Working Paper

MODELS OF EXPENDITURE SYSTEMS FOR KENYA

C. Williamson
M.M. Shah

June 1981
WP-81-71

International Institute for Applied Systems Analysis
A-2361 Laxenburg, Austria

MODELS OF EXPENDITURE SYSTEMS FOR KENYA

C. Williamson
M.M. Shah

June 1981
WP-81-71

INTERNATIONAL INSTITUTE FOR APPLIED SYSTEMS ANLALYSIS
A-2361 Laxenburg, Austria

PREFACE

Understanding the nature and dimensions of the world food problem and the policies available to alleviate it has been the focal point of the IIASA Food and Agriculture Program since it began in 1977.

National food systems are highly interdependent, and yet the major policy options exist at the national level. Therefore, to explore these options, it is necessary both to develop policy models for national economies and to link them together by trade and capital transfers. For greater realism the models in this scheme are being kept descriptive, rather than normative. In the end it is proposed to link models to twenty countries, which together account for nearly 80 per cent of such important agricultural attributes as area, production, population, exports, and imports.

A model for Kenya is being developed at IIASA. This model will provide a prototype for African developing countries with growing populations and emerging development problems.

The present report by Williamson and Shah describes the analysis and modelling of expenditure systems for Kenya. For the evaluation of alternative agricultural policies, one needs a demand system that reflects the expenditure and consumption patterns in the country. In the context of Kenya the rural-urban dimension as well as the respective income distributions have to be explicitly considered. The study is the second in a set of studies which analyze the food consumption system in Kenya.

Kirit S. Parikh
Acting Program Leader
Food and Agriculture Program

ACKNOWLEDGEMENTS

Many people have contributed to this study, and in particular we wish to acknowledge the extensive cooperation of the Central Bureau of Statistics, Nairobi, Kenya and the FAO/UNDP/Kenya Food and Marketing Project, Ministry of Agriculture, Nairobi. We have also benefitted from numerous discussions and insights from members of FAO's Commodity and Trade Division and IIASA's Food and Agriculture Program. The contributions of the following require particular acknowledgement.

Within Kenya

Central Bureau of Statistics

Mr. P. Singh (Director)
Mr. J. Kekovole (Senior Economist)
Members of the Household Budget Survey team, CBS

Within FAO

Dr. M. De Nigris (Commodity and Trade Division)
Dr. J. Hrabovszky (Agriculture Department)

Within IIASA

Mr. G. Fischer
Dr. M. Keyzer
Ms. B. Lopuch
Prof. K. Parikh
Prof. F. Rabar
Ms. U. Sicnra

Finally, we appreciate the patience of Mrs. C. Enzlberger in turning the illegible into the readable.

Needless to say, the errors and shortcomings are ours.

CONTENTS

1. INTRODUCTION

PATTERNS OF CONSUMER FOOD DEMAND IN KENYA

Structures of relative prices in an economy such as Kenya's result largely from the interaction of forces of supply and demand. Patterns of demand depend generally on the incomes and taste preferences of consumers and on the structure of relative prices in the marketplace. Models of consumer behaviour seek to estimate the effects of changes in these and other independent variables on consumption patterns. The purposes of this paper are:

(1) to analyze patterns of food consumption in Kenya and how these patterns are changing over time;

(2) to discuss certain policy relevant consumption parameters, including income and price elasticities, individually estimated for Kenya; and

(3) to suggest how these parameters might be used as part of a complete demand system to fit into the general equilibrium model of Kenya being built at IIASA.

Because of the very different consumption patterns of and data sources for urban and rural Kenya, all sections of the analysis are divided between the two populations; when possible, the populations are disaggregated still further to isolate regional or income class effects.

1.1. Expenditure Patterns: Urban Kenya

1.1.1. Data Sources

Four cross section expenditure surveys conducted over the past twenty years in urban areas of Kenya were used for the analysis of urban food consumption patterns. These include the Nairobi "African Middle Income Workers Survey" of 1963, the "Urban Household Budget Survey" of 1968-69 for Nairobi and Mombasa, the 1974 "Urban Household Budget Survey" for Nairobi, and the 1977 "Urban Food Purchasing Survey" for Nairobi, Mombasa, Kisumu and Nakuru. Data for Nairobi was used because of the availability of reliable price data for that city, taken primarily from the annual Statistical Abstract. Price data for Mombasa was not available, and the other smaller towns were excluded on the hypothesis that their access to rural markets causes their consumption

behaviour to fit more of a rural pattern.*

Expenditure data from the four surveys cited above is divided between seven, nine, eight and four income classes respectively. Although all four surveys provide interesting information regarding the distribution of expenditure among various food and nonfood commodities, only the first three were used for the estimation of food consumption parameters (discussed in part II below) because of the high level of aggregation of the food commodities in the 1977 survey.

1.1.2. Commodity Classification

Patterns of expenditure were analyzed for eighteen food and one non-food commodity. Such a high level of disaggregation allows a close look at trade-offs between food substitutes and is a useful tool for analysis of specific commodity policies. The commodity breakdown is generally in line with that suggested by the Food and Agriculture Program at IIASA, although staple foods are disaggregated further because of their importance in the average diet of countries such as Kenya.

1.1.3. Budget Shares

Table 1 shows the average budget shares for the nineteen commodities for each of the four surveys.† Averages across income classes are unweighted by the number of sample observations in each class because of the different patterns of skewness in the four sample populations, some surveys being more heavily weighted towards upper income brackets than others.

Shown at the bottom of Table 1 are the unweighted average total per capita (per month) expenditure for each survey and, for comparison, the 1963 average total expenditure, KSh. 142 per capita, expressed in current 1969, 1974, and 1977 Kenyan Shillings. The latter figures indicate that the mean expenditure levels of the four surveys are close in real terms, Table 2 and 3 expand on Table 1 by showing separately the time series of average budget shares for low and upper-middle income classes. Again, the division between classes has been chosen to reflect as closely as possible a constant real level of expenditure through the four years surveyed.§

The general pattern of expenditure confirms Engel's law that share spent on food declines with income. For lower income groups the food share is about 45%

---

* There are minor differences in expenditure patterns between urban areas. Nuts and fish are more common purchases in Mombasa, and bread is more popular in Mombasa than elsewhere. Cereals meat and milk are the most commonly purchased items everywhere. For more details on expenditure patterns in Mombasa, Nakuru, and Kisumu, see the report Urban Food Purchasing Survey, 1977, Part I, and M.M.Shah, "Food Demand Projections Incorporating Urbanization and Income Distribution: Kenya 1975-2000", FAO-UNDP-KENYA Food Marketing Project, Nairobi, 1979

† These shares were calculated by first determining the average share breakdown for each income class and by then averaging these mean shares going to any one commodity across the various income classes in each survey. Thus they reflect the breakdown of the average family's budget, not necessarily the breakdown of total expenditure in Nairobi. The latter calculation is not possible without exact data on income distribution in Nairobi for each survey year. Roots are not included in the urban analysis due to inconsistencies in the data. They are relatively unimportant in the urban diet, accounting for about 1% of urban expenditure over the period covered by the four surveys, with approximately constant expenditure across income classes in any year.

§ The lowest income class includes households with current annual per capita income level in 1968/9, 1974, and 1977 of from KSh 0 to KSh 1565, KSh 1765, and KSh 2880, respectively. The analogoos figures for the upper-middle income class are KSh 1058 - 3064, KSh 1600 - KSh 4918, KSh 1567-KSh 5263, and KSh 2772-KSh 4950 for 1963, 1968/9, and 1977 respectively.

of total expenditure, while for upper middle classes it falls to about 30%. All groups spend a large share on cereals, with this category accounting for about 25% of food expenditure on average, ranging from 23% for the upper income group to 29% for the lower income group. Maize is the primary staple, particularly among poorer families where it accounts for two-thirds of all expenditure on cereals.

The urban cereals diet is more diversified than in many developing countries, however, with wheat having a substantial role, particularly at the higher income levels. The share of cereal expenditure going to wheat bread or flour averages about 25% for poorer groups and 40% for middle income groups, rising to as high as 60% for the highest income families. The share of cereal expenditure allocated to wheat has been increasing through time only for upper income groups and seems to have declined for lower income families since 1968.

Unlike urban populations in developing countries, Kenyans spend a large amount on animal protein sources, with all groups spending about 33% of their food budget on meat, eggs and dairy products together. Expenditure on beef is particularly high, amounting to 15% to 20% of the food budget of all groups and about 8% of total expenditure of low income urban dwellers. Milk is also consumed by all groups as are vegetables, legumes, sugar products, and fats and oils.

The only food budget shares skewed heavily toward higher income groups are those of alcoholic beverages, tobacco and fruits. Those skewed toward lower income groups, and thus particularly well suited for as tools for nutrition policy, are maize and to a lesser extent dairy products, legumes and wheat bread.

1.2. Rural Kenya

1.2.1. Data Sources

The Integrated Rural Survey 1974-75 (IRS 1) was used for analysis of rural consumption patterns. In the present study the household income group data is analyzed.* The survey covers smallholder households† in most areas of the country. Budget shares were taken primarily from the survey report,§ although raw data, broken down simultaneously by income class and province, was used in estimating consumption parameters. Price data by province was obtained primarily from the Ministry of Agriculture.**

1.2.2. Commodity Classification

The commodities included in the budget breakdown reflect those used in the final survey report. Raw data for parameter estimation, however, was available for eight food and two non-food commodities only. Data for four of the food commodities--grains, meat, dairy products and fruits and vegetables--was divided between purchased and home produced products, both valued at market price. Although this breakdown was the most disaggregated possible from the raw data at hand, it also reflects the less-varied diet of rural areas as compared with urban areas in Kenya. Most grain eaten is maize and most meat is either

*The consumption patterns and analysis by per capita income groups is given in Shah (1979).

† A smallholding is defined as < 20 hectares. There are nearly 1.5 million smallholdings, mean size of holding 2.33 ha. and about 10% of the holdings are above 5 ha. in size.

§ Central Bureau of Statistics Integrated Rural Survey 1974-75 Basic Report, March 1977.

** An idea of the relative prices between provinces of maize, beans, roots and vegetables was obtained by comparing spot market checks of various market prices throughout the country begun in 1977 by the Ministry of Agriculture and reported in its publication "Yields, Costs, Prices, 1979".

beef or goat.

1.2.3. Budget Shares

Table 4 shows the breakdown by income class of total cash expenditure between food, clothing, and other non-food categories. Table 5 shows the analogous breakdown of total consumption, i.e., cash plus home-produced items. Although Engels law--that food expenditure shares decline with rising incomes--seems to hold when considering only purchased items, if home production is included, shares of total consumption going to food remain above 70% for all income groups and decline only slightly with rising income levels.* Since lower income groups by definition produce less,† they must purchase a higher percentage of what they eat. The share of food purchased to total food consumption decreases from 63.2% for the lowest income group to 38.5% for the highest income group. On the average smallholders purchase 50% of total food consumption.

Some of the increasing food expenditure for particular commodities that occurs at higher income levels may reflect increases in quality rather than supply in quantity. A commodity-wise breakdown of food con- sumption by income class indicates, however, that the quality change is not the controlling one in this case.

Tables 6 and 7 show the shares of total food consumption going to various bought and own produced commodities, Table 6 showing the shares by province and Table 7 by income class. Table 8 summarizes the data by income class to show the distribution of total food consumption by broad categories of food.

The food consumption patterns are very different than those of urban areas, and strong regional differences are noticable as well. Overall the budget share going to staples--grains and root crops--is very high (almost 50%) and is not falling with income, although the home produced portion is rising with income relative to the purchased portion. The rural diet is heavily dependent on maize, the urban taste for wheat not having penetrated the rural areas. Roots are more widely eaten than in urban areas, particularly in western Kenya. Further diversification of the staple crop would help to reduce the nutritional risk associated with shortfalls in maize production.

The budget shares going to beans and to dairy products rise with income, but the shares going to meat and to fruits and vegetables, typically considered luxuries, fall with income for rural Kenya as a whole.

Overall, the food budget share going to animal protein sources (27%) is lower than the corresponding urban figure of 35% but still quite high, particularly for low income groups. Fruit and vegetable expenditure is much lower in rural than in urban areas, with a food budget share in 1974/5 (3.39%) less than one third as large as that of Nairobi (11.08%).

In summary, the rural diet in Kenya is dominated by maize, milk and meat, with fats and oils and fruits and vegetables being relatively unimportant. These aggregate figures mask a set of more complicated provincial patterns, however, as will become more evident when estimated consumption parameters are discussed below.

---

* Some expenditure items, such as educational fees, were omitted from the survey, causing a slight downward bias in the estimates of non-food expenditure shares. There has also been some suggestion that the monetary values placed on home consumption were too high.

† Home consumption of own-produced products was included in the definition of income in the IRS.

2. CONSUMPTION PARAMETERS

2.1. Urban Kenya

2.1.1. Cross Section Analysis: Methods

Policies of income-generation and of retail pricing are two governmental instruments capable of affecting nutritional status. The impact of changing incomes and prices on urban consumption was estimated for urban Kenya, first using only cross section data for separate estimations for each of the three disaggregated urban surveys, 1963, 1968/9, and 1974 and then using all data from the three years together in a cross-section time-series analysis. The cross-section analysis assumed relative prices were constant for all consumers, while price was allowed to vary in the cross-section time-series analysis. For comparision, expenditure elasticities were also estimated for Mombasa using data from the 1968/69 "Urban Household Budget Survey" for Mombasa. All estimations were made on a per capita basis, using household expenditure data divided by average household size, and each data point was weighted by the square root of the number of observations in that particular income class and year to correct for heteroscedasticity bias. Total expenditure rather than income was used as the independent variable because of its smoother, more dependable and more easily interpretable characteristics. Current expenditures and prices in all three years were used for both practical and theoretical reasons.

2.1.2. Cross-section Analysis

Expenditure elasticities were estimated separately for each of the three Nairobi surveys for each of 18 agricultural commodities and one non-agricultural good. Quantity (expenditure divided by price) was used as the dependent variable rather than expenditure because of the more interesting nutritional implications of the parameter estimates. For these estimates one of the following four functional forms of the Engel (consumption-expenditure) curve was chosen:

		Expenditure Elasticity
1. log-log	$\ln q_i = \alpha_i + \beta_i \ln E$	β_i
2. semi-log	$q_i = \alpha_i + \beta_i \ln E$	β_i / q_i
3. inverse	$q_i = \alpha_i + \beta_i / E$	β_i / Eq_i
4. log-log inverse	$\ln q_i = \alpha_i + \beta_i / E + \delta_i \ln E$	$(-\beta_i / E) + \delta_i$

Each form of the Engel curve has different properties, being more applicable to some commodities than others. The log-log form, for example, imposes a constant elasticity across all income classes, a characteristic approximating reality for many non-food expenditures and consumer durables but unlikely to hold in the case of most food commodities, for which satiation levels are quickly reached. The semi-log form performs better for many foodstuffs, since it allows for diminishing elasticities with higher income levels. The inverse form provides for decreasing elasticities and imposes a satiation level; although these properties are desirable, its curvature often fails to provide a good fit to the data. The final form, the log-log inverse allows for a good to pass from a luxury ($\eta>1$) to a necessity ($0<\eta<1$) to an inferior good ($\eta<0$) with rising income, a characteristic that provides a good fit to certain staple foods. It should be emphasized that each functional form of the demand curve makes sense only when used to estimate elasticities within a limited range of income and price levels; the functions should not be extrapolated beyond the range of data employed in their

estimation.

Table 9 shows the best fitting estimates for η* for the 1963, 1968/9, and 1974 Nairobi surveys and for the 1968/9 Mombasa survey. To enable direct comparison all elasticities are evaluated at the mean income level of 1974 for Nairobi, adjusted to current terms for 1963 and 1968.

Certain broad generalizations stand out from the elasticity estimates for 1963 to 1974. Maize, the primary Kenyan staple, is an inferior good at mean income levels in urban areas in all cases. The preference for wheat over maize has been growing over time. The wide differences in the parameter estimates for "other course grains" probably results from the growth of porridge consumption among the well-to-do.

Estimates for meat and dairy are stable and quite low compared to those for many developing countries, reflecting the central role of meat and milk in the Kenyan diet. Elasticities of fruit are quite high, probably reflecting primarily an increase in quality rather than quantity of fruits consumed as incomes rise. Alcoholic beverages and non-food commodities are luxuries as is expected. Aside from these generalizations, however, what stands out is the wide discrepancies between parameters estimated for the various years and for the two large urban areas. With significant parameter estimates, high $\bar{R}^2$ statistics and weighting to correct for heteroscedasticity, it is unlikely that the elasticities fail to reflect the data accurately. It is more likely that a change in relative prices through these years--either caused by supply shifts, taste changes, marketing practices, or changes in the pattern of income distribution and thus of demand--altered patterns of consumer spending.

2.1.3. Cross Section Time Series Analysis.

If changes in relative prices contribute to the discrepancies in expenditure elasticity estimates, unbiased estimates should be attained by regressing quantities consumed by all income classes in all years on both total expenditure and prices (or relative prices) faced by those consumers. The demand function

$$q_i = f(E, P_i, \ldots, P_n) \qquad (1)$$

was fitted to the aggregate data for Nairobi surveys of 1963, 1968, and 1974 (24 data points) in the following forms:

		η	e_{ij}
1. log–log	$\ln q_i = \alpha_i + \beta_i \ln E + \sum_j \gamma_{ij} \ln P_j$	β_i	γ_{ij}
2. semi–log	$q_i = \alpha_i + \beta_i \ln E + \sum_j \gamma_{ij} \ln P_j$	β_i / q_i	γ_{ij} / q_i
3. log–log inverse	$\ln q_i = \alpha_i + \beta_i / E + \delta_i \ln E + \sum_j \gamma_{ij} \ln P_j$	$(-\beta_i / E) + \delta_i$	γ_{ij}

The first form imposes constant expenditure and price elasticities across all income classes, the second forces both to fall with income, and the third imposes constant price responses but allows variation in expenditure elasticities across income classes. A dummy variable for time was included in some equations as a proxy for taste changes, but this tended to introduce problems of multicollinearity since prices varied only between time points. To increase degrees of freedom, cross price parameters were estimated only for products deemed a priori to be substitutes or complements.

* "Fit" was judged from the t-statistics for α^i and β^i, the $\bar{R}^2$ statistics, and the pattern of the residuals.

Prices were derived primarily from the Kenya Statistical Abstracts for the relevant year, with some assistance from other published and unpublished material from the Central Bureau of Statistics, Nairobi. A commodity "bundle" of individual foodstuffs (representative of a bundle consumed by lower income groups) was constructed for each commodity grouping, and the price of this "bundle" was evaluated in each year (see Table 10). Thus, although members of each income group faced different prices for the goods they actually consumed (fruits eaten by higher income groups such as papaya and pineapples being more expensive than those eaten by lower income groups, typically bananas), all were assumed to face the same set of relative market prices. As a result, estimated parameters indicating prices and income effects on quantities consumed actually overestimate pure quantity changes but include instead, particularly in higher income groups, a significant change in quality, also important to nutritional status.

The expenditure elasticities are all of reasonable magnitude and should be representative since the effect of price changes has been removed with the inclusion of price variables. The price elasticities have the right sign and a reasonable magnitude in some cases but not in others. More time series data would no doubt improve the reliability of these parameter estimates; without* more data it is still worthwhile to proceed, however, drawing whatever insights may be possible with the data at hand.

2.1.4. Cross Section Analysis: Results

Results of selected equations are printed in Table 11. They can best be summarized in related groups of commodities.

2.1.5. (a) Staples

Expenditure elasticities are as expected, with bread being a "necessity" with a low mean elasticity that falls with income, wheat flour and rice (a relatively expensive commodity in Kenya) being more sensitive to income, and maize being an inferior good at mean income levels in urban areas. The good fit of the log-log inverse form for maize indicates that at low incomes it is a necessity and at very low incomes a luxury. The high elasticities for "other coarse grains" probably reflects the preference of higher income classes for porridge. The price elasticity estimate for wheat is counterintuitive and indicates that the maize/wheat relative price policy followed through these years did little to counter the rapidly growing taste preferences for wheat bread, particularly among higher income groups.

2.1.6. (b) Animal Protein Sources

Most expenditure and price elasticity estimates for this class of commodities are significant and within the expected range. Expenditure elasticities reflect the widespread consumption (relative to most developing countries) of beef and mutton and goat meat across all income classes and more skewed consumption of poultry/eggs and dairy products. The slightly better fit of the semi-log form in the first two cases indicates that expenditure falls slightly with rising incomes. Fish is not widely consumed in Nairobi but its consumption is quite sensitive to income and price levels. Price elasticities of animal products shows the driving force of meat prices on meat consumption as well as on consumption of poultry and eggs† and dairy (a strong substitute).

---

* Disaggregated data from the 1977 Urban Food Purchasing Survey has recently become available and will be incorporated in the final demand system of the IIASA model.

†The high correlation between prices of meat and poultry/eggs prevented the estimation of reliable independent own and cross-price elasticities for the latter.

2.1.7. (c) Vegetables and Fruits

The low and high expenditure elasticities for vegetables and fruit, respectively, are in line with expectations, the latter incorporating a large degree of quality as well as quantity change. Own price elasticities, when calculated with cross- price effects omitted, are roughly equivalent to the negative of income effects. The simultaneous calculation of own and cross-price effects indicates that fruits and vegetables are strong substitutes for each other, although the parameter estimates might be exaggerated by the correlation between the two independent price variables. These estimates, as well as those discussed above and below, indicate the strong bias in own price elasticities that can result when the prices of substitutes or complements are omitted from an equation.

2.1.8. (d) Other

Expenditure and price elasticities for most other categories are significant and have the "right" sign. The mean expenditure elasticities for fats and oils, (.334), sugar (.19) and tobacco (.35) are low, indicating their widespread popularity in urban areas at all income levels. High price elasticities for alcohol and coffee are indicative of the presence of close substitutes (tea and other beverages), although the high correlation in prices prevented significant estimates of the cross-price effects.

2.2. Rural Kenya

Consumption parameters for rural Kenya were estimated from the 1974-75 Integrated Rural Survey (IRS I). Mean household expenditure figures for seven income classes in each of six provinces were divided by provincial price indices for each commodity group(Table 12) to arrive at average quantity consumption levels per household* for each commodity category. As discussed in Part I above, the foodstuff categories are more highly aggregated than those used in the urban estimations, although the raw data allowed the separation of relevant categories between home-produced and purchased items.†

Two approaches were used to estimate consumption parameters, one similar to the analysis done for the urban areas and the other region-specific. First the log-log form,

$$\log q_i = \alpha_i + \beta_i \log E + \sum_j \gamma_{ij} \log p_j \qquad (2)$$

was used to estimate expenditure and own price elasticities, both overall (42 data points) and broken down by three income classes (with 18, 12, and 12 data points, respectively). This demand curve is based on the hypothesis that prices and expenditure levels are the primary determinants of consumption patterns throughout rural Kenya. Second, price data--variation among provinces--was replaced with dummy intercept shifters for each province, resulting in the

---

* As mentioned earlier, due to the lack of province and income class specific data for family size, all estimates were made for aggregate households only. This will lead to a slight upward bias in the parameter estimates since families at higher income levels tend to be larger than those at lower income levels.

† Raw data on home consumption of crops, milk, cattle and other stock was utilized for this purpose. Since crop data was not broken down between grains and fruit and vegetables, the average provincial proportions of home produced consumption between the two categories was assumed to apply to each income class within the respective province. This assumption, thought not completely accurate, should not cause major distortions because production statistics indicate that most smallholders grow a variety of crops (including most major crops), often in rotation or double cropping systems.

following equation:

$$\log q_i = \alpha_i + \beta_i \log E + \sum_p \gamma_{ip} D_p. \quad (3)$$

D_p = zero-one variable for each of six provinces. Dummy slope and intercept shifters were also tested to see if expenditure elasticities vary significantly across provinces. These dummy variable equations are based loosely on the hypothesis that not price differences per se but differences in tribal habits, dietary preferences and environmental factors lead to the observable differences between provincial consumption patterns in Kenya.

2.2.1. Parameters for Aggregated Data with Price as an Independent Variable.

Elasticity estimates for the aggregated data are listed in Table 13. The expenditure elasticity estimates are all higher than the corresponding urban estimates, a result of both the lower overall average income and of the absence of alternative consumption opportunities in rural areas. Of the foodstuffs, dairy products, fats and oils, and beverages are luxuries, having elasticities greater than one. The figure of .708 for grains--mostly maize in rural areas--is surprisingly high for staples and is in fact the lowest of all the expenditure elasticities estimated. These estimates indicate the substantial increase in quantity (or alternatively in quality) of food consumption which would result from increased incomes in rural areas.

Own price elasticities were estimated for those commodities for which recorded variation in prices between provinces were substantial. Parameter estimates for meat and dairy products show a strong sensitivity to price, while the estimate for grain is positive, counter to expectations derived from economic theory.

Price elasticity estimates purely from cross-section data must be interpreted with caution. Different areas of a country, as environmentally and culturally diverse as Kenya, may have made very different long-term adjustments to structures of relative prices. Thus, the assumed causal link between prices and consumption levels might not be entirely applicable to the cross section data. For example, both prices and consumption of grains are higher on the coast of Kenya than in the far interior; however, it is doubtful that demand is responding to price (resulting in a positive price elasticity as the regession equation assumes) but more probably that higher market demand for grains, itself caused by different cultural habits and tastes, results in higher prices on the coast. Similarly, the Masai tribe of the Rift Valley are herders* who depend on livestock for most of their livelihood; their higher consumption of animal products is not so much a result of slightly lower prices than in other parts of Kenya but is arguably more a result of tribal custom and lifestyle.

2.2.2. Parameters for Aggregated Data with Province as an Independent Variable.

The dummy variable equations described earlier (Equation 3) were designed in recognition of this cross-section diversity in Kenya. Results of estimations using dummy variables to shift the intercepts from α_i, fitting only one expenditure elasticity for the country as a whole are shown in Table 14a. Most of the dummy variable coefficients are significant--indicating substantial provincial variation in average consumption levels. Resulting expenditure elasticity estimates are within 0.2 of those estimated earlier for rural areas as a whole. When

* The pastoral population is not covered in the IRS1 Survey.

slope shifter dummy variables are estimated,* however, substantial variation is found in expenditure elasticities as well, particularly for meat and fish, sugar and fruits and vegetables. For example, (Table 14b) for meat and fish, central province has a much higher η and Rift Valley and Nyanza much lower ηs than average. The message communicated from these estimations is that regional diversity plays a major role in setting rural consumption patterns. Responses to income and price changes will not be uniform--perhaps not even similar--across the country, and thus policies more tailored to provincial characteristics will be more likely to achieve desired objectives.

2.2.3. Income-Specific Parameters.

The final analysis carried out on the rural data was to estimate parameters separately for three income groups-- low, (annual income of 0-2999 KSh/family) medium, (3000-5,999 KSh/family) and high (6000 + KSh/family). The resulting expenditure elasticities β_i are shown in Table 15.† The magnitudes of the estimates (when they are significant) are generally within the expected range. The surprising result is the greater magnitude for the middle and/or upper income than for the lower groups of the η for some major foodstuffs--grains, meat and fish, and beverages--and for non-food items. The parameters are significantly greater for the lower income groups only for dairy products, fat and oils, and sugar. The values for η of home-produced consumption are high, particularly of meat and dairy for the lowest two income groups and of grains and fruits and vegetables for those of medium and higher income groups.

This reflects in part the fact that much of the increase in income results from increased ownership of livestock and land that contribute to increased food supplies. The parameters thus suggest that the lowest income groups may earn income first as hired laborers, being able to purchase cattle to provide milk and meat before they can purchase land necessary for home production of grains and fruit and vegetables.

2.3. Complete Demand System

Two approaches have been taken in modeling consumer demand in Kenya. The first approach, discussed above, analyzes demand for each commodity or class of commodities individually by fitting a demand curve to the function.

$$q_i = f(I, \sum_j p_j, t) = f(I, p_i, \sum_j p_j, t) \qquad (4)$$

where I = total income or total expenditure
P_i = own price of commodity i
$\sum_j p_j$ = prices of all other commodities in the market
t = a proxy variable representing habits or tastes

This disaggregated analysis permits estimation within reasonable ranges of income and price, of income (or expenditure), own-price, and cross-price elasticities for each commodity taken individually. It is a useful starting point for partial equilibrium analysis of policies centering on certain commodities or directed toward particular economic goals.

* Since the slope shifters are also in log form, the provincial elasticity is found by adding the provincial β_i to the base δ_i. The elasticity for Central Province is δ_i alone.

† Dummy intercepts were used in the estimation of one overall expenditure elasticity to control for differences in average consumption across provinces.

The first approach, while very useful for selected policy analysis, is not comprehensive enough to fulfill the needs of an economy-wide general equilibrium model like the one of Kenya being constructed at IIASA. Complete demand systems are needed that cover all products in an economy (and savings if desired). Such demand systems satisfy some of the laws of demand desired from utility theory, including (depending on the system chosen) "adding up" (that total expenditure cannot exceed a consumer's total budget),

$$\sum p_i x_i = m \tag{5}$$

homogeneity* of degree zero (that equal proportional increase in total expenditure and all prices will not effect budget shares, thus ruling out "money illusion"),

$$\sum_j \frac{\partial x_i}{\partial p_j} p_j + \frac{\partial x_i}{\partial m} m = 0; \tag{6}$$

i.e.

$$\sum_j e_{ij} + \eta_{im} = 0 \tag{7}$$

and the presence of symmetrical cross- substitution effects between products

$$\frac{\partial x_i}{\partial p_j} + x_j \frac{\partial x_i}{\partial m} = \frac{\partial x_j}{\partial p_i} + x_i \frac{\partial x_j}{\partial m}$$

Complete systems of demand equations have disadvantages as well, however. In choosing which of several systems introduced in economic literature to use, one immediately faces a partial tradeoff between ease of estimation and realistic, results. In this paper two demand models as applied to Kenyan data will be discussed, the well-known Linear Expenditure System (LES)† and the recently published Almost Ideal Demand System (AIDS).§ Although perhaps not as useful† as the individual commodity results for analysis of certain micro-policy questions, the demand systems tend to be more consistent with economic theory and to satisfy overall adding-up requirements, thus being useful analytical tools when applied as part of a general equilibrium model of the Kenyan economy.

2.4. The Linear Expenditure System

The well-known linear expenditure system is a complete set of demand equations that fits well into a general equilibrium model because of its satisfaction of the axoims of demand theory and of its relative ease of estimation. As its name indicates, the equations are linear in expenditure and of the form

$$p_i q_i = p_i c_i + b_i (\mu - \sum_j p_j c_j)$$

$$\sum_{i=1}^{n} b_i = 1$$

* Homogeneity requires that budget shares will remain constant if all prices and income rise by the same proportional amount. It follows from this (dividing by x_i) that $\sum_j e_{ij} + \eta_{im} = 0$, the sum of all price elasticities and the income elasticities for a product is zero.

† J.R.N. Stone, "Linear Expenditure Systems and Demand Analysis--An Application to the Pattern of British Demand", Economic Journal, Sept. 1954, No. 64, 511-27.

§ Angus Deaton and John Muellbauer, "An Almost Ideal Demand System", American Economic Review, June 1980, pp. 312-326.

where q_i represents the quantity of the ith commodity consumed, p_i represents its unit price, and μ represents total expenditure i.e.

$$\mu = \sum_{i=1}^{i} p_i q_i. \tag{11}$$

A popular interpretation of LES is that the c_i's represent "committed" or "subsistence" quantities* and the term in parenthesis represents "supernumerary income", with the b_i's thus representing the marginal budget shares going to each commodity. The LES derives from an additive utility function of the form

$$U = \sum_{i=1}^{n} b_i \log (q_i - c_i) \tag{12}$$

$$\sum_{i} b_i = 1 \tag{13}$$

subject to the budget constraint

$$\sum_{i} p_i q_i = \mu \tag{14}$$

Like all additive systems, it thus assumes "want independence", that the marginal utility of consumption of one commodity is independent of the quantities consumed of other commodities. This assumption, together with the imposition of constant non-negative marginal budget shares across all consumers, is a strict one unlikely to hold across all commodities or consumers.† The LES thus provides a more realistic model when the level of aggregation is quite high and when separate estimations can be done for separate income classes. The above disadvantages of the LES are offset in part by the advantages, including satisfaction of adding up and homogeneity criterion,§ suitable aggregation over consumers, readily interpretable parameters and relative ease of estimation.

2.4.1. Methods of Estimating Parameters

The expenditure elasticity of demand for commodity i is given by

$$\eta_i = \frac{\partial p_i q_i}{\partial \mu} \frac{\mu}{p_i q_i} \tag{15}$$

$$= \frac{b_i \mu}{p_i q_i}.$$

Therefore, with exogenous estimates of expenditure elasticities the marginal share parameters b_i can be determined:

$$b_i = w_i \eta_i \tag{16}$$

where w_i is the average budget share of good i.

The "subsistence" parameters c_i's are directly computable from income elasticities using the Frisch flexibility of money parameter β. β is defined as the elasticity of the marginal utility of income (λ):*

* This interpretation is not always possible, however, since c_i's can be negative.

† The strictness of constant marginal budget shares--or linear Engel curves--can be modified by using a dynamic version of the LES in which committed quantities are allowed to move over time, linked partially to earlier values through a "habit formation" parameter (analogous to any function with lagged variables). This cannot be done in the case of Kenya for urban and rural areas because of the absence of reliable year-by-year time series data on prices and expenditure.

§ Satisfaction of theoretical properties is extremely important for the computation of the exchange equilibrium in the linked system of agricultural models being built at IIASA.

$$\beta = \frac{\partial \lambda}{\partial \mu} \frac{\mu}{\lambda} \tag{17}$$

For LES demand functions

$$\beta = \frac{\partial \lambda}{\partial \mu} \frac{\mu}{\lambda} = - \frac{\mu}{\left[\mu - \sum p_j c_j\right]} \tag{18}$$

and the negative of its inverse equals the ratio of supernumerary to total income

$$\varphi = -\frac{1}{\beta} = \frac{\left[\mu - \sum p_j c_j\right]}{\mu} \tag{19}$$

For any chosen values of φ, values of the LES parameters c_i can be arrived at since

$$\eta_i = \frac{b_i \mu}{p_i q_i} \tag{20}$$

$$= \frac{b_i \mu}{p_i c_i + b_i (\mu - \sum_j p_j q_j)}$$

and with some manipulation

$$p_i c_i = \mu (w_i - \varphi b_i) \tag{21}$$

Values of the supernumerary income parameter φ are typically about 0.5 for developed countries, resulting in a β of -2; for developing countries β rises much above this value. One study† has estimated the following function for β using cross-country data:

$$-\beta \approx 36X^{-.36} \tag{22}$$

where X is GNP per capita in 1970 U.S dollars. For Kenya in 1974 this translates approximately to

$$-\beta \approx 36(\$165)^{-.36}$$

or

$$\beta \approx -5.73$$

A value of -5.73 for β implies that over 4/5 of average per capita expenditure in 1974 was "committed" or "subsistence" level consumption, rising to a much higher level at very low income levels.

If calculated separately for urban and rural areas§ of Kenya using per capita income figures rather than GNP per capita, the corresponding figures for β are -4.12 for the urban (per capita income in Nairobi of 3975 KSh or 413 U S. dollars 1970) and -8.54 for the rural (per capita income of smallholders of 524 KSh or 54 U.S. dollars 1970) population as a whole. Alternatively if per capita expenditure levels are used then β = -4.57 for urban areas and β = -8.71 for rural areas.

---

model with many sectors", Econometrica, 27, 1959, pp. 177-96.

† C. Lluch, A.A.Powell, and R.A. Williams, Patterns of Household Demand and Saving, Oxford University Press, 1977, p.76.

§ M.M.Shah and F. Willekens, "Rural-Urban Population Projections and Implications for Development" RM-78-55, IIASA, Nov. 1978, and "1974 Nairobi Household Budget Survey", CBS, Nairobi.

From expenditure data it seems, however, that some families were consuming less than this "subsistence" level in 1974, and thus that this method of computing the Frisch parameter must be used with caution. The average per capita expenditure level of the lowest income class in urban Kenya in 1974 was KSh 1532, about 51% of the average per capita of KSh 2980 (see Tables 1 and 2). For rural Kenya the poorest income class (KSh 0 - 999) spent only about KSh 2188 per family 63% of the average of KSh 3450 (see Table 15).* Using these minimum expenditure levels as "subsistence" expenditure and the difference between them and the average as supernumerary income leads to estimates of β only -2.04 and -2.73 for urban and rural areas respectively, much lower than the figures of -4.57 and -8.71 derived from the function above.

Own and cross-price elasticities are directly computable with expenditure elasticities and any chosen value of φ. Because of the additive nature of the utility function, the elasticities reflect essentially the income effects of changes in supernumerary income through both a change in committed quantities of the jth commodity and a change in the amount of supernumerary expenditure going to buy commodity j. Aside from these tandem income effects, explicit "substitution" effects between direct substitute or complementary commodities, as hypothesised in economic theory, are not included in the price elasticity formulas of LES. This lack of flexible substitution effects is one drawback of the system.

If η_i and e_{ij} represent expenditure and price elasticities of quantity demand for good i respectively

$$\eta_i = b_i \,/\, w_i \tag{23}$$

$$e_{ij} = \begin{cases} -\varphi\,\eta_i - \eta_i\, w_i\,(1 - \varphi\,\eta_i), & i = j \\ -\eta_i\, w_j\,(1 - \varphi\, n_j), & i \neq j \end{cases} \tag{24}$$

Expenditure compensated price elasticities e_{ij}^* are given by

$$e_{ij}^* = \begin{cases} -\varphi\,\eta_i\,(1 - \beta_i), & i = j \\ \varphi\,\eta_i\,\beta_j, & i \neq j \end{cases} \tag{25}$$

Price elasticities are related to expenditure elasticities through the supernumerary income ratio φ and the budget share of the good whose price is changing:

$$\frac{e_{ij}}{\eta_i} = \begin{cases} -\varphi - w_i\,(1 - \varphi\,\eta_i), & i = j \\ -w_j\,(1 - \varphi\,\eta_j), & i \neq j \end{cases} \tag{26}$$

2.4.2. LES Estimation for Kenya

To estimate the LES for Kenya, the expenditure and price elasticities of demand for good i estimated for urban and rural Kenya as described earlier were combined with the data on average budget shares† to calculate the

* Family data is used in rural areas to be consistent with regression results.

† Average budget shares as obtained from the three surveys are only proxies for the breakdown of total private consumption in urban and rural Kenya, and these parameter estimates should thus be corrected when more accurate information on total budget shares for the country or for selected provinces or income classes become available. Such correction and updating to account for changes in budget shares in later years will be necessary before the model is applied in a general equilibrium framework. This discussion and application is intended primarily as an illustration of a methodology of demand analysis in data-poor areas, not as a final estimation of all demand parameters.

marginal budget share parameters b_i (equation 16).

To arrive at the subsistence level expenditures the supernumerary income ratio was calculated. Three alternative methods were tested and compared. First, the ratio of the estimated price and expenditure elasticities for beef were used in equation (26)to arrive at an estimate of φ for urban areas. The price elasticity estimates for rural areas were too unreliable to apply this method in rural areas. Second, the relationship of per capita expenditure (a proxy for per capita GNP) to φ as expressed in the function

$$\frac{1}{\varphi} = 36\ x^{-.36} \tag{27}$$

was used to estimate φ. Third, the directly observable relationship between the lowest and the average expenditure levels in urban and rural areas was used as an estimate for φ. Table 16 shows the three alternative estimates of φ and thus of the flexibility of money parameter β for urban and rural areas in Kenya. The third method was chosen because of its origin in the actual data and its more reasonable results. Interpreted in non mathematical terms, these estimates imply that 49% of urban expenditure and 63.4% of rural expenditure is "supernumerary", i.e., free to move among various commodities in response to income and price changes.

Tables 17 and 18 show the estimates of the two parameters of the LES for urban and rural Kenya, the b's and c's. Also shown are resulting expenditure and price elasticities, the former taken from estimation results discussed in Part II. Price elasticities are all negative, a result assured by the strict specification of the model with absolute values less than their corresponding expenditure elasticities (an effect caused by the presence of committed expenditures). Consumer responses to price changes are relatively flexible in the case of luxury commodities, such as alcoholic beverages, poultry and eggs, and non-agricultural goods in the case of urban consumers and dairy products, fats and oils, and clothing in the case of rural consumers. However, price responses as calculated in this model are inflexible, for "necessities" such as staple foods, meat, vegetables and legumes.

Price response in the LES specification depends on budget shares as well as on expenditure elasticities and the super numerary income ratio. This is an important characteristic for pricing policy formulation, because food in general and staple foods in particular have a much larger share of the consumption basket of poor consumers than that of wealthier consumers, and thus poor consumers will respond more flexibly to price changes. Although this result arises here from the LES specification, it is likely to hold in practice because of the tighter budget constraint facing poorer consumers.

2.5. The Almost Ideal Demand System

The "Almost Ideal Demand System" (AIDS) is a more flexible one than LES in that it allows specifically for cross-price substitution effects and does not impose constant marginal expenditure levels (linear Engel curves). The system derives from minimization of a cost function

$$\log c(u,p) = \alpha_o + \sum_k \alpha_k \log p_k + \frac{1}{2}\sum_k \sum_j \gamma_{kj} \log p_k \log p_j + u\,\beta_o \prod_k p_k^{\beta_k} \tag{28}$$

resulting in a series of demand equations describing budget shares as a function of prices and total expenditure

$$w_i = \alpha_i + \sum_j \gamma_{ij} \log p_j + \beta \log \left\{\frac{x}{\bar{P}}\right\} \tag{29}$$

where w_i is the budget share of good i
x is total expenditure
p_k is price of good k
$\bar{P}$ is a price index defined as,

$$\log \bar{P} = \alpha_o + \sum_k \alpha_k \log p_k + \frac{1}{2} \sum_j \sum_k \gamma_{kj} \log p_x \log p_j \tag{30}$$

and where w_i = budget share of good i,
x = total expenditure,
p_k = price of good k.

Each γ_{ij} term in equation (30) represents 100 times the effect on the ith budget share of a one percent increase in the jth price if real expenditure (x/p) is held constant. Own price terms γ_{ii} are positive for commodities with inelastic demand and negative for those with elastic demand, while cross price terms γ_{ij} are positive for substitutes and negative for complements.

The β_i coefficients represent the change in the budget share going to the ith commodity with a one percent increase in total expenditure, relative prices held constant; all β_i's add to zero and are positive for luxuries and negative for necessities.

Although the demand equations are nonlinear, replacement of $\bar{P}$ by a suitable price index P^* results in a series of linear demand equations

$$w_i = \alpha_i^* + \sum_j \gamma_{ij} \log p_j + \beta_i \log \left[\frac{x}{P^*}\right] \tag{31}$$

where $\bar{P} = \varphi P^*$
and $\alpha^* = \alpha_i - \beta \log \varphi$,

that can be estimated by regular OLS techniques. If relative prices are changing only slightly over time P^* can be approximated with the use of a consumer price index or an index of weighted prices

$$\log P^* = \sum_k w_k \log p_k$$

The advantages of the AIDS specification lies in its flexible functional form and its simplicity of estimation with a suitable price index P^*. The flexible form not only allows formal cross-price "substitution" effects but also allows testing of axioms of consumer choice such as homogeneity

$$\sum_j \gamma_{ij} = 0 \tag{33}$$

and symmetry of cross-price effects*

$$\gamma_{ij} = \gamma_{ji} \tag{34}$$

* Both of these axioms were rejected by Deaton and Muellbauer, but they suggest that the rejection of homogeneity may have been due to the omission of dynamic adjustment aspects of consumer behaviour from the model.

The main disadvantage of the AIDS system in practical work--the mirror image of the flexibility it provides--is the large number of parameters to be estimated (and thus the need for a large data base). In total, if n is the number of commodities, there are n - 1 βs and a matrix of n x n γs in the system, or a total of (n - 1) n^n independent parameters. Prior restrictions can be put on the parameters, such as the imposition of symmetry and the setting of many of the cross price parameters γ_{ij} to zero, to save degrees of freedom.

2.5.1. AIDS Estimation for Kenya

The AIDS system was estimated for urban and rural Kenya with selected results shown in Tables 19A, 19B and 20. Equation (31) was used with two specifications for P^*, one being the consumer price index for Nairobi (used only with urban data) and the other being the weighted price index (used with urban and rural data).

$$\log P^* = \sum_k w_k \log q_k \qquad (35)$$

Due to the limited variation in prices implicit in the use of a mixture of cross-section and time-series data together, significant parameter estimates resulted for urban areas only when stringent restrictions were imposed on the cross price effects by setting most equal to zero a priori. All price effects could not be estimated for rural areas either, due both to the lack of price variation in controlled commodities such as sugar, fats and oils, and beverages and to the lack of cross-section price data for non-agricultural goods. Therefore, the results shown in Table 19A/B and 20 are not final but are meant primarily to illustrate some limited application of this relatively new consumer demand system.

The results of this preliminary AIDS estimation are promising. The β estimates for urban areas indicate that all commodities except fruit and the non-food category are necessities ($\beta<0$)and poultry and eggs having an elasticity of 1. Similar results were obtained with the individual estimates reported in Section 2.1.3 above. For rural areas, dairy products, fats and oils, beverages and clothing are luxuries (with sugar on the margin). These results are also in line with individual cross- section estimations.

Although bias is present in some of the price parameters γ_{ij} due to left-out variables (necessary to avoid problems of multicollinearity),* the only urban commodities with elastic price response (negative γ_{ii}s) are dairy products, vegetables and fish. For rural areas meat and dairy products show elastic price responses, qualities not brought out by the stricter LES specification.

Cross price responses are not symmetrical ($\gamma_{ij}=\gamma_{ji}$) in either urban or rural estimates, although this exercise is not a full test of Slutsky symmetry since so many price parameters have by necessity been set equal to zero.

Significant cross price effects in rural areas, though to be interpreted cautiously due to left-out-variable bias, tend to support a priori expectations; for example, meat and dairy products emerge as gross substitutes (γ_{ij}=1.17), while pairs of gross complements include, among others, grains and meat (γ_{ij}=-.8917), grains and dairy (-1.08), sugar and meat (-.206), and sugar and dairy (-.226). Some cross price effects are ambiguous, however, with the pair of fruits/vegetables and dairy products appearing as gross complements in the

* The bias is evident from the different values for γ_{ii} for the same commodity when joined with different commodities as independent variables in different equations.

dairy equation (-.654) and gross substitutes in the fruits/vegetables equation (.362).

Direct comparison of AIDS with LES can be made by looking at the elasticity estimates resulting from application of the two systems.

The expenditure elasticity η_i for the AIDS demand function is derived as follows:

$$w_i = \frac{p_i q_i}{x} = \alpha_i + \sum_j \gamma_{ij} \log p_j + \beta_i \log \frac{x}{P} \tag{36}$$

$$q_i = \frac{x}{p_i}(\alpha_i + \sum_j \gamma_{ij} \log p_j + \beta_i \log \frac{x}{P}) = \frac{x}{P_i} w_i \tag{37}$$

$$\eta_i = \frac{\partial q_i}{\partial x} \frac{x}{q_i} = \left[\frac{x}{p_i} \frac{\partial w_i}{\partial x} + w_i \frac{\partial x / p_i}{\partial x} \right] \frac{x}{q_i} \tag{38}$$

$$\eta_i = \left[\frac{x}{p_i} \frac{\beta_i}{x} + w_i \frac{1}{p_i} \right] \frac{x}{q_i} \tag{39}$$

$$= \frac{\beta + w_i}{p_i} \frac{x}{q_i}$$

$$= \frac{\beta + w_i}{w_i}$$

$$= \frac{\beta_i}{w_i} + 1$$

Holding the price index $\bar{P}$ as exogenous, own and cross price elasticities are derived as follows:

Own (e_{ii})

$$w_i = \frac{p_i q_i}{x} = \alpha_i + \sum_j \gamma_{ij} \log p_j + \beta \log \frac{x}{\bar{P}} \tag{40}$$

$$p_i q_i = w_i x \tag{41}$$

$$p_i \frac{\partial q_i}{\partial p_i} + q_i = \frac{\partial w_i}{\partial p_i} x + w \frac{\partial x}{\partial p_i} \tag{42}$$

$$= \frac{\gamma_{ii}}{p_i} x + 0$$

Dividing through by q:

$$e_{ii} + 1 = \frac{\gamma_{ii} X}{p_i q_i} \tag{43}$$

or

$$e_{ii} = \frac{\gamma_{ii}}{w_i} - 1 \tag{44}$$

Cross (e_{ij})

$$p_i q_i = w_i x \tag{45}$$

$$p_i \frac{\partial q_i}{\partial p_j} + q_i \frac{\partial p_i}{\partial p_j} = \frac{\partial w_i}{\partial p_j} x + w \frac{\partial x}{\partial p_j} \tag{46}$$

$$p_i \frac{\partial q_i}{\partial p_j} + 0 = \frac{\gamma_{ij}}{p_j} x + 0$$

Multiplying through by p_j over q_i

$$p_i e_{ij} = \frac{\gamma_{ij} x}{q_i} \tag{47}$$

or

$$e_{ij} = \frac{\gamma_{ij}}{w_i}$$

Tables 21 and 22 show resulting expenditure and price elasticity estimates for the urban and rural areas using the AIDs demand function. Expenditure elasticity estimates are reasonable and are in fact very similar to those obtained with the best fitting individual curves. Thus even with poor price data the effect of income changes on consumption is quite well estimated by AIDS demand functions. Only a few of the price elasticity estimates are negative and of reasonable magnitude, while the majority are unreasonable either in sign or in absolute value. The primary blame for the result should be placed on the limited variation in price data used in the estimations; this resulted in collinearity unless most cross-price terms were set at zero. With more price variation--preferably using more time series data--and sufficient degrees of freedom the Almost Ideal Demand System could better fill the needs of the general equilibrium model than the LES with its tight parameter restrictions, inflexible price responses, and linear Engel curves.

Table 1. Average Breakdown of Family Budget in Four Household Surveys in Nairobi.
All Figures in Percents.

	1963	1968/9	1974	1977*	1963-74 Average	1963-74 Average Share of Food Budget
A. Cereals						
Wheat Bread	1.71	2.71	2.49	2.22	2.34	6.7
Wheat Flour	.85	1.20	.52	1.28	.87	2.5
Rice	.89	.92	.58	.96	.80	2.3
Maize	3.75	4.25	5.32	5.19	4.46	12.8
Other Coarse Grains	.09	.11	.07	.33	.09	.3
Total Cereals	7.29	9.19	8.98	9.98	8.56	2.45
B. Fats and Oils	2.17	2.06	2.73	2.62	2.32	6.6
C. Sugar and Sweets	1.95	2.56	2.63	3.05	2.40	6.9
D. Animal Protein						
Bovine and Ovine Meat	5.17	6.68	5.79		5.94	17.0
Poultry and Eggs	1.32	1.08	1.18		1.18	3.4
Dairy Products	3.79	5.51	4.19	4.34	4.57	13.1
Fish	.58	.85	.69	.51	.72	2.1
Total Animal Protein	10.86	14.12	11.85	11.59	12.41	35.5
E. Vegetables	1.63	2.38	3.13	3.05	2.38	6.7
F. Legumes	.83	.92	1.38	.93	1.05	3.0
G. Fruits and Nuts	.65	.70	.75	1.36	.70	2.0
H. Beverages						
Coffee	.22	.22	.11		.18	.5
Tea	.61	.68	.64		.65	1.9
Alcoholic Beverages	5.06	2.09	1.72		2.83	8.1
Total Beverages	8.05	2.99	2.47	1.69	3.66	10.5
I. Tobacco	2.16	1.23	1.10		1.46	4.2
J. Other				1.94		
Food (incl. tobacco)	33.43	36.15	35.02	36.21	35.53	100.00
Nonfood	66.57	63.85	64.98	63.79	64.47	
	100.00	100.00	100.00	100.00	100.00	
Average per capita expenditure (K. Sh. per month)	142.02	136.22	248.35	208.10		
1963 average expenditure in current terms (K. Sh. per month)	142.02	159.96	230.97	326.59		

* This survey reports aggregated commodities, namely, cereals, rice (expenditure on wheat bread is given separately), meat and beverages. Disaggregated amounts for individual commodities have been estimated, Shah (1979).

Table 2. Average Budget Breakdown for Low-Income Families in Nairobi. All Figures in Percents

	1968/9	1974	1977**
A. Cereals			
Wheat Bread	3.36	2.92	2.49
Wheat Flour	1.67	.50	.89
Rice	1.24	.47	.52
Maize	5.93	8.91	8.79
Other Coarse Grains	.09	.11	.06
Total Cereals	12.29	12.91	13.29
B. Fats and Oils	2.53	2.88	3.15
C. Sugars and Sweets	3.52	3.28	3.83
D. Animal Protein			
Bovine and Ovine Meat	8.16	7.29	7.43
Poultry and Eggs	1.15	.79	
Dairy Products	6.70	4.48	5.47
Fish	1.10	.58	.72
Total Animal Protein	17.11	13.14	13.62
E. Vegetables	2.99	4.56	3.85
F. Legumes	1.48	1.94	1.43
G. Fruits and Nuts	.74	.85	1.43
H. Beverages			
Coffee	.17	.11	0.09
Tea	.90	1.00	0.59
Alcoholic Beverages	1.50	1.32	0.86
Total Beverages	2.57	2.43	1.54
I. Tobacco	1.37	1.11	
J. Other	-	-	1.92
Food (incl. tabacco)	43.60	43.10	46.55
Nonfood	55.40	56.90	53.45
	100.00	100.00	100.00
Average per capita expenditure (K. Sh. per month)	80.14	127.71	145.18
1963 average expenditure in equivalent current terms (K. Sh. per month)	80.14	115.71	163.62

* The 1973 survey covered only middle income workers.
** Disaggregation of commodity groups in 1977 Urban Survey as estimated in Shah (1979).

Table 3. Average Budget Breakdown for Upper-Middle Income Families in Nairobi. All Figures in Percents.

	1963	1968/9	1974	1977*
A. Cereals				
Wheat Bread	1.71	2.37	2.51	1.74
Wheat Flour	.85	.94	.55	.96
Rice	.89	.70	.65	.67
Maize	3.75	3.30	3.84	3.09
Other Coarse Grains	.09	.15	.05	.19
Total Cereals	7.29	7.46	7.60	6.65
B. Fats and Oils	2.17	1.87	3.04	1.92
C. Sugar and Sweets	1.95	1.99	2.56	2.19
D. Animal Protein				
Bovine and Ovine Meat	5.17	6.02	5.33	
Poultry and Eggs	1.32	1.05	1.48	5.31
Dairy Products	3.79	4.82	4.18	3.93
Fish	.58	.71	.83	.27
Total Animal Protein	10.86	12.60	11.82	
E. Vegetables	1.63	2.08	2.53	1.92
F. Legumes	.83	.54	1.19	.76
G. Fruits and Nuts	.65	.73	.61	1.38
H. Beverages				
Coffee	.22	.32	.11	
Tea	.61	.55	.48	
Alcoholic Beverages	5.06	2.60	2.12	
Total Beverages	5.89		2.71	1.65
I. Tobacco	2.16	1.16	1.24	
J. Other				1.38
Food (incl. tobacco)	33.43	31.90	33.30	27.36
Nonfood	66.57	68.10	66.70	72.64
	100.00	100.00	100.00	100.00
Average per capita expenditure (K. Sh. per month)	142.02	153.56	230.42	369.80
1963 average expenditure in equivalent current terms (K. Sh. per month)	142.02	159.96	230.97	326.59

* The 1977 breakdown among cereals other than wheat bread and animal proteins are approximate estimates, Shah (1979).

Table 4. Percentage Shares of Total Rural Cash Expenditure by Household Income Group. (All Figures in Percents)

Household Income Group	Food	Clothing	Other Nonfood	Total Cash Expenditure (K. Sh./Household)
0-999	68.2	12.3	19.5	1153
1000-1999	67.6	13.5	18.9	1414
2000-2999	65.7	14.2	20.1	1753
3000-3999	68.1	9.8	22.1	2171
4000-5999	57.6	14.6	27.8	2405
6000-7999	54.7	14.4	30.9	3356
8000+	60.2	20.1	19.7	3559
Total	60.2	15.0	24.8	2153

Source: *Integrated Rural Survey 1974/75*, Basic Report, Central Bureau of Statistics, Nairobi, May 1977.

Table 5. Percentage Shares of Total Rural Consumption by Household Income Group (Purchased and Home Produced).

Household income group*	Purchased Food	Home-Produced Food	Total Food	Clothing	Other Nonfood	Total Consumption (K sh. per household)
0-999	.488	.284	.772	.088	.140	1611
1000-1999	.442	.347	.789	.088	.123	2165
2000-2999	.423	.356	.779	.092	.130	2721
3000-3999	.439	.355	.794	.063	.143	3364
4000-5999	.356	.382	.738	.090	.172	3892
6000-7999	.330	.403	.732	.086	.182	5618
8000+	.284	.453	.737	.110	.153	6505
Total	.376	.376	.752	.094	.154	3450

Source: *Integrated Rural Survey 1974/75*, Basic Report, Central Bureau of Statistics, Nairobi, May 1977. The IRS1 report gives data on a "under 0" household income group comprising 6.67% of survey households. This group has a total cash expenditure of 2732 KSh and a total consumption expenditure of KSh 3691. The food consumption pattern for this group is similar to the KSh 3000-3999 income group, Shah (1979). In the present analysis the "Under 0" group has been excluded.

* Kenya shillings per annum.

PERCENTAGE DISTRIBUTION OF HOUSEHOLD FOOD CONSUMPTION BY TYPE OF FOOD AND PROVINCE (1)

Table. 6

Percent

	Central	Coast	Eastern	Nyanza	Rift Valley	Western	Total
Own Produced Items							
Maize	11.74	12.55	10.76	20.60	24.49	17.55	14.88
Finger Millet	0.00	0.00	0.29	0.98	2.22	1.80	0.66
Sorghum	0.00	0.00	0.20	7.01	0.00	1.14	1.66
Beans	7.70	1.26	12.45	1.18	0.23	3.32	6.32
English Potatoes	8.60	0.00	7.59	0.00	0.08	0.00	4.43
Other Crops	5.97	3.25	8.15	5.05	0.51	5.22	5.86
Beef	0.19	1.76	0.68	0.88	3.20	1.80	0.96
Other Meat and Poultry	3.01	4.02	3.19	4.07	3.12	5.27	3.66
Milk	11.87	2.76	11.02	11.57	31.90	6.36	11.57
Total Consumption of Own Produce	49.07	25.64	54.34	51.35	65.76	42.50	50.00
Purchased Items:							
Dairy Products and Eggs	2.02	2.79	1.37	1.18	1.09	2.80	1.77
Grains, Flours and Root Crops	19.56	44.55	23.66	11.23	9.36	16.79	19.20
Meat and Fish	4.71	9.11	3.75	19.27	6.59	14.52	9.10
Fats and Oils	5.23	2.41	2.97	2.31	0.78	2.47	3.20
Sugar and Sweets	8.15	6.85	4.20	5.89	7.53	9.25	6.63
Fruits and Vegetables	4.04	3.02	3.49	3.29	1.25	3.13	3.39
Drinks and Beverages	6.29	4.59	4.37	4.12	6.71	7.21	5.40
Salt and Other Flavourings	0.93	1.03	1.79	1.42	0.94	1.28	1.35
Total Food Purchases	50.93	74.36	45.66	48.65	34.24	57.50	50.00
Total Food Consumption	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Total Value of Food Consumption (K.Shs.)	3,118	2,613	3,068	2,039	2,564	2,108	2,594

(1) Excludes pastoral and large farm areas

PERCENTAGE DISTRIBUTION OF HOUSEHOLD FOOD CONSUMPTION BY TYPE OF FOOD AND HOUSEHOLD INCOME GROUP

Table. 7

Percen

	Under 0 K.Shs.	0-999 K.Shs.	1,000-1,999 K.Shs.	2,000-2,999 K.Shs	3,000-3,999 K.Shs.	4,000-5,999 K.Shs.	6,000-7,999 K.Shs.	8,000 K.Shs. and over	Total
Own Produced Items:									
Maize	12.58	11.82	12.18	15.43	11.87	14.55	13.27	20.44	14.85
Finger Millet	0.98	0.64	0.80	0.61	0.60	0.70	1.09	0.27	0.66
Sorghum	1.06	2.97	2.28	1.46	1.31	2.44	0.68	1.36	1.66
Beans	3.83	4.50	5.51	5.90	5.88	6.82	7.78	7.36	6.32
English Potatoes	3.46	1.05	1.24	4.34	5.54	4.49	8.82	4.61	4.43
Other Crops	4.31	6.03	7.15	5.10	5.05	5.26	5.98	6.45	5.86
Beef	0.98	2.17	1.82	0.61	0.30	0.84	0.46	0.96	0.96
Other Meat and Poultry	2.77	3.05	4.34	3.92	3.44	3.80	3.91	3.36	3.66
Milk	9.04	4.74	8.26	8.35	10.67	12.85	12.98	16.65	11.57
Total Consumption of Own Produce	39.03	36.82	44.00	45.68	44.66	51.78	54.97	61.45	50.00
Purchased Items:									
Dairy Products and Eggs	2.24	2.09	1.87	2.17	2.25	1.71	1.12	1.38	1.77
Grains, Flours and Root Crops	25.15	26.93	22.55	21.33	22.84	17.10	18.40	12.10	19.20
Meat and Fish	9.52	12.70	10.37	9.53	8.95	9.30	7.58	7.91	9.10
Fats and Oils	4.92	2.25	3.05	2.83	3.14	3.27	3.28	3.21	3.20
Sugar and Sweets	8.91	6.67	6.74	7.27	6.89	7.07	5.59	5.76	6.63
Fruits and Vegetables	2.73	3.86	4.16	3.68	4.57	3.76	3.16	2.04	3.39
Drinks and Beverages	5.94	6.91	5.57	5.76	5.20	4.91	4.84	5.26	5.40
Salt and Other Flavourings	1.51	1.77	1.70	1.70	1.54	1.15	1.09	0.90	1.35
Total Food Purchases	60.97	63.18	56.00	54.32	55.34	48.22	45.03	33.55	50.00
Total Food Consumption	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Total Value of Consumption (K.Shs.)	2,457	1,244	1,707	2,119	2,671	2,872	4,115	4,794	2,594

Source. Integrated Rural Survey, 1974-75. Basic Report, pp. 66. Central Bureau of Statistics, Ministry of Finance and Planning, Nairobi, Kenya. March 1977.

Table 8. Distribution of Total Rural Household Food Consumption by Household Income Group. (in percent)

	Household Income Group (KSh per annum)							
	0-999	1000-1999	2000-2999	3000-3999	4000-5999	6000-7999	8000+	Total
Staple, Cereals and Roots	49.44	46.58	48.27	47.21	44.54	48.24	45.23	46.66
Beans (home produced)	4.50	5.51	5.90	5.88	6.82	7.78	7.36	6.32
Meat	17.92	16.53	14.06	12.69	13.94	11.95	12.23	13.72
Dairy and Eggs	6.83	10.13	10.52	12.92	14.56	14.10	18.03	13.34
Fats and Oils	2.25	3.05	2.83	3.14	3.27	3.28	3.21	3.20
Sugar and Sweets	6.67	6.74	7.27	6.89	7.07	5.59	5.76	6.63
Fruits and Vegetables	3.86	4.16	3.68	4.57	3.76	3.16	2.04	3.39
Others	8.68	7.27	7.46	6.74	6.06	5.93	6.16	6.75
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Table 9. Expenditure Elasticity Estimates for Nairobi and Mombasa.*

	Nairobi		Mombasa	
	1963	1968	1974	1968
Cereals				
Wheat	n.s.**	.25	.52	.04
Rice	1.09	.47	2.03	.29
Maize	-.38	-.15	-.64	-.17
Other Coarse Grains	-.59	n.s.**	1.12	n.s.**
Fats and Oils	-.63	-.29	1.45	.46
Sugars and Sweets	-.15	.08	.25	.12
Animal Protein				
Bovine and Ovine Meat	.37	.46	.60	.35
Poultry and Eggs	.26	.95	1.53	1.64
Dairy	.41	.55	.86	.60
Vegetables	.42	.31	1.21	.59
Legumes	1.82	.31	.21	n.s.**
Fruits and Nuts	1.29	.75	.97	.61
Fish	.63	.26	.81	.11
Beverages				
Coffee	n.s.**	.70	1.75	.87
Tea	1.47	.12	n.s.**	.02
Alcoholic Beverages	1.52	1.40	1.63	.77
Other Foods	2.04	.70	1.95	.67
Clothing	.91	.93	.45	.86
Nonagriculture	.97	1.38	1.26	1.51

* All elasticities are evaluated at the mean expenditure level of 1974.
** n.s. - not significant at .10 level two tailed test.

Table 10. Prices for Commodity Grouping in Nairobi for Three Years. (K. Sh. per kg.

	1963	1968/9	1974
A. Cereals			
Wheat Bread	1.65	1.65	2.40
Wheat Flour	1.21	1.32	1.70
Rice	2.20	1.75	2.25
Maize	.66	.57	.95
Other Coarse Grains	.53	.63	.97
B. Fats and Oils	4.95	5.50	12.00
C. Sugar and Sweets	1.43	1.55	2.40
D. Animal Proteins			
Bovine and Ovine Meat	3.41	5.13	6.40
Poultry and Eggs	8.09	7.80	9.36
Dairy Products	1.43	1.49	1.60
Fish	3.76	4.22	6.65
E. Vegetables	.44	.51	1.36
F. Legumes	1.08	1.10	2.33
G. Fruits and Nuts	.40	.46	1.02
H. Beverages			
Coffee	6.60	8.80	10.57
Tea	9.57	9.76	12.00
Alcoholic Beverages	4.00	4.60	4.90
I. Tobacco (per package of 20)	2.00	1.50	2.25

Table 11. Selected Expenditure, Own-Price, and Cross-Price Elasticity Estimates for Urban Kenya. (t-statistics in parenthesis)

	(form of equation)	PWF	PWB	PM	PRI	POCG	E	R^2
Cereals								
Wheat Flour	(ll)	-3.63					.63	.207
		(-2.29)					(1.74)	
Wheat Bread	(ll)		.25				.37	.545
			(.689)				(3.54)	
	(ll)		3.45	-2.68			.39	.705
			(3.40)	(-3.30)			(4.51)	
Maize	(ll)		.68	-.13			-.56	.660
			(.60)	(.14)			(-5.74)	
	(sl)			.41			-.41	.593
				(1.90)			(-5.30)	
	(lli)			.27			-.60*	
				(1.57)				
Rice	(ll)				-1.35		.81	.700
					(2.08)		(6.87)	
	(ll)			-.94	-.94		.77	.589
				(-1.72)	(-.18)		(5.30)	
	(ll)		-.88		-.78		.77	.589
			(-1.72)		(1.04)		(5.30)	
Other Coarse Grains	(sl)					-1.63	.80	.104
						(-1.22)	(1.50)	

		PMT	PP	PDA	PFI	E	R^2
Animal Protein Sources							
Bovine and Ovine Meat	(ll)	-.51				.49	.823
		(-4.14)				(10.60)	
	(ll)	-.58	.42			.47	.849
		(-3.79)	(.85)			(8.69)	
	(ll)	-.73		1.75		.47	.849
		(-2.26)		(.87)		(8.92)	
Poultry and Eggs	(ll)		-.41			.98	.839
			(-.48)			(8.63)	
	(ll)	-.55	.58			.99	.861
		(-1.74)	(.57)			(8.92)	
Dairy Products	(ll)			.47		.69	.916
				(.60)		(12.31)	
	(ll)	1.26		-6.27		.75	.958
		(4.44)		(-3.64)		(17.47)	
Fish	(ll)				-.71	.65	.468
					(-1.82)	(4.22)	
	(sl)				-.40	.63	
					(-1.28)	(5.21)	

		PV	PL	PF	PMT	E	R^2
Other Foods							
Vegetables	(ll)	-.39				.31	.668
		(-5.79)				(5.80)	
	(ll)	1.02	-1.97			.33	.753
		(1.90)	(-2.64)			(6.88)	
	(ll)	-8.10		9.38		.33	.753
		(2.77)		(2.64)		(6.88)	
Legumes	(ll)		.37		-.31	.06	.143
			(1.10)		(-.71)	(.49)	
Fruit	(ll)			-1.13		1.19	.841
				(-6.57)		(10.52)	

		PC	PT			E	R^2
Coffee	(sl)	-1.44				.68	.288
		(-1.73)				(2.87)	
	(ll)	-1.81	.30			.75	.260
		(-1.04)	(.09)			(2.28)	
Tea	(l)		.49			.10	.256
			(1.07)			(1.30)	
	(ll)	-.25	.87			.10	.269
		(-.60)	(1.11)			(1.24)	

		PFO	PS	PA	PTO	E	R^2
Fats and Oils	(ll)	-.32				.34	.465
		(-2.57)				(4.27)	
Sugar	(ll)		.02			.19	.363
			(.08)			(2.74)	
	(ll)			-6.57		1.09	.7610
				(-5.68)		(7.70)	
Alcoholic Beverages	(sl)			-5.52		.81	.840
				(-7.92)		(9.57)	
Tobacco	(ll)				-.07	.35	.224
					(-1.20)	(2.17)	

* Coefficients: log total expenditure = $\frac{-1.17}{(-7.82)}$;

Inverse of total expenditure = $\frac{-126.85}{(-4.64)}$.

Headings refer to quantity elasticities with respect to:

PWF = price of wheat flour
PWB = price of wheat bread
PM = price of maize
PRI = price of rice
POCG= price of other coarse grains
PMT = price of bovine and ovine meat
PP = price of poultry and eggs
PDA = price of dairy products
PFI = price of fish
PV = price of vegetables
PL = price of legumes
PF = price of fruits
PC = price of coffee
PT = price of tea
PFO = price of fats and oils
ps = price of sugar
PA = price of beer
PTO = price of tobacco
E = total expenditure

Table 12. Prices* for Commodity Groupings in Rural Kenya, 1974. (In Kenyan Shillings/Kg.)

	Central	Coast	Eastern	Nyanza	Rift Valley	Western
Grains	.66	.69	.62	.58	.58	.66
Meat and Fish	7.75	8.52	7.62	5.85	7.55	7.00
Fats and Oils	11.00	11.00	11.00	11.00	11.00	11.00
Dairy Products	1.60	1.60	1.71	1.33	1.57	1.63
Sugar	3.50	3.50	3.50	3.50	3.50	3.50
Fruits and Vegetables	1.18	1.62	1.22	1.06	1.14	1.04
Beverages	6.00	6.00	6.00	6.00	6.00	6.00
Other Foods (flavors)	2.00	2.00	2.00	2.00	2.00	2.00
Clothing	14.50	14.50	14.50	14.50	14.50	14.50
Other Non-food**	1.00	1.00	1.00	1.00	1.00	1.00

* Derived from retail price data from Kenya Statistical Abstracts and Shah (1979).

** Nonagricultural price indices by province were not available, so expenditure levels were used in the regressions for the tenth commodity rather than quantity levels.

Table 13. Expenditure and Own-Elasticity Estimates for Rural Kenya (t-statistic in parenthesis).

	Own Price, e_{ii}	Expenditure η_i	R^2
Grains and Roots	2.13 (2.78)	.71 (6.13)	.588
Meat and Fish	-4.71 (-7.87)	.75 (4.68)	.600
Fats and Oils	*	1.45 (7.95)	.599
Dairy Products	-2.62 (-3.01)	1.97 (10.54)	.729
Sugar and Sweets	*	1.01 (9.83)	.698
Fruits and Vegetables**	.08 (.09)	.82 (4.05)	.285
Beverages	*	1.15 (11.65)	.766
Clothes	*	1.42 (12.50)	.790
Nonagriculture	*	.958 (10.44)	.723

* No price variation was present due to price controls.
** In all rural elasticities estimates this category includes beans.

Table 14a. Rural Elasticity Estimates with Province Specific Intercept Terms. (t-statistics in parenthesis)

	C	DCO	DE	DN	DR	DW	LTEXP = η_1
Grains	1.83	.513	.306	-.354	-.570	-.211	.563
R^2 = .8310	(2.75)	(3.19)	(3.23)	(3.36)	(-3.75)	(-1.92)	(7.06)
Bought	2.55	.536	.307	-.581	-.706	-.351	.479
R^2 = .9102	(4.91)	(4.29)	(4.13)	(7.11)	(5.95)	(-4.10)	(7.44)
Home Produced	-2.71	.035	.282	.456	-.199	.0743	.853
R^2 = .0680	(-1.05)	(.06)	(.79)	(1.13)	(-.337)	(.175)	(2.67)
Meat	-3.91	.460	.055	1.58	.606	1.06	.903
R^2 = .7502	(-3.67)	(1.86)	(.361)	(9.43)	(2.48)	(5.05)	(6.65)
Bought	-5.41	.545	-.392	1.95	.432	1.16	1.02
R^2 = .1367	(-2.94)	(1.23)	(-1.49)	(6.74)	(1.02)	(3.62)	(4.49)
Home Beef	-33.70	2.66	-1.26	4.96	4.56	4.61	3.96
R^2 = .3015	(-2.27)	(.747)	(-.590)	(2.12)	(1.35)	(1.68)	(2.15)
Home Other Stock	4.12	.254	.377	.607	.295	.736	.786
	(-2.66)	(.730)	(1.82)	(3.55)	(.892)	(3.09)	(4.45)
Fats and Oils	-7.17	-.743	-.489	-.703	-2.08	-.610	1.23
R^2 = .8963	(-6.21)	(-3.52)	(-3.90)	(-5.11)	(-10.38)	(-5.62)	(11.34)
Dairy	-10.05	-.697	-.090	.502	1.11	-.0920	1.94
R^2 = .8069	(-7.31)	(-2.10)	(-.458)	(2.32)	(3.51)	(-.406)	(11.37)
Bought	-2.90	.381	-.343	-.426	-714	.292	.605
R^2 = .5617	(-2.12)	(1.16)	(-1.76)	(-1.995)	(-2.29)	(1.30)	(4.77)
Home Produced	-12.59	-1.33	-.066	.677	1.31	-.296	2.23
R^2 =.7577	(-6.63)	(-2.89)	(-.324)	(2.26)	(3.00)	(-.945)	(9.47)
Sugar	-3.69	-.135	-.536	-.299	-.0565	.0549	.992
R^2 = .8688	(-5.80)	(-.875)	(-5.87)	(-2.98)	(-.387)	(.522)	(12.57)
Fruits and Vegetables	.347	-1.105	.149	-654	-1.86	-.402	.571
R^2 = .8959	(.503)	(-6.53)	(1.51)	(-6.03)	(-11.80)	(-3.54)	(6.69)
Home Produced	-1.33	-1.88	.445	-1.84	-4.43	-.565	.686
R^2 = .8207	(-.645)	(-3.76)	(1.51)	(-5.67)	(-9.38)	(-1.66)	(2.70)
Bought	-.627	-.671	-.202	-.174	-1.23	-.257	.606
R^2 = .5468	(-.566)	(-2.51)	(-1.27)	(-1.00)	(-4.66)	(-1.41)	(4.42)
Beverages	-5.30	-.362	-.211	-.336	.0615	.186	1.09
R^2 = .8657	(-7.52)	(-2.13)	(-2.09)	(-3.03)	(.381)	(1.60)	(12.46)
Clothing	-6.26	-.587	-.0586	-.532	-.0015	-.2004	1.21
R^2 = .8617	(-7.22)	(-2.79)	(-.551)	(-3.69)	(-.0075)	(-1.396)	(11.24)
Nonagriculture	-3.45	-.117	-.166	.384	-.273	.0882	1.16
R^2 = .8798	(-6.09)	(-.852)	(-2.03)	(4.29)	(-2.10)	(.951)	(16.47)

Table 14b. Rural Elasticity Estimates with Province Specific Slope & Intercept Shifters. (t-statistics in parenthesis)

	C	DCO	DE	DN	DR	DW	COLEX	ELEX	NLEX	RLEX	WLEX	LTEXP
Grains	2.89	-3.71	-.972	-2.25	2.77	.341	.536	.160	.245	-.429		-0.081
R^2 = .8331	(1.14)	(-.993)	(-.347)	(-.822)	(.694)	(.116)	(1.14)	(.458)	(.709)	(-.851)	(-.217)	(1.42)
Meat & Fish	-13.41	6.27	9.16	13.27	13.22	10.56	-.710	-1.13	-1.48	-1.58	-1.16	2.09
R^2 = .8211	(-3.46)	(1.10)	(2.15)	(3.16)	(2.17)	(2.36)	(-.990)	(-2.13)	(-2.61)	(-2.06)	(-2.09)	(4.33)
Fats & Oils	-4.39	1.13	-3.06	-3.40	-9.69	-5.38	-.849	.320	.320	.335	.962	.562
R^2 = .8950	(-1.30)	(.227)	(-.820)	(-.929)	(-1.82)	(1.37)	(-.396)	(.686)	(.727)	(1.43)	(1.17)	(2.09)
Dairy	-5.70	2.23	-6.03	-4.75	1.27	-4.75	-.386	.744	.663	-.033	.583	1.39
R^2 = 7968	(-1.06)	(.280)	(-1.01)	(-.810)	(.149)	(-.758)	(-.386)	(.996)	(/899)	(-0.305)	(.733)	(2.06)
Sugar	-1.06	2.20	-1.36	-4.61	-.140	-4.84	-.306	.098	.561	.00322	.627	.664
R^2 = .9091	(-.518)	(.736)	(-.605)	(-2.18)	(-.043)	(-2.05)	(-.814)	(.349)	(2.09)	(.0079)	(2.10)	(2.61)
Fruit & Vegetables	4.43	-7.53	-5.18	-5.77	-6.63	-.805	.808	.667	.648	.596	.022	.063
R^2 = .9159	(1.85)	(-2.15)	(-1.97)	(-2.24)	(-1.77)	(-.291)	(1.83)	(2.03)	(1.20)	(1.26)	(.063)	(.213)
Bought Fruit & Vegetables	16.88	-12.35	-16.81	-9.74	-14.01	-10.96	1.46	2.08	1.17	1.60	1.33	-.828
R^2 = .7065	(3.27)	(-2.45)	(-4.46)	(-2.63)	(-2.60)	(-2.76)	(2.29)	(4.41)	(2.51)	(2.35)	(2.64)	(-1.94)
Beverages	-5.64	-1.16	1.91	-2.10	2.49	1.87	.104	-.269	.241	-.306	-.220	1.13
R^2 = .8751	(-2.26)	(-.303)	(.665)	(-.745)	(.605)	(.617)	(.214)	(-.749)	(.679)	(-.594)	(-.574)	(3.47)
Clothing	-7.55	2.06	1.05	2.39	-2.16	-.633	-.334	-.139	-.379	-.281	-.0676	1.36
R^2 = .8536	(-2.22)	(.408)	(.278)	(.641)	(-.402)	(-.158)	(-.524)	(-.294)	(-.609)	(.411)	(.134)	(3.22)
Nonag.	-1.06	-1.01	-3.67	-1.35	-6.62	-2.10	.108	.439	.209	.802	.272	.883
R^2 = .8824	(-.498)	(-.318)	(-1.54)	(-.577)	(-1.94)	(-.838)	(.265)	(1.47)	(.711)	(1.87)	(.856)	(3.20)

Headings refer to dummy variables with respect to:

DCO Coast Province
DE Eastern Province
DN Nyanza Province
DR Rift Valley Province
DW Western Province
COLEX Coast Province (log of expenditure)
ELEX Eastern Province (log of expenditure)
NLEX Nyanza Province (log of expenditure)
RLEX Rift Valley Province (log of expenditure)
WLEX Western Province (log of expenditure)

Table 15. Expenditure Elasticity Estimates for Three Rural Household Income Classes. (t-statistics in parenthesis)

	Low	Medium	High
Grains and Roots	.347	.147	.869
	(1.43)	(.635)	(2.61)
Bought	.521	-.086	.505
	(2.40)	(-.401)	(4.45)
Home Produced	-.361	1.93	2.12
	(-.352)	(2.28)	(1.39)
Fats and Oils	1.36	.0428	1.02
	(4.13)	(.134)	(2.61)
Meat and Fish	1.24	2.28	.856
	(3.96)	(2.12)	(2.79)
Bought	1.34	5.51	1.12
	(5.65)	(2.24)	(2.49)
Home Produced Beef	8.70	3.72	.264
	(1.12)	(.764)	(.103)
Home Produced Other Stock	1.02	.542	.194
	(1.88)	(1.63)	(.350)
Dairy	2.34	1.77	1.37
	(3.62)	(2.14)	(4.84)
Bought	.688	-1.53	.880
	(1.33)	(-1.28)	(1.56)
Home Produced	2.93	2.70	1.43
	(3.35)	(2.19)	(4.67)
Sugar	1.21	.271	.638
	(6.37)	(1.65)	(2.54)
Fruits and Vegetables	.316	.0022	.250
	(1.40)	(.0045)	(.985)
Bought	.814	-.175	-.254
	(2.63)	(-.226)	(-.636)
Home Produced	.346	1.92	2.08
	(-.806)	(2.29)	(1.49)
Beverages	1.16	.950	1.24
	(4.02)	(1.85)	(5.69)
Clothes	1.26	2.88	1.62
	(4.77)	(4.80)	(3.99)
Other Nonfood	.890	1.67	1.22
	(5.01)	(2.76)	(3.56)

Table 16. Alternative Estimates of the Flexibility of Money Parameter β and the Supernumerary Income Ratio φ for Nairobi 1974.

	Urban	Rural
1. Ratio of Price to Expenditure Elasticity	$\eta_{beef} = .490$	
	$w_{beef} = .0579$ $e_{beef} = -.507$	$\beta = -1.00$ $\varphi = 1.00$
$\beta = \frac{\eta_i(1-w_i\eta_i)}{e_{ii}+w_i\eta_i}$	$\beta = -0.99$ $\varphi = 1.01$	
2. Ratio of β to per capita expenditure in US dollars (1970) $\beta - 36\,\bar{X}^{.36}$	$\beta = -4.57$ $\varphi = .219$	$\beta = -8.71$ $\varphi = .115$
3. Ratio of Lowest Expenditure Level (X_L) to Average Expenditure Level (X_A) $\varphi = \frac{X_A - X_L}{X_A}$	$\beta = -2.04$ $\varphi = .49$	$\beta = -2.73$ $\varphi = .366$

Table 17. LES Parameter Estimates for Urban Kenya.

	Marginal Budget Share	Subsistence expenditure	Expenditure Elasticity	Own Price Elasticity	Average 1974 Budget Share
	b	pc	η_i	e_{ii}	w_i
Wheat Bread	.0097	60.1	.390	-.197	.0249
Wheat Flour	.0033	10.6	.626	-.306	.0052
Rice	.0045	10.8	.769	-.377	.0058
Maize	.0000	158.4	.000	0.000	.0532
Other Coarse Grains	.0037	3.3	1.060	-.514	.0007
Fats and Oils	.0093	67.8	.339	-.172	.0273
Sugar	.0049	71.2	.187	-.095	.0263
Bovine and Ovine Meat	.0272	133.0	.469	-.249	.0579
Poultry and Eggs	.0116	18.3	.987	-.486	.0118
Dairy	.0312	79.6	.745	-.382	.0419
Fish	.0045	14.0	.648	-.318	.0069
Vegetables	.0097	79.2	.311	-.159	.0313
Legumes	.0008	40.0	.061	-.031	.0138
Fruits and Nuts	.0090	9.2	1.200	-.587	.0075
Coffee	.0007	2.2	.679	-.330	.0011
Tea	.0007	20.0	.102	-.050	.0064
Alcoholic Beverages	.0140	31.0	.813	-.404	.0172
Tobacco	.0028	28.6	.255	-.126	.0110
Nonagriculture	.8524	701.7	1.320	-.952	.6498
	.1000	1532.0			1.0000

Average per capita expenditure = Kenyan Shillings 2980.

φ = .486

Subsistence expenditure = Kenyan Shillings 2980. (1 - φ) = Kenya shillings 1532.

Table 18. LES Parameter Estimates for Rural Kenya.

	Marginal Budget Share	Subsistence expenditure	Expenditure Elasticity	Own Price Elasticity	Average 1974 Budget Share*
	b	pc	η_i	e_{ii}	w_i
Grains and Roots	.249	90	.71	-.443	.351
Meats and Fish	.078	26	.75	-.332	.103
Fats and Oils	.035	39	1.45	-.547	.024
Dairy Products	.190	105	1.90	-.753	.100
Sugar and Sweets	.050	109	1.01	-.402	.050
Fruits, Vegetables, Beans	.059	177	.82	-.340	.073
Other Food	.059	102	1.15	-.455	.051
Clothing	.133	156	1.42	-.584	.094
Nonagriculture	.147	346	.968	-.447	.154
	1.00	2188			1.00

Average per family expenditure = Kenyan Shillings 3450.
φ = .366
subsistence expenditure = Kenyan Shillings 3450.*
(1 - φ) = Kenyan Shillings 2188.

* Includes home-produced products (see Table 5).

Table 19a. AIDS Parameter Estimates for Urban Kenya Using Consumer Price Index. (t-statistics in parenthesis)

	α	γ_{wbr}	γ_{ma}	β
Wheat Bread	-.0279 (-1.51)	.0715 (3.55)	-.483 (-2.96)	-.0127 (-7.33)
Maize	.0987 (2.45)	-.0180 (-.409)	.0342 (.961)	-.0401 (-10.65)
	α	γ_{bom}	γ_{p}	β
Bovine and Ovine Meat	.117 (2.45)	.0167 (1.89)	-.0289 (-1.03)	-.0278 (-8.97)
Poultry and Eggs	-0.182 (-.938)	-.00657 (-1.85)	.0193 (1.79)	-.000459 (-.366)
	α	γ_{bom}	γ_{da}	β
Bovine and Ovine Meat	.0818 (4.66)	.0313 (1.54)	-.119 (-1.08)	-.0278 (-8.97)
Dairy	.0907 (7.36)	.0672 (4.70)	-.3466 (-4.48)	-0.115 (-5.27)
	α	γ_{veg}	γ_{fr}	β
Vegetables (not roots)	.171 (5.53)	-.459 (-4.16)	.574 (4.28)	-.0148 (-8.23)
Fruits	.015 (1.07)	-.033 (-.657)	.0403 (.66)	.00145 (1.77)
	α	γ_{veg}	γ_{leg}	β
Vegetables	.112 (6.51)	.0995 (4.88)	-.1207 (-4.28)	-.0148 (-8.33)
Legumes	.0083 (.705)	-.0077 (-.553)	.0168 (.872)	-.0084 (-6.82)

Table 19b. AIDS Parameter Estimates for Urban Kenya Using Weighted Price Index. (t-statistics in parenthesis)

	α	γ_{wbr}	γ_{ma}	β
Wheat Bread	-.0045 (-.256)	.0807 (4.08)	-.0554 (-3.47)	-.00846 (-7.50)
Maize	.170 (3.69)	.0109 (.228)	.0110 (.283)	-.0262 (-9.56)
	α	γ_{bom}	γ_{p}	β
Bovine and Ovine Meat	.197 (4.58)	.0215 (2.63)	-.0366 (-1.49)	-.0188 (-9.79)
Poultry and Eggs	-.0175 (-.950)	-.0065 (-1.86)	.0202 (1.91)	-.00059 (-.717)
	α	γ_{bom}	γ_{da}	β
Bovine and Ovine Meat	.1515 (9.21)	.03996 (2.13)	-.1510 (-1.40)	-.0188 (-9.79)
Dairy	.1190 (9.46)	.0711 (4.96)	-.363 (-4.68)	-.0075 (-5.14)
	α	γ_{bom}	γ_{fish}	β
Bovine and Ovine Meat	.1346 (10.86)	.0301 (2.37)	-.0188 (-1.49)	-.0188 (-9.79)
Fish	.0138 (2.87)	.0093 (1.98)	-.0081 (-1.65)	-.0017 (-2.30)
	α	γ_{veg}	γ_{fr}	β
Vegetables	.222 (6.57)	-.515 (-4.29)	.642 (4.39)	-.0095 (-7.27)
Fruits	.0099 (.715)	-.0284 (-.5575)	.0346 (.576)	.0010 (1.86)
	α	γ_{veg}	γ_{leg}	β
Vegetables	.157 (8.04)	.110 (4.95)	-.135 (4.39)	-.0095 (-7.27)
Legumes	.033 (2.60)	-.0018 (-.123)	.0088 (.433)	-.0054 (-6.26)
Nonfood				.1097 (18.49)

Table 20. AIDS Parameters for Rural Kenya. (t-statistics in parentheses)

	α^*	γ_{grain}	$\gamma_{meat\&fish}$	γ_{dairy}	$\gamma_{fruitsandvegetables}$	β
1. Grains	2.12 (4.51)	.408 (1.90)	-.8917 (-3.37)	.893 (3.90)	.973 (6.48)	-.0758 (-3.50)
2. Meat & Fish	2.166 (4.77)	.353 (1.71)	-.740 (-2.89)	-.079 (-.358)	.157 (1.08)	-.061 (-2.90)
3. Dairy	-2.95 (-7.50)	-1.08 (-5.99)	1.17 (5.27)	-.673 (-3.51)	-.654 (-5.20)	.107 (5.90)
4. Fruits & vegetables	.355 (1.40)	-.0022 (-.019)	-.198 (-1.38)	.362 (2.92)	.101 (1.24)	-.012 (-.987)
5. Fats & Oils	-.130 (-1.08)	.087 (1.58)	.101 (1.49)	-.103 (-1.78)	-.044 (-1.14)	.0089 (1.59)
6. Sugar	-.107 (-.779)	.203 (3.17)	-.206 (-3.31)	-.226 (-3.31)	-.16 (3.57)	-0.0013 (-.20)
7. Beverages	-.138 (-1.19)	.080 (1.52)	.129 (1.97)	-.051 (-.902)	-.140 (-3.79)	.0031 (.589)
8. Clothing	-.929 (-2.47)	-.197 (-1.15)	.477 (2.25)	-.093 (-.509)	-.274 (-2.29)	.016 (.937)
9. Other	.473 (2.62)	.188 (2.29)	-.173 (-1.70)	-.122 (-1.39)	-.0064 (-.111)	.020 (2.42)

Table 21. 1974 Elasticity Estimates for Urban Areas Using AIDS Demand Functions and Consumer Price Index.

	η_i	e_{ii}	e_{ij}		Budget Share W_i
1. Wheat Bread	.490	1.87	-19.40	(maize)	.0249
2. Maize	.246	-.357	-.338	(wheat bread)	.0532
3. Bovine & Ovine Meat	.520	-.712	-.499	(poultry & eggs)	.0579
			-2.06	(dairy)	
4. Poultry & Eggs	.961	-3.45	-.556	(bovine & ovine meat)	.0118
5. Dairy	.726	-9.29	1.60	(bovine & ovine meat)	.0419
6. Vegetables	.527	-15.66	18.34	(fruits & vegetables)	.0313
		2.18	-3.86	(legumes)	
7. Fruits	1.193	4.37	-4.4	(vegetables)	.0075
8. Legumes	-.12	1.24	-1.03	(legumes)	.0138
Nonagriculture*	1.169				.6498

* Using parameter estimates with weighted price index rather than consumer price index.

Table 22. 1974 Elasticity Estimates for Rural Areas Using AID's Demand Functions and Weighted Price Index.**

	η_i	e_{ii}	e_{ij}		Budget Share W_i
1. Grains	.784	.162	-2.54	(meat & fish)	.351
			2.54	(dairy)	
			2.77	(fruits & vegetables)	
2. Meat & Fish	.408	-8.18	3.43	(grains)	1.03
			-.767	(dairy)	
			1.52	(fruits & vegetables)	
3. Dairy	2.07	-7.73	-10.8	(grain)	.100
			11.7	(meat & fish)	
			-.654	(fruits & vegetables)	
4. Fruits & Vegetables	.836	.384	-.030	(grain)	.073
			-2.71	(meat & fish)	
			4.96	(dairy)	
5. Fats & Oils	1.37	*	*		.024
6. Sugar	.974	*	*		.050
7. Beverages	1.06	*	*		.051
8. Clothing	1.170	*	*		.094
9. Other Nonagriculture	1.130	*	*		.154

* No price variation across provinces.
** Home-produced commodities included.

Table 23. Maize Farmer/Retail Price Spread and the Farmer's Share.

	Net Farm-gate value equivalent			Retail Value			Farm-Retail Price Spread			The Farmer's Share		
	n	wh/f	wh/b	n	wh/f	wh/b	n	wh/f	wh/b	n	wh/f	wh/b
1972	0.52	0.78	0.31	0.85	1.35	0.85	0.33	0.57	0.54	61	58	36
1973	0.52	0.87	0.35	0.85	1.35	1.05	0.33	0.48	0.70	61	64	33
1974	0.62	1.23	0.48	0.95	1.62	1.11	0.33	0.39	0.63	65	76	43
1975	0.94	1.61	0.64	1.38	2.46	1.48	0.44	0.85	0.84	68	65	43
1976	1.02	1.79	0.71	1.40	2.50	1.50	0.38	0.71	0.79	73	72	47

e.g. 1972

90 kg bag leaving a farm x 0.83 milling · · · = 67 kg Maize flour x 0.95

= 64 kg Maize flour at retail level.

$$\frac{\text{90 kg shelled maize at farm gate}}{\text{64 kg retail flour}} = 1.41 \text{ kg shelled maize equivalent}$$

REFERENCES

Government of Kenya

Urban Food Purchasing Survey, 1977, Part 1, Central Bureau of Statistics, GOK/UNDP/FAO Food Marketing Project, Nairobi, 1979.

Intergrated Rural Survey 1974-75, Basic Report, Central Bureau of Statistics, March 1977, Nairobi

"Yields, Costs, Prices 1979" Ministry of Agriculture, 1980, Nairobi

"Kenya Statistical Abstracts" Various Issues 1968-76, Central Bureau of Statistics, Nairobi

"Urban Household Budget Survey 1968/69", Central Bureau of Statistics, Nairobi

"Rural Household Survey Nyanza Province 1970/71" Central Bureau of Statistics, Nairobi, March 1977

"Consumer Price Indices Nairobi" Central Bureau of Statistics, Nairobi, March 1977

"Nairobi Household Budget Survey 1974" Central Bureau of Statistics, Nairobi

"The Pattern of Income, Expenditure and Consumption of African Middle Income Workers in Nairobi" Central Bureau of Statistics, Nairobi, July 1963

"Economic Survey of Central Province, 1963-64, Central Bureau of Statistics, Nairobi, 1968

Casley, D. and T. Marchant "Smallholder Marketing in Kenya" Central Bureau of Statistics, GOK/UNDP/FAO Food and Marketing Project, Nairobi, May, 1979

Deaton, A. and J. Muellbauer, An Almost Ideal Demand System, American Economic Review, June 1980, pp. 312-326

Frisch, R., A Complete Scheme for Computing all Direct and and Cross Price Elasticities in a Model with Money Sectors, Econometrica, 27, 1959.

Lluch, C., A.A. Powell and R.A. Williams, Patterns of Household Demand and Saving, Oxford University Press, 1977

Mukui, J.T.,(editor), Price and Marketing Control in Kenya, Institute for Development Studies, University of Nairobi, Occasion Paper No. 32, 1979

Shah, M.M.,"Food Demand Projections Incorporating Urbanization and Income Distribution: Kenya 1975-2000, FAO-UNDP-Kenya Food Marketing Project, 1979, Nairobi

Shah, M.M. and F. Willekins, Rural-Urban Population Projections for Kenya and Implications for Development, RM-78-55, IIASA, Nov. 1978

Schmidt, G., Maize and Beans Marketing in Kenya: The Interaction and Effectiveness of Informal and Formal Marketing Systems, Project Working Paper, GOK/UNDP/FAO Marketing Development Project, Sept. 1979, Nairobi