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Food Calorie Intake and Food Security under Grain Price Inflation: Evidence from Malawi

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ABSTRACT

A comprehensive analysis of food demand and nutrient consumption using recent, representative household survey data from Malawi is presented. Expenditure and price elasticities have been estimated for 20 food groups using a quadratic almost ideal demand system based on 4 income groups identified by the Goldfeld-Quandt tests. Although the current boom of maize price provides an opportunity to rethink development strategies that diversify the commodity sectors, developing countries will not necessarily benefit from this change absent significant improvements in production capacities and trade infrastructures. Malawi is likely to suffer from higher commodity prices in the short-run.

Key words: Goldfeld-Quandt tests; a quadratic almost ideal demand system; Malawi
JEL codes: D12; O13; R21; R31; Q11; Q12

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Introduction

The 2007/08 global food price crisis and the global financial crisis soon thereafter brought about considerable strain on world food consumption and security. In Malawi, the monthly maize retail price in Lilongwe almost tripled from 20 Kwacha/kg in August 2007 to 59 Kwacha/ka in August 2008. In developing countries like Malawi where national capacities for timely and forward-looking assessments of the global and local food situation are weak, national responses to food crises are delayed. To bring to bear the urgency to develop more effective strategies, it is critical to evaluate the impacts of the recent crisis on households' food calorie intake.

Although food insecurity is linked to a number of adverse health and social outcomes, it is closely linked with income and wealth inequality and with social exclusion and disadvantage in developed countries. The Food and Agriculture Organization (FAO), in its measure of food deprivation, refers to food insecurity as the prevalence of undernourishment based on a comparison of usual food consumption expressed in terms of dietary energy(kcal) against a certain energy requirement norm (FAO, 2002). The part of the population with food consumption below the energy requirement norm is considered undernourished ("underfed").

Numerous theoretical and empirical studies have attempted to explain households' food calorie intake decision (Aromolaran, 2004; Akinleye & Rahji 2007; Pan, Fang, and Rejesus, 2009). But only few of these studies have looked at the nutritional or caloric intake decision specifically in the presence of grain price inflation. That the expected price of grains plays a significant role in the amount of food calorie intake is a reasonable presumption, especially in an environment like Malawi where maize accounts for most of the prescribed daily nutritional value. As one of the poorest developing countries in the world, an evaluation of Malawi households' food calorie intake decision in the presence of grain price inflation would provide insights that have not been observed in previous studies. These insights have important implications for the design of nutritional and public health policies that can assist in the alleviation of hunger in Malawi and in other less-developed countries. As far as we know, Ecker and Qaim (2008) was the only paper to analyze the prevalence of nutritional deficiencies and estimate expenditure (income) and price elasticities for calories and twelve essential macro- and micronutrients in Malawi. However, they did not estimate the elasticites based on income categories. As Jensen and Manrique (1999) suggested, it is neither effective nor useful to analyze all consumers as one group if policymakers are concerned with the effects of policy adjustments on the well-being of specific target groups.

Therefore, the objective of this paper is to examine whether grain output price inflation significantly influences the amount of food calorie intake in Malawi. To this end, a household food calorie intake model was developed to evaluate the price inflation effects.

Data and Classification of Households by Income Groups

The data are from a cross-section survey of the second Malawi Integrated Household Survey (HIS-2), which was carried out over one year in 2004/05. The sample comprises 11,280 households and is representative nationwide at the district level. Farm prices and retail prices are imputed prices based on regional prices and other demographic variables to account for locational and quality differences. Food production values are derived by multiplying quantities produced by regional farmgate sale prices.

Household food consumption was surveyed through a seven-day recall. The survey data on food consumption includes food purchased in the market, obtained from own production, and purchased or consumed away from home.

To assess consumed nutrient amounts from food quantities, we apply conversion factors of the World Food Dietary Assessment System (WFOOD2 1996). Expenditure on each food item included purchased food plus the value of nonpurchased food items. In addition to purchased quantities and monetary values, the survey provided information on the quantities of food that were not purchased (such as food from home production, gifts, free food, and so forth). The nonpurchased quantities were assigned monetary values by evaluating them at (mean) imputed prices and these values were then added to expenditures on purchased food items. The nonpurchased quantities were evaluated separately for rural and urban households by using appropriate prices. Nonpurchased food represented about 10-97 percent of related food consumption. Maize, groundnut, bean, and other crops have relatively stable self sufficiency rates while self sufficiency rates for protein products such as chicken are relatively low.

For estimation purposes, expenditures on various food commodities were aggregated into 20 categories: maize, other grains, cassava, other roots stuff, groundnut, bean, other pulses, banana, mango, other fruits, leaf vegetables, other vegetables, beef, chicken, beef, other meats, eggs, fish, sugar and confectionery items, alcoholic products, and other beverages (Figure 2).

As would be expected from the observations, the income distribution is heavily skewed. Differences in income and household characteristics lead to differences in household behaviors in the acquisition of goods. Food expenditures are almost completely explained by income for low- income households while a host of other factors such as household demographic characteristics account for high-income households' food expenditures. Households were classified into income groups based on an analysis of the homogeneity of variances of residuals. Following Jensen and Manrique (1999), the procedure has two basic steps: estimation of Engel relations and tests for homoskedasticity of variances. Successive Goldfeld-Quandt tests using the residuals from the Engel estimation were performed in order to classify the household observations into groups with different variances. Following Jensen and Manrique (1999), the 11,280 observations in the sample were grouped into four: poor, less poor, less rich, and, rich.

Weekly household food expenditure is used to measure the food purchasing power of a household. Table 1 shows that the weekly average food expenditure for the poorest (accounts for 22% of the sample size, stratum I), the less poor (stratum II) and the less rich (stratum III) corresponded to only 14%, 24% and 39% of weekly food expenditure for the richest (accounts for 11% of the sample size, stratum IV). Average food expenditure shares of the four strata are also shown in the lower part of Table 1. In Table 1, the high-income group has relatively higher expenditure shares in protein products such as beef, and chicken, as well as in alcohol consumption than those in other strata.

Next, we apply conversion factors of the World Food Dietary Assessment System (WFOOD 1996) to assess consumed nutrient amounts from food quantities. The distribution of total caloric consumption was also found to be skewed in favor of higher incomes. The average daily per capita intake of calories for the sample as a whole is estimated to be 2801, 133% of international standard requirement (2100 calorie daily per capita). Therefore, no additional food would be needed if available food were distributed evenly. However, because of the skewed distribution of available food, the average daily per capita calorie intake in rich households (stratum I) was twice as much as those in the poor households (stratum IV), and 30% of the sample households were deficient in calories.

Data on the Normalized Difference Vegetation Index (NDVI)[1] was provided by the Geographic Information Systems (GIS) group under the World Food Program. Macroeconomic data such as the consumer price index (CPI), gross domestic product (GDP), and the exchange rate are from *Global Insight*.

Methodology

A household food calorie intake model is developed based on the survey data. It includes four major sections: income (includes both agricultural and non-agricultural income) generation; food demand estimation (self-consumption and food purchased in the market); partial equilibrium modeling and estimation to derive price changes; and food calorie intake estimation. Figure 1 presents the basic model structure.

In the first step, climate conditions, expected output prices and a Cobb-Douglas production specification are used to estimate the production function at the household level. In the second step, a quadratic almost ideal demand system is used to estimate the demand for different food categories. To account for the price changes and domestic food shortage endogenously, we linked the net surplus in a specific household for the major crops such as maize (production-demand) with the net import equation in the regional partial equilibrium. It is expected that the domestic price would increase if household net surplus decreases; the

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[1] The Feb NDVI is used to estimate the yield equation. In Malawi, maize is harvested in May. Feb is the main growing month.

domestic price would decrease if household net surplus increases. Following this setup, a price increase leads to higher production and generates more income for farmers but at the same time decreases urban households' and net rural consumers' purchasing power and subsequently, lower food calorie intake. However, the net effects of a price increase on the average food calorie intake would depend on the household size of rural and urban population, food calorie income as well as price elasticities.

Income Generation Sector

The first part of the Malawi food calorie intake model covers agricultural income and non-agricultural income. Agricultural income is derived from the summation of agricultural production while non-agricultural income is linked to GDP, national wage rate, and the CPI.

(1) $A_{ij} = f(P_{io}, P_{ic}, Land_j, HHSIZE_j)$

(2) $y_i = f(NVP_i, rain, time)$

(3) $I_{io} = f(GDP, Wage\ Rate, CPI)$

(4) $I_i = \sum_{i=1}^{K} P_{io} A_i y_i + I_{io}$

Equation (1) indicates that harvesting acreage of a specific crop *i* (for example, maize) is a function of its own price, competing crop prices, total land owned in the household, and household size. Equation (2) indicates that yield is a function of rainfall, the Feb NDVI, and a time trend that represents technology development. Equation (3) indicates that non-farm income in a household such as wage income is a function of GDP, wage rate, and CPI. Equation (4) is total income that includes farm income (summation of all crop values planted in the household as well as livestock values) and non-farm income.

Self - Consumption Sector

The second part of the model is related with self food consumption. In most developing countries, semi-subsistence agriculture remains the dominant type of agriculture. Under semis-subsistence agriculture, farmers produce mainly for self-consumption, but also sell a certain part of the production ("surplus").

To account for self-consumption, we create a market share equation that allows the output and income variables to be endogenous and use instrumental variables to identify their effects on the market participation decision. Following Kan, Kimhi, and Lerman (2006), "the aim of the household is to maximize utility over consumption of farm products as well as non-farm products and leisure. Purchase of non-farm products can be paid from proceeds of sales of farm products and/or non-farm income. Income effects increase consumption of both farm products and non-farm products, and also leisure. An increase in non-farm income, holding farm output constant, has a negative net effect on market participation, since the household demand for farm products increases. On the other hand, holding non-farm income constant, an increase in farm output has a positive direct effect on market participation but also a negative indirect effect resulting from the income effect on consumption."

(5) $S_i = f(y_i, I_{io}, HHSIZE_i, AGE_i)$

Equation (5) indicates that the share of farm output sold in the market (S) for household *i* depends on farm output (*y*), non-farm income (*I*), household size (*HHSIZE*), and age of household head (*AGE*). The equation is simultaneously solved with equations (1), (2), (3), and (4). Those equations are used to estimate the total food expenditure for households.

Food Demand Sector

The third part of the model involves estimation of a household food demand system. To estimate the parameters of the food demand system considered in Figure 1, we adopt the Nonlinear Quadratic Almost Ideal Demand System (NQAIDS) developed by Banks, Blundell and Lewbel (1997). Existing literature points to several advantages of the NQAIDS over other flexible demand systems. In particular, these refer to the flexibility of including nonlinearities and interactions with household-specific characteristics in the utility function (which can be important for household survey data), as well as better forecasting performance (Blundell, Pashardes, and Weber, 1993; Lyssiotou, Pashardes and Stengos, 2002).

NQAIDS Model

The NQAIDS specification used in this study can be represented as follows:

(6) $$w_i = \alpha_i + \sum_j \gamma_{ij} \ln P_j + \beta_i (\ln y - \ln P) + \frac{\lambda_i}{\prod_j p_j^{\beta_i}} (\ln y - \ln P)^2 + \sum_{ik} \kappa_{ik} R_k + \varepsilon_i$$

where P is the corresponding price index, w_i is the budget share of the i^{th} good, ε_i is the error term, and the α's, β's, λ's and κ's are parameters to be estimated. R's are dummy variables corresponding to different demographic characteristics. Furthermore, the price index P in equation (6) is defined as:

(7) $$\ln P = \alpha_0 + \sum_j \alpha_j \ln p_j + \frac{1}{2} \sum_j \sum_i \gamma_{ij} \ln p_i \ln p_j \ .$$

The use of equation (7) in estimating the budget share equation in (6) implies that the model is truly non-linear. We did not replace (7) by any linear approximations because such approximations give rise to additional difficulties (Buse 1994; Green and Alston 1990; Thompson 2004).

Following Pofahl, Capps, and Clauson (2005) and Thompson (2004), the uncompensated price and income elasticities are:

(8) $$\eta_{ij}^{2ndStage} = \frac{\partial \ln Q_i}{\partial \ln P_j} = -\delta_{ij} + \frac{\partial \ln w_i}{\partial \ln P_j} = -\delta_{ij} + \frac{1}{w_i}\frac{\partial w_i}{\partial \ln P_j}$$

where

(8a) $$\frac{\partial w_i}{\partial \ln P_j} = \{\gamma_{ij} - \beta_i(d_A - 1)\frac{\partial \ln P}{\partial \ln P_j} + \frac{\lambda_i(\ln y - \ln P)}{(\prod_j P_j^{\beta_i})}[2(d_A - 1)\frac{\partial \ln P}{\partial \ln P_j} - (\ln y - \ln P)\beta_i]\}$$

(8b) $$\frac{\partial \ln P}{\partial \ln P_j} = \alpha_j + 0.5 * \gamma_{ii} \ln P_i + \sum_{i \neq j} \gamma_{ij} \ln P_i$$

(8c) $$\delta_{ij} = \begin{cases} 1 & if\ i = j \\ 0 & otherwise \end{cases}$$

Income elasticities are computed as:

(8d) $$\varepsilon_i^{2ndStage} = d_Y(1 + \frac{\partial \ln w_i}{\partial \ln y}) = d_Y(1 + \frac{1}{w_i}\{(\beta_i + \frac{2\lambda_i}{\prod_j P_j^{\beta_i}}(\ln y - \ln P))\})$$

The compensated price elasticites can be estimated by Slusky equation.

Food Calorie Elasticity Calculation

Following Beatty and Lafrance (2001, 2005), calorie intake can be thought as a production process that uses food as inputs. We can combine the income and price elasticities of foods and the nutrient content of foods to obtain price and income elasticites for nutrients. Following their suggestions, the total amount of calories consumed is a linear function of the amount of food ingested. Therefore, the compensated and uncompensated price elasticities of calories can be written as a weighted average of own- and cross price food elasticties:

$$e_k^N = \sum_{j=1}^{k} s_j e_j^q \tag{9}$$

where e_k^N is the (compensated or uncompensated) price elasticity of food calorie intake with respect to the price of food *k*, e_j^q is the corresponding (uncompensated or compensated) price elasticity of food *j* with respect to the price of food *k*, and S_j is the proportion of calories that is contributed by food item *j*. Similarly, the income elasticity of calories is derived as:

$$e_m^N = \sum_{j=1}^{m} S_j e_j^N \tag{10}$$

where e_j^N is the income elasticity of food calorie intake with respect to food *j*.

Results

Food Expenditure and Price Elasticities

Differences in consumption behavior and demand for food across income groups show the importance of estimating separate food demand parameters for the income groups in Malawi.

Table 2 presents expenditure elasticities for the 20 food categories examined in our study. For poor families, only maize, root stuff, pulse, tomato and leafy vegetables had relatively low expenditure elasticities; all other food demands either had total expenditure elasticties more than unity or close to unity. However, only the expenditure elasticity of beef was larger than one. As the consumption behavior of less rich families is pretty similar to rich families, this suggests that most foods especially beef are still considered luxury goods across all households.

The matrix of uncompensated own-price, cross-price and total expenditure elasticities for all income groups are not presented here in the interest of space.[2] Essentially, all the own-price elasticities are negative which suggest that all goods are normal goods. For most food categories, the estimated price elasticities were relatively higher in low-income groups than those for high-income groups. In general, households were more responsive to own-price changes than to cross- price changes. Households in poor and less poor groups showed greater own-price elasticities and stronger cross-price effects than households in the high income group. Cross-price effects were statistically significant for only small portion of commodity groups. In general, demand was price elastic for most of the food categories in poor and less poor households.

Food Calorie Elasticities

Table 4 shows the implied food calorie expenditure elasticities evaluated at population means. Unsurprisingly, the high expenditure elasticity for starchy foods entails high calorie elasticity. The food calorie expenditure is elastic in poor and less poor households while it is inelastic in less rich and rich households.

Table 5 presents the food calorie own price elasticities evaluated at population means. The cross-price elasticities are not presented since most of them are statistically

[2] Available from the authors upon request.

insignificant. Except maize and root stuff, other food items have relatively low absolute magnitudes. These results suggest that increasing maize and root stuff prices will have more effects on calorie intake as compared to the other food items. Given that maize and root stuffs are also a staple food for lower-income families in Malawi, increasing maize and root stuff prices would likely worsen the nutritional status of households in the country.

Model Policy Scenarios

A major goal of agricultural modeling is to model the effects of changes in policies and technologies. The model created based on the estimated calorie elasticities can be used to simulate the nutritional outcomes of policies or other external shocks. We evaluate the effects of maize price increases on household food calorie intake. The effect on every single household in the data set is simulated in order to derive new mean consumption levels of calories and nutrients and new prevalence rates of associated deficiencies.

The rise of maize prices in 2008 - when the FOB gulf price increased from $155 per metric ton to $218 per metric ton (41%) - has several interrelated causes: a rapidly expanding industrial production that drives the demand for biofuels, a relatively high growth of the population in the developing world, a tightening of fundamentals in commodity markets, and an associated increase of speculative activities (Flassbeck and Boffa, 2009; UNCTAD, 2009; Herrmann, 2009). The effects of commodity price increases on household food calorie intake have several consequences. Foremost, it increases the cost of commodity purchases. How food price inflation affects different consumers strongly depends on income levels. The effects are worse for low-income groups since the demand for maize is relatively inelastic and rising food prices will have negative effects on real disposable income. Second, it increases production income. Based on Anderson, Martin, and van der Mensbrugghe (2006), world agricultural prices grew by about 21 per cent cumulatively between the 1990s and 2003-2008. Such a price shock would lead to an annual increase in agricultural output by 6.3 percent in developing countries. However, the increase in world market prices has had very small benefits for producers in most low-income countries due to frail infrastructures as well as weak productive capacities (FAO, 2008; Conforti, 2004; Baffes and Gardner, 2003).

Figure 3 presents undernourishment population share changes before and after the maize price shock in the different regions of Malawi. The most striking result from this analysis is that increasing maize prices raises significantly the share of the undernourished in the population in most of the regions. Although the current boom in maize prices provides an opportunity to rethink development strategies to diversify the commodity sectors, developing countries will not automatically benefit from this change absent significant improvements in their production capacities and trading infrastructure. Malawi, especially households in the low-income categories, is likely to suffer from higher commodity prices in the short-run.

Conclusion

In this article, we have presented a comprehensive analysis of food demand and nutrient consumption using recent, representative household survey data from Malawi. Expenditure and price elasticities have been estimated for 20 food groups using a quadratic almost ideal demand system based on 4 income groups identified by the Goldfeld-Quandt tests.

The government of Malawi, as well as international organizations such as FAO, WFP, the World Bank, are interested in food markets to provide a stable and consistent nutrition supply for all the households. The resulting food price increases have had differential effects on consumers as well as commodity producers across income groups. The results in the paper suggest that different income groups consume different types of foods and have different demand responses to price and income changes. Low-income households are unlikely to benefit from a price surge in the short run. In order to benefit from a price increase in the medium run, it is imperative to facilitate trade by developing trading infrastructures that allow for more transparent and timely transmission between world market prices and producer prices.

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Figure 1. Malawi Food Calorie Intake Model Structure

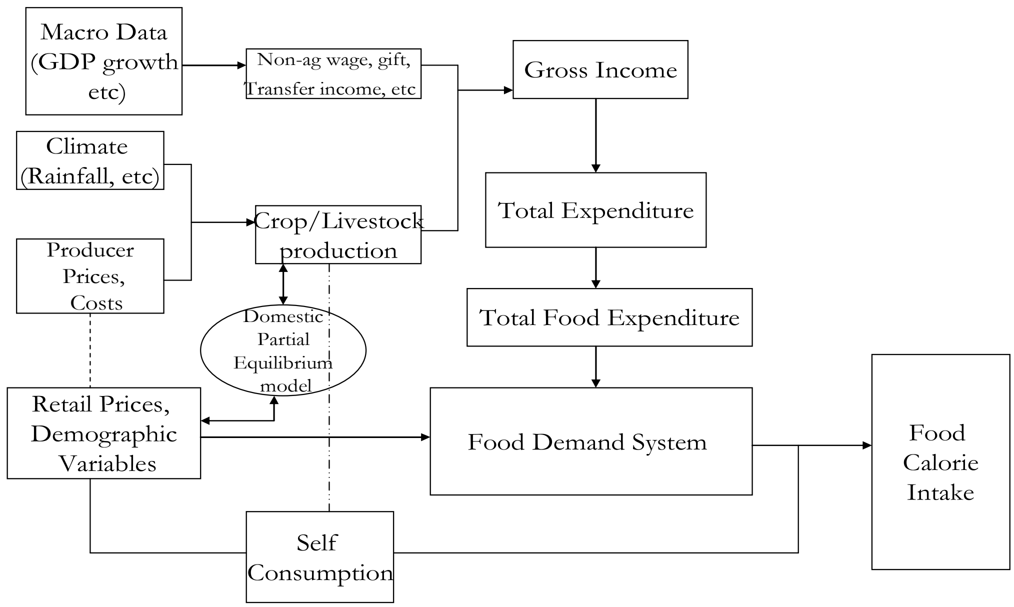

Figure 2. Expenditure Structure at Malawi Household

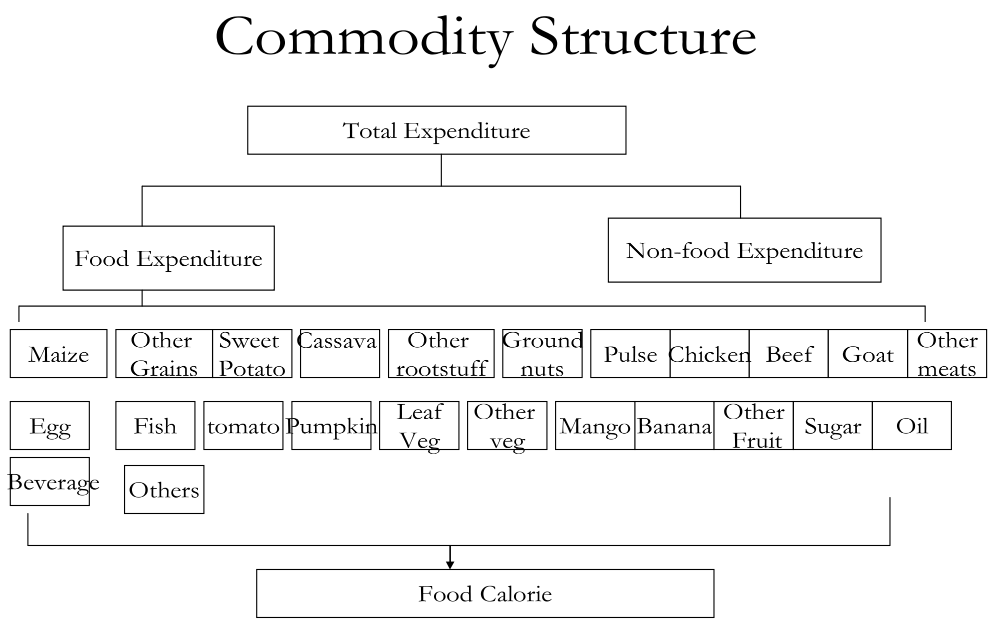

Table 1. Basic Statistics

	Poor		Less Poor		Less Rich		Rich		Total	
	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev
Food from Home Production										
Maize	6.42	7.31	9.99	10.21	10.18	62.05	12.40	105.56	8.25	11.59
Rice	0.05	0.38	0.17	7.09	0.20	1.29	0.29	4.40	0.17	4.83
Cassava	1.60	7.34	2.37	5.71	2.91	6.95	2.31	15.89	2.31	6.59
Ground nuts	0.27	0.37	0.75	3.33	1.02	2.78	1.16	5.63	0.83	2.36
Chicken	0.03	0.25	0.10	0.15	0.18	0.85	0.23	0.79	0.12	0.51
Beef	0.00	0.09	0.00	0.23	0.01	0.62	0.42	1.02	0.05	0.49
Potato	0.53	1.97	0.93	4.22	1.22	9.78	0.81	4.25	0.89	2.63
Beans	0.63	1.79	0.77	14.62	0.86	23.32	3.48	14.17	1.06	9.79
Consumption Quantity										
Maize	10.91	9.35	13.60	20.65	15.15	70.31	18.49	82.25	12.58	16.14
Rice	0.11	0.54	0.45	7.13	0.72	1.73	1.44	3.77	0.55	5.01
Cassava	2.50	9.44	3.37	10.98	4.41	15.99	4.22	13.44	3.50	12.86
Ground nuts	0.33	1.07	0.91	3.82	1.13	2.71	1.45	4.82	0.99	3.06
Chicken	0.04	0.31	0.12	0.36	0.28	0.99	0.54	1.12	0.19	0.68
Beef	0.01	0.09	0.04	0.24	0.15	0.58	0.86	14.15	0.15	4.73
Egg	0.02	0.10	0.06	0.20	0.13	0.23	0.26	0.56	0.09	0.27
Potato	0.90	3.50	1.56	6.28	2.31	8.73	2.75	5.13	1.71	4.13
Beans	0.91	3.01	1.38	15.56	1.69	17.47	4.49	77.12	1.69	27.17

Table 1. (Continued)

	Poor		Less Poor		Less Rich		Rich		Total	
	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev
Expenditure										
Weekly food expenditure	544.03	261.70	959.78	511.59	1583.08	1025.17	4019.03	11442.94	1345.95	3990.92
Shares										
Maize	0.43	0.21	0.33	0.18	0.24	0.16	0.15	0.16	0.31	0.20
Rice	0.03	0.07	0.05	0.09	0.07	0.10	0.09	0.10	0.05	0.09
Ground nuts	0.03	0.07	0.04	0.09	0.05	0.09	0.04	0.11	0.04	0.09
Chicken	0.01	0.05	0.03	0.08	0.04	0.08	0.05	0.09	0.03	0.08
Beef	0.00	0.02	0.01	0.03	0.01	0.05	0.03	0.06	0.01	0.04
Egg	0.01	0.03	0.01	0.03	0.02	0.03	0.02	0.03	0.01	0.03
Fish	0.06	0.08	0.06	0.08	0.07	0.10	0.08	0.16	0.07	0.10
Potato	0.07	0.11	0.06	0.10	0.05	0.08	0.04	0.05	0.06	0.08
Beans	0.08	0.10	0.08	0.09	0.06	0.08	0.04	0.08	0.07	0.09
Leafy vegetables	0.07	0.08	0.05	0.07	0.04	0.07	0.03	0.07	0.05	0.08
Mango	0.01	0.06	0.01	0.06	0.01	0.05	0.01	0.04	0.06	0.06
Banana	0.01	0.02	0.01	0.02	0.01	0.01	0.01	0.02	0.02	0.02
Sugar & oil	0.04	0.07	0.06	0.07	0.08	0.07	0.08	0.08	0.06	0.07
Beverage	0.03	0.07	0.04	0.08	0.07	0.12	0.14	0.20	0.06	0.11
Demographics										
Household size	5.58	2.24	4.63	2.17	3.93	2.29	3.37	2.34	4.55	2.34
Age of household head	45.01	16.18	42.92	16.47	41.01	16.37	38.12	15.35	42.43	16.39
Female household head	0.28	0.45	0.23	0.42	0.20	0.40	0.17	0.37	0.23	0.42
Number of chronic illness	0.46	0.82	0.44	0.78	0.43	0.76	0.37	0.69	0.44	0.78
No. of observations	2507		5013		2506		1254		11280	

Table 2. Malawi Sample Income Distribution

	Poor	Less Poor	Less Rich	Rich
Chitipa-Northern Karonga-Central	21.25%	44.06%	21.88%	12.81%
Kasungu Liongwe Plain	9.90%	45.27%	28.60%	16.23%
Lake Chilwa-Phalombe Plain	25.06%	48.58%	18.91%	7.45%
Lower Shire	19.33%	37.96%	26.89%	15.83%
Middle Shire Valley	36.60%	37.25%	16.67%	9.48%
Thyolo Mulunje Tea Estate	19.25%	47.55%	23.20%	9.99%
Northern Lakeshare-Southern Lakeshore	19.65%	52.42%	18.86%	9.07%
Phirilongwe Hills	20.08%	48.65%	21.74%	9.52%
Rift Valley Escarpment	13.03%	49.81%	25.67%	11.49%
Shire Highlands	17.78%	55.71%	17.62%	8.89%
Nkhata Bay Cassava-Southern Karonga	8.51%	51.45%	29.05%	11.00%
Western Rumphi-Mzimba	7.47%	54.36%	30.29%	7.88%
Whole Sample	22.22%	44.44%	22.22%	11.12%

Table 3. Expenditure Elasticties

	Poor	Less Poor	Less Rich	Rich
Maize	0.906	0.807	0.793	0.753
Other grain	5.956	4.412	0.805	0.456
Root stuff	0.657	0.403	0.380	0.348
Groundnuts	1.235	1.257	1.138	1.057
Pulse	0.729	0.719	0.698	0.687
Chicken	1.295	1.227	1.048	0.951
Beef	1.854	1.629	1.142	0.985
Goat	1.127	1.131	0.985	0.926
Other meats	1.034	0.953	0.916	0.864
Egg	1.120	1.084	0.909	0.797
Fish	0.959	0.797	0.644	0.579
Tomato	0.844	0.658	0.359	0.328
Pumpkin	1.071	1.101	0.906	0.890
Leafy vegetables	0.277	0.670	1.059	0.941
Other vegetables	1.199	1.102	0.651	0.294
Mango	1.026	0.971	0.928	0.898
Banana	1.062	1.010	0.946	0.659
Other fruit	1.208	1.116	0.929	0.895
Sugar & oil	0.977	1.166	0.674	0.523
Beverage	1.237	1.215	0.903	0.800

Table 4. Food Calorie Expenditure Elasticities

	Poor	Less Poor	Less Rich	Rich
Maize	0.563	0.536	0.458	0.330
Other grain	0.384	0.139	0.047	0.025
Root stuff	0.330	0.111	0.123	0.093
Groundnuts	0.018	0.044	0.063	0.100
Pulse	0.037	0.047	0.054	0.042
Chicken	0.005	0.004	0.007	0.010
Beef	0.006	0.001	0.003	0.016
Goat	0.003	0.001	0.003	0.004
Other meats	0.002	0.003	0.007	0.012
Egg	0.002	0.001	0.002	0.002
Fish	0.041	0.023	0.026	0.050
Tomato	0.002	0.001	0.001	0.001
Pumpkin	0.003	0.007	0.007	0.006
Leafy vegetables	0.003	0.006	0.011	0.012
Other vegetables	0.009	0.007	0.004	0.005
Mango	0.001	0.002	0.003	0.002
Banana	0.004	0.003	0.004	0.004
Other fruit	0.007	0.010	0.011	0.082
Sugar & oil	0.123	0.063	0.061	0.049
Beverage	0.021	0.016	0.009	0.021
Total	1.565	1.030	0.902	0.866

Table 5. Own Price Food Calorie Elasticties

	Poor	Less Poor	Less Rich	Rich
Maize	-0.591	-0.655	-0.368	-0.308
Other Grains	0.066	0.032	0.038	0.001
Root Stuff	-0.469	-0.245	-0.244	-0.246
Groundnuts	-0.015	-0.032	-0.042	-0.024
Pulse	-0.056	-0.067	-0.073	-0.053
Chicken	-0.004	-0.003	-0.005	-0.008
Beef	-0.004	-0.002	-0.005	-0.008
Goat	-0.002	-0.001	-0.004	0.000
Other meats	-0.001	-0.004	-0.007	-0.011
Egg	-0.002	-0.001	-0.002	-0.002
Fish	-0.046	-0.029	-0.036	-0.076
Tomato	-0.002	-0.001	-0.001	-0.001
Pumpkin	-0.002	-0.005	-0.005	-0.003
Leaf Vegetables	-0.009	-0.004	-0.001	-0.001
Other Vegetables	-0.007	-0.005	-0.004	-0.010
Mango	-0.001	-0.002	-0.003	-0.002
Banana	-0.003	-0.002	-0.001	-0.002
Other Fruit	-0.006	-0.009	-0.010	-0.058
Sugar & Oil	-0.132	-0.049	-0.076	-0.041
Beverage	-0.017	-0.013	-0.009	-0.021

Figure 3. Undernourished Population under Price Shock