that households in Ghana are very responsive to prices.

It is noteworthy that the rankings of the costs of calories by crop vary over time as well as over regions. It is also noteworthy that households appear to be very reliant on food purchases, even households that produce food crops. Other facets of the data also point to more efficient marketing and storage networks than is often assumed. For example, bulky root crops provide a substantial portion of energy even for urban (and middle income) households. This not only indicates preferences that depart from stylized dietary shifts in other regions of the world, but also implies that the volume of food moving into the marketplace is substantial.

Postharvest crop losses as reported by households in the GLSS sample are roughly 5 percent of harvests and, therefore, around 10 percent of on-farm storage. This result is extremely close to that obtained from two other regional surveys in 1989 and 1990 (Alderman and Shively 1991). Differences between the household's own assessment of such losses and that of national and international agencies likely account for much of the difference between calorie availability estimates derived from the household survey and those reported elsewhere. While the GLSS results imply high and skewed food intakes, food balances sheets indicate that food availability in Ghana is among the lowest in the world. If the latter is true, then measures to increase aggregate supply might be necessary especially if — contrary to current evidence — the low supply is putting upward pressure on prices. On the other hand, if the GLSS results can be verified — the range of reported intakes is such that one cannot be completely confident — food security is more transparently an issue of purchasing power and resource control.

The equations that predict household or per capita expenditures as a function of assets and household composition show that households that are headed by women have lower expenditures than other households with similar assets. Moreover, the calorie regressions also indicate that these households do not allocate more resources to food — contrary to prevailing evidence in other countries. It is noteworthy, however, that this result is mainly due to expenditure patterns in the savannah, a region where a high proportion of households are headed by women, and where nutrition levels as measured by anthropometrics are also low relative to those predicted by expenditure levels.

Turning to methodological issues, the failure to include quantities in a survey of a rural-based economy creates a number of difficulties, including some that go beyond the special concerns of food policy. As mentioned previously, due to the omission of information on the rate of stock utilization between the first and second interviews, one has to assume a rate of stock drawdown rather than analyze whether, and to what degree, the rate depends on price. Only with such assumptions can one relate the purchase data to price information. Moreover, as food purchase and consumption data are reported only in value terms, there is a poor mapping to quantities; since the respondent does not indicate which month's price is used to estimate annual expenditures, any attempt to derive quantities by dividing one by the other compounds any other sources of error. Furthermore, it is likely that households give more accurate responses using a shorter period for stock recall (Scott and Amenuvegbe 1990). Such marginal recall of both purchases and drawdowns would also provide an opportunity for the interviewer to flag misunderstandings regarding the answers to the annual recall and, hence, obtain more accurate information on total farm profits as well as of food consumption.

Similarly, respondent error might be reduced if the recall period is fixed. It may be unnecessary to ask the respondent how often a purchase is made of a food consumed if the recall covers a fixed — and brief — gap between interviews, and the respondent is notified on the first visit that he or she will be asked about subsequent purchases at the next interview. This would then reduce the apparent tendency to confuse the amount of food used in a given period with the amount used *each time it is eaten* (purchased) in that period. Moreover, when consumption is reported in quantities, an alert interviewer is more likely to note an inconsistency and to verify the respondent's understanding. This might reduce, for example, the chance that the recall includes foods used for home enterprises or for ceremonies and social obligations outside the household.

For those households who do not purchase an item, greater accuracy might also be obtained if home consumption is reported in quantity terms. This would be consistent with the manner in which data is collected in regards to market surplus and seed utilization. Producer households often are unfamiliar with measurements of the value of their production or the area they cultivated, but they generally know the volume they harvested.

It would also be useful to collect prices along with quantities of purchased goods — at least for the main items in the Ghanaian budget. From the perspective of food policy analysis, this would allow direct testing of differences of prices by household characteristics or by volume purchased. Moreover, given the apparent frequency of purchases reported in the survey even by producers, this means collecting price information would provide more observations — and possibly more accuracy — than the three per cluster obtained in the market price survey.

As mentioned above, while expenditures as reported in the survey are broadly useful for welfare analysis, there are indications that estimates of the money metric of household welfare (income or expenditures) may be systematically biased due to inaccuracies in the food consumption data. To a degree, analysis of the first year's GLSS data points to inconsistencies in other data available for Ghana. For example, the data indicate the range of uncertainty on such basic information as total national food production and the likely level of consumption under scenarios of income growth. Over rounds, these uncertainties are likely to be narrowed, but it remains important that individuals responsible for data collection remain in close contact with those involved in analysis in order to fully realize the potential of the GLSS ongoing data collection.

There is also some uncertainty regarding household definition. While the implications of errors in household listing on incomes and consumption is generic, the problem is worse if there is a systematic error due to an inappropriate working definition of households as economic and consumption units. The number of one- and two-family households in the GLSS data is surprising and needs verification.

Finally, the study reinforces the view that it is possible to use cross-sectional surveys to derive information on price response. Moreover, there is evidence that short-run as well as long-run prices can be derived with such information. While the approach differs from fixed effects estimates in general, they provide similar information using a more commonly available source of data.

Appendix Table 1 — Ghana: Income and Price Elasticities of Demand of Food, National Estimates (Without Correction for Binding Non-Negativity Constraints)

Commodity	Proportion of Households Consuming	Budget Share	Expenditure Elasticity	Compensated Price Elasticity with Respect to the Price: Maize	Rice	Millet, Sorghum	Cassava	Other Roots and Tubers	All Other Foods
Maize[a]	0.944	0.087	0.425	-1.128	0.120	-0.514	-0.553	0.093	0.661
Rice	0.592	0.024	0.877	0.425	-1.317	0.304	0.465	0.036	-1.733
Millet and sorghum	0.126	0.029	0.203	-1.549	0.258	-0.587	0.330	1.448	2.337
Cassava[b]	0.908	0.087	0.703	-0.552	0.130	0.109	-1.487	0.333	0.594
Other roots and tubers[c]	0.879	0.086	0.996	0.093	0.010	0.485	0.337	-1.537	-0.2[illegible]9
All other foods[d]	0.999	0.343	1.159	0.167	-0.123	0.196	0.151	-0.055	0.043

Source: Estimated from GLSS (1987-1988).

[a] Includes maize cob, grain, flour, dough, kenkey, banku, akpler, and tuo zaafi.

[b] Includes raw cassava, gari, fufu, tapioca, dough, and other processed forms.

[c] Includes yams, cocoyams, plantains, and bananas.

[d] Includes vegetables, fruits, meats, fish, poultry, dairy products, eggs, oils, fats, sugar, bread, groundnuts, and all other foods and beverages.

Notes: Derived from a seven-equation linearized AIDS demand system, the seventh equation (nonfoods) being dropped for estimation purposes. Slutsky symmetry and adding-up properties imposed. Corrections performed for binding non-negativity constraints in all but the last equation.

Appendix Table 2 —Ghana: Income and Price Elasticities of Demand of Food, National Estimates (with Quarterly Dummies)

Commodity	Proportion of Households Consuming	Budget Share	Expenditure Elasticity	Compensated Price Elasticity with Respect to the Price: Maize	Rice	Millet, Sorghum	Cassava	Other Roots and Tubers	All Other Foods
Maize[a]	0.944	0.087	0.364	-0.517	0.139	-0.566	-0.636	-0.367	0.141
Rice	0.592	0.024	0.832	0.496	-1.133	0.183	0.304	0.226	-1.392
Millet and sorghum	0.126	0.029	0.181	-1.706	0.156	-0.746	0.526	2.115	1.996
Cassava[b]	0.908	0.087	0.631	-0.634	0.085	0.174	-1.555	0.214	0.582
Other roots and tubers[c]	0.879	0.086	0.835	-0.370	0.064	0.708	0.216	-1.500	-0.423
All other foods[d]	0.999	0.343	1.149	0.036	-0.099	0.167	0.148	-0.106	-1.019

Source: Estimated from GLSS (1987-1988).

[a] Includes maize cob, grain, flour, dough, kenkey, banku, akpler, and tuo zaafi.

[b] Includes raw cassava, gari, fufu, tapioca, dough, and other processed forms.

[c] Includes yams, cocoyams, plantains, and bananas.

[d] Includes vegetables, fruits, meats, fish, poultry, dairy products, eggs, oils, fats, sugar, bread, groundnuts, and all other foods and beverages.

Notes: Derived from a seven-equation linearized AIDS demand system, the seventh equation (nonfoods) being dropped for estimation purposes. Slutsky symmetry and adding-up properties imposed. Corrections performed for binding non-negativity constraints in all but the last equation.

Appendix Table 3 —Ghana: Income and Price Elasticities of Demand of Food, Rural Savannah Zone

Commodity	Proportion of Households Consuming	Budget Share	Expenditure Elasticity	Compensated Price Elasticity with Respect to the Price					
				Maize	Rice	Millet, Sorghum	Cassava	Other Roots and Tubers	All Other Foods
Maize[a]	0.866	0.113	1.162	-1.045	0.135	-0.331	-0.438	0.313	0.085
Rice	0.597	0.027	1.442	0.557	-0.067	0.899	0.302	-0.197	-1.960
Millet ard sorghum	0.830	0.217	0.247	-0.173	0.113	-1.697	-0.181	0.440	0.370
Cassava[b]	0.589	0.044	0.981	-1.132	0.189	-0.899	-2.487	0.836	2.978
Other roots and tubers[c]	0.729	0.067	1.019	0.533	-0.081	1.436	0.550	-3.229	0.489
All other foods[d]	1.000	0.259	1.392	0.037	-0.207	0.310	0.504	0.126	-1.757

Source: Estimated from GLSS (1987-1988).

[a] Includes maize cob, grain, flour, dough, kenkey, banku, akpler, and tuo zaafi.

[b] Includes raw cassava, gari, fufu, tapioca, dough, and other processed forms.

[c] Includes yams, cocoyams, plantains, and bananas.

[d] Includes vegetables, fruits, meats, fish, poultry, dairy products, eggs, oils, fats, sugar, bread, groundnuts, and all other foods and beverages.

Notes: Derived from a seven-equation linearized AIDS demand system, the seventh equation (nonfoods) being dropped for estimation purposes. Slutsky symmetry and adding-up properties imposed. Corrections performed for binding non-negativity constraints in all but the last equation.

Appendix Table 4 —Ghana: Estimates from a National AIDS Food Demand System

Independent Variables	Dependent Variables (Budget Shares) Maize	Rice	Millet, Sorghum	Cassava	Other Roots and Tubers	Other Foods
Intercept	0.6218 (0.0843)	0.1840 (0.0506)	-0.2219 (0.0749)	0.2605 (0.0981)	0.1483 (0.0640)	-0.5786 (0.1939)
Prices						
Maize[a]	0.0016 (0.0113)	0.0094 (0.0046)	-0.0387 (0.0067)	-0.0498 (0.0088)	0.0095 (0.0057)	0.0436 (0.0150)
Rice	—	-0.0035 (0.0045)	0.0073 (0.0038)	0.0071 (0.0060)	-0.0009 (0.0029)	-0.0336 (0.0101)
Millet and sorghum	—	—	0.0077 (0.0079)	0.0118 (0.0074)	0.0416 (0.0047)	0.0635 (0.0122)
Cassava[b]	—	—	—	-0.0452 (0.0163)	0.0271 (0.0056)	0.0590 (0.0230)
Other roots and tubers[c]	—	—	—	—	-0.0325 (0.0060)	-0.0189 (0.0094)
Other foods[d]	—	—	—	—	—	0.0064 (0.0450)
Expenditures	-0.0567 (0.0047)	-0.0044 (0.0021)	-0.0225 (0.0040)	-0.0305 (0.0044)	-0.0132 (0.0048)	0.0553 (0.0074)
Household size	0.0074 (0.0007)	0.0001 (0.0003)	0.0031 (0.0006)	0.0049 (0.0007)	0.0032 (0.0007)	-0.0135 (0.0011)

(continued)

Appendix Table 4 (continued)

Independent Variables	Maize	Rice	Millet & Sorghum	Cassava	Other Roots and Tubors	Other Foods
	Dependent Variables (Budget Shares)					
Location						
Urban	-0.0013 (0.0041)	0.0071 (0.0019)	-0.0271 (0.0036)	-0.0256 (0.0041)	-0.0156 (0.0041)	-0.0081 (0.0068)
Semiurban	-0.0065 (0.0041)	0.0024 (0.0019)	-0.0084 (0.0037)	-0.0094 (0.0039)	0.0012 (0.0041)	0.0090 (0.0066)
Coast	0.0407 (0.0036)	-0.0029 (0.0016)	-0.0016 (0.0031)	0.0191 (0.0033)	-0.0684 (0.0038)	-0.0019 (0.0057)
Accra	0.0089 (0.0057)	-0.0035 (0.0026)	0.0077 (0.0050)	-0.0375 (0.0054)	0.0002 (0.0058)	-0.0260 (0.0092)
Kumasi	0.0480 (0.0083)	0.0015 (0.0037)	0.0134 (0.0072)	0.0053 (0.0079)	-0.0407 (0.0083)	-0.0479 (0.0132)
Savannah	0.0321 (0.0069)	0.0103 (0.0033)	0.1945 (0.0060)	-0.0441 (0.0077)	-0.0543 (0.0061)	-0.0656 (0.0115)
Inverse mills ratio	-0.0487 (0.0034)	-0.0467 (0.0027)	-0.0235 (0.0037)	-0.0440 (0.0036)	-0.0504 (0.0035)	—
Mean dependent variable	0.0868	0.0244	0.0288	0.0871	0.0861	0.3434

Source: Estimated from GLSS (1987-1988).

[a] Includes maize cob, grain, dough or flour, kenkey, banku, akpler, and tuo zaafi.

[b] Includes raw cassava, gari, fufu, tapioca, dough, and other processed forms.

[c] Includes yam, cocoyam, plantain, and banana.

[d] Includes fruit, vegetables, meat, fish, poultry, dairy products, egg, oils, fats, sugar, groundnuts, and all other foods.

Notes: Standard errors in parentheses. System weighted R^2 = 0.2758.

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