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INTRA-HOUSEHOLD REDISTRIBUTION OF INCOME AND CALORIE CONSUMPTION IN SOUTH-WESTERN NIGERIA

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Intra-Household Redistribution of Income and Calorie Consumption in South-Western Nigeria

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Abstract

This study investigates how per capita calorie intake in low income households of rural south-western Nigeria responds to changes in total household income and women's share of household income. The study addresses two major questions. First, is calorie-income elasticity large enough to justify the use of income increases as a food/nutrition policy strategy for increasing calorie intake among low income households? Second, what is the potential effect of intra-household redistribution of income from men to women on per capita calorie consumption? My results show that calorie-income elasticity is small and close to zero, implying that income policies may not be the most effective way to achieve substantial improvements in calorie consumption. I also find that increases in women's share of household income are likely to result in marginal declines in per capita food calorie intake, suggesting that income redistribution from men to women would not increase per capita food energy intake in these households.

Key words: Nigeria, Intra-Household Redistribution of Income, Women's Income Share Elasticity, Income Elasticity, Calorie Consumption.

JEL Classifications: D13, I12, O15, Q18

1.0 INTRODUCTION

A wide range of empirical literature has provided evidence that the level of per-capita calorie intake has a strong positive but non-linear relationship with household income, after controlling for household and demographic variables (Bouis and Haddad, (1992), Subramanian and Deaton (1996), Grimard (1996)).[1] Prior to 1987, calorie-income elasticity for low-income populations throughout the developing world was estimated to be between 0.4 and 0.8 (Boius *et al*, 1992). Thus, income increases for the poor as a food policy strategy have received strong justification in that it is expected to reduce malnutrition (Alderman, 1986).

However, Behrman and Deolalikar (1987) analyzed ICRISAT data for India, and found calorie-income elasticity estimates that were not significantly different from zero. They concluded that the linkage between income and nutrient consumption is weak and that nutrient improvements should not be expected with income gains in low income communities.[2] This result was reinforced by Bouis and Haddad (1992) who estimated calorie intake-total expenditure elasticity ranging between 0.08 and 0.14 with four different estimation techniques using a sample of Philippine farm households. Bouis et al (1992), argue that several studies after Behrman and Deolalikar (1987) reported calorie-income elasticity estimates which are in most cases lower than 0.2.

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[1] The article by Bouis and Haddad (1992) presented results of 30 investigations into calorie-income elasticity between 1979 and 1991. The range of calorie-income elasticity estimates for those who used calories from food expenditures was 0.22 – 1.18, while estimates from studies that used calories from 24 hour recall of quantity intake range between 0.01 – 0.37. Subramanian and Deaton (1996), estimated calorie-total expenditure elasticity of between 0.3 and 0.5 for households in rural Maharashtra in India. Grimard (1996) reported the calorie-expenditure elasticity for urban Pakistan to range between 0.51 and 0.25 from low to high-income households and 0.62 to 0.35 for the rural sector.

[2] This was a follow-up on Wolfe and Behrman (1983) who found calorie income elasticity in the neighborhood of 0.01 for household sample collected from Nicaragua.

This revisionist school attributed the previous high estimates of calorie-income elasticity to two major sources. The first source is the wide use of calories estimated from food expenditure data rather than direct collection of data on food intake quantities, due to the dearth of food quantity information in existing household surveys. The second source of upward bias is believed to be the endogeneity of household income in the calorie intake – income model.

The use of calorie intake quantities from food expenditure data creates two kinds of upward bias in the estimate of the calorie-income elasticity. The first is *non-classical measurement error bias*[3] and the second is *aggregation bias*.[4] This study addresses these problems by using data collected directly on actual food intake quantities to estimate the calorie-income elasticity.

Upward bias in calorie-income elasticity estimate which results from endogeneity of household income is basically of the type known as simultaneity bias[5]. Another form

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[3] The non-classical measurement error bias can arise in two ways. First, when expenditure is used as a proxy for income (as in this paper) and calorie intake quantity data are derived from food expenditure data, the measurement error in both the left and right hand side of the equation are correlated. In other words, when calorie intake quantity is calculated as the ratio of food expenditure to the price, part of the measurement error in the expenditure variable (when it proxies for income) on the right hand side is carried over to the calorie quantity measure on the left hand side of the equation. This is called non-classical measurement error and results in upward bias of the income elasticity of calorie intake. Second, because expenditure data does not distinguish between food consumed at home and those given as gifts to the less privileged, calorie quantity intake for the rich is over estimated and that of the poor is underestimated. This results in an upward bias in calorie-income elasticity. According to Bouis (1994), failure to take accurate account of food transfers from the rich to the poor is a source of upward bias for calorie-income elasticity generated from food expenditure survey.

[4] *Aggregation bias* describes a situation in which consumers substitute more expensive and low concentration sources of calories in the diet for less expensive and high calorie concentration foods as income increases. Consequently, when food calorie intake is estimated from food expenditure survey data with no quantity information, this substitution effect is lost in aggregation of the two types of foods and results in the overestimation of calorie-income elasticity.

[5] This is due to the reverse causation between calorie intake and income and is based on the nutrition-productivity hypothesis. Strauss (1986), using Sierra Leone data found a highly significant effect of calorie intake on labor productivity, and took this to be an evidence in support of the reverse causation hypothesis.

of bias that results from endogeneity of income is the omitted variable bias.[6] The sign of this bias is however dependent the nature of relationship between income and the dominant source of bias.[7] In this study, I adopt the instrumental variable technique to address this problem of endogeneity of income.

On the other hand, the conventional school of thought which support the traditional view that calorie-income elasticities are sizeable at least among low income households argue that recent low estimates of calorie-income elasticity in households could arise from two sources. First is the frequent use of current income as a measure of wealth rather than permanent income (Behrman and Deolalikar, 1990)[8], while the second is measurement error in income and expenditure. A major problem associated with data collected in developing countries is the difficulty in obtaining accurate data on income and expenditure.[9] Both the use of current income and measurement error in the data

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[6] This bias arises because labor income is a choice variable in the household decision model that allows for labor supply/leisure choices. If both labor supply and consumption decisions are driven by same unobserved factor such as 'taste for work', then some proportion of the estimated effect of income on calorie intake may be the result of spurious correlations between calorie intake and income rather than the evidence of a causative effect from income to calorie intake.

[7] For example, Wolfe and Behrman (1983) attributed the higher estimate of calorie income elasticities in rural relative to urban areas obtained by Ward and Sanders (1980) to the fact that omitted price variables are likely to be correlated with the location variable, resulting in an upward bias of the rural calorie income elasticity.

[8] The reasons for this are twofold: First, current income is a very noisy measure of the wealth flow into a household and this enlarges the value in the denominator of the regression coefficient estimator. Second, the covariance between current income and food consumption is believed to be lower than that between permanent income and food consumption (permanent income hypothesis). Thus if current income is used, the numerator of the regression coefficient estimator is understated. The interaction of these two effects would lead to a downward bias in the estimate of the regression coefficient of income in the food calorie intake equation.

[9] Two major reasons for this are: the disproportionately large informal sector with little or no formal income records, and the general view that detailed information on personal income is private and that this privacy should be protected from second parties including members of the same household.

would bias the ordinary least square regression estimate of the calorie-income elasticity downwards. [10]

Per-capita expenditure is therefore used in place of current income in this study since it is a better proxy for permanent income. Furthermore, the use of per capita expenditure as proxy for income reduces measurement error in income since it is easier to get information on expenditures than on income in developing countries. To further reduce the magnitude of error, I used income, expenditure and daily calorie intake values which are averages over 12 fortnightly visits to each sample household.

The second point of investigation in this study is the effect of women's share of income on calorie intake in low income households. Studies that investigate the effect of variation in household resource control pattern on household investment and consumption patterns in developing countries are not common, due to the dearth of gender disaggregated household level information on income, expenditure and consumption. No such study is available for Nigeria.

Hopkins et al (1994) found that in Niger that changes in female annual income, while controlling for male income impacted positively on household food expenditures. These results, they claim, hold for both earned and non-labor income. Hoddinott and Haddad (1995), using data from Cote De 'Ivoire found a positive but small marginal effect of women's income share on household food budget share. A doubling of the proportion of household cash income received by wives would lead to a meagre 1.9 % rise in budget share of food eaten within the household. Thomas (1997) on the other hand found in his analysis of Brazilian data that the marginal effect of increasing women's income on food expenditure share is negative and higher than the marginal effect of

[10] This bias is called the classical measurement error bias or attenuation bias.

husband's income. He also found that household food calorie intake, protein intake, height-for-age and weight-for-height of children intake responds more positively to increases in women's income than to increases in husband's income. He concludes that the identity of the identity of the household member controlling income (non-labor or total) affects calorie intake, protein intake, height-for-age of children, and weight-for-height of children.

On the whole, the observed impact of women's income share on household consumption and investment patterns is thought to be a reflection of gender differentiated preferences. The analysis in this paper in based on household consumption, income, and expenditure data disaggregated by gender and thus gives us a rare opportunity to examine the effect of variation resource control pattern on per capita calorie intake. This paper hopes to contribute to the growing literature on determinants of calorie intake at the household level by investigating the response of calorie intake of individuals in the household to increases in both per capita expenditure and the share of household income controlled by women. The model estimated in this paper also allows for differential income responses for individuals, taking account of the effect of age and sex[11].

The major findings of this study are as follows. First, expenditure elasticity of per capita calorie intake is estimated to be between 0.00 and 4.00 percent, suggesting that calorie intake does not get a substantial share of marginal increases in household income. Thus, increasing household disposable income may not be a very effective strategy for bringing about increased food energy intake among low income populations in Nigeria.

[11] Behrman and Deolalikar (1990) observed that not many existing studies have used individual level data to examine calorie- income response relationships as used in this paper. (Behrman and Deolalikar , 1990)

Second, we find some support for the Engel proposition that expenditure elasticity varies inversely with income level, in the ordinary least square estimate of the calorie-expenditure function. Log per capita expenditure entering either singly or in conjunction with its quadratic term was not statistically significant under the Instrumental variable two stage least square technique. (IV-2SLS)

Third, I estimate women's share of income elasticity of per capita calorie intake to be between -0.02 and –0.05 and show that this negative marginal response is neither a consequence reallocation of income towards more expensive and low calorie food sources nor an evidence of positive transaction cost resulting from imperfect substitution between male and female income in food consumption. This estimate is a rejection of the hypothesis that per capita calorie intake is positively related to increasing women's share of household income and suggests that wealth redistribution from men to women would not increase per capita food energy intake in low income households in rural south western Nigeria.

Finally, it is observed that the OLS and 2SLS estimates of women share of income are both negative, showing some consistency in the sign attached to the coefficient of women's income share variable irrespective of type of estimator (i.e. OLS or 2SLS).

2.0 IMPORTANCE OF FOOD CALORIE INTAKE

Economic analysis of calorie consumption by households derives from the important role calories play in the definition of important welfare concepts such as health and labor productivity[12]. According to Maxwell and Frankeberger (1992), enough food is mostly defined with emphasis on calorie and on requirements for an active, healthy life rather than simple survival. [13]

Food calorie intake has been found to have a strong empirical linkage with both human health and productivity. The human body needs energy to maintain normal body function (basic metabolic rate), engage in required minimal activity related to good health and hygiene (standard minimum requirement), and carry out productive activities to sustain the supply of energy and other required nutrients to the body. The level of calorie intake (both stock and flow) by an individual should therefore be adequate to sustain these functions over his expected lifetime. When this lifetime calorie consumption pattern falls short of a minimum threshold, the individual is at a health risk. Secondly whenever there is a persistent short fall in the flow of calorie intake relative to the amount required for optimal productive activity, the inflow of other nutrient intakes is likely to be affected since the resources required to acquire these nutrients is obtained from productive work. This situation is especially true in populations where the major income-earning asset is human labor efforts, as is investigated in this study. That is, populations made up of poor households where non-earned income forms an insignificant component of full income. In such populations, increased calorie intake may imply increased productivity, increased income and thus improved overall nutrition.[14] Increased nutrition

[12] See Stiglitz (1976) for a detailed discussion of the efficiency wage hypothesis which provides the theoretical framework for understanding the link between productivity and calorie intake.

[13] Food energy requirements are often used as proxy for all nutritional requirements, even though adequacy in calories may occur simultaneously with serious deficiencies in other nutrients.

[14] Using household level data from Sierra Leone, Strauss (1986) found highly significant effect of calorie intake on labor productivity.

is associated with sustained increments in productivity and thus sustained access to food energy intake.

3.0 THEORETICAL FRAMEWORK

The analysis in this paper is approached from the point of view of a cooperative bargaining household model. There are two general classes of household models namely: income pooling and bargaining models. The income pooling models assume that household demand (or expenditure share) is not affected by the identity of the individual that earns the income. The effective constraint on the household welfare function is the pooled household income. On the other hand, the bargaining model throws away the income pooling assumption of the income pooling models and allows for the explicit effect of distributional factors on demand or expenditure share.

Income pooling models are of two types – unitary or common preference models and collective or individual preference models of the household. The unitary model (which is a restricted form of income pooling models) assumes that the preferences of household members are uniform or that the preference of just one household member (the household head or dictator) is imposed on all other members. The unitary household thus maximizes a welfare function whose only component is the utility function of the dictator or household head. On the other hand, the collective model allows for a more general formulation of the household welfare function while still accommodating income the pooling restriction. Unlike in the unitary model, it allows for differences in preferences between actors within the household.

In the set of collective or individual preference models, household welfare function is defined as:

$$U^h = \sum_{i=1}^{I} \Phi_i U_i ; \; i = 1 \ldots\ldots I \qquad (3.1)$$

and $\Phi_i = K$

where U^h is the household welfare function, U_i is individual i's utility function in a household with I individuals. Φ_i is the welfare or Pareto weight attached to the utility function of each individual I and K is a vector of constants with i elements whose values range between 0 and 1. By characterization of this model, Φ_i is fixed and does not change with changes in factors that affect resource control power (also called distributional factors) within the household such as individual income, assets, and schooling. Thus, changes in distributional factors do not affect the relative expenditure share on goods in a collective model. It is assumed that Φ_i is set from marriage and does not change throughout the life time of the household. So the collective model results in a demand system derived from a Pareto optimal allocation with a fixed Φ_i vector. There is no movement along the utility possibility frontier of the household, since only one point on the contract curve is relevant.[15] The predictions of the collective model is that income changes only affect household demand directly through the Slutsky income effect and not through the power sharing factor in the household welfare function. The unitary model is a special case of the collective model where $\Phi_i = [1,0]$, given that i = 2.

The second broad class of household models is the non-income pooling or bargaining model. This is the model that is assumed for the analysis carried out in this paper. The bargaining model jettison the income pooling assumption of the collective model and allows for the explicit effect of distributional factors on household demand or

[15] The contract curve is a locus of Pareto optimal allocations for the household.

expenditure levels. The model specifically assumes that $\Phi_i \neq [1, 0]$ and that $\Phi_i \neq K$. Thus, the whole range of utility possibility frontier is the set of feasible Pareto optimal allocations for the decision making environment characterized by bargaining. In this model, changes in power sharing or distributional factors are expected to lead to changes in Φ_i and the changes in Φ_i are in turn expected to result in changing demand pattern or expenditure shares. Thus, the bargaining model predicts that income changes affect demand both directly (through the Slutsky income effect) and indirectly (through the power sharing factor, Φ_i).

Assume that a household in this study is made up of a man (m), a woman (f), and others members who are non-income earners (c); individuals in the household have differentiated preferences; and household income is not pooled. Suppose that the each individual in the household derive utility from two composite good: calorie/energy producing good, C, and non-calorie producing goods, Q. Calorie itself cannot be purchased but its intake depends on the amount of food item X_j consumed. The amount of food item, X_j, consumed in turn depends on its price, P_j, and a number of tastes factors such as characteristics of the individual (γ^i) and household level characteristics (γ^h). We assume that the pareto/welfare weights of the man, Φ^m , and the woman, Φ^f , sum to unity, implying that other members of the household, (c), who have no bargaining power have pareto weights $\Phi^c = 0$. Also the household income, Y^h, is the sum of the individual incomes of the man, Y^m, and the woman, Y^f. Given a particular level of household income, higher levels of Y^f would imply higher bargaining power for the woman or higher Φ^f. Thus Φ^f is a function of the distributional /power sharing factor Y^f/Y^h.

The household solves the maximization problem stated in expressions 3.2 to 3.7:

$$\text{Maximize } U^h = \Phi^m U^m (C, Q) + \Phi^f U^f (C, Q) \qquad (3.2)$$

Subject to:

$$Y^h = p_j X_j + Q \qquad (3.3)$$

$$Y^h = Y^m + Y^f \qquad (3.4)$$

$$C = C(X_j, \gamma^i, \gamma^h) \qquad (3.5)$$

$$\Phi^i \neq K\text{; where K is a constant and } i = (m, f) \qquad (3.6)$$

$$\Phi^f = \Phi^f (Y^f/Y^h)\text{, and } \Phi^m = (1- \Phi^f) \qquad (3.7).$$

From this constrained maximization problem, we derive an optimal demand function for calorie intake as a function of prices, household income, a power sharing or distributional factor, individual and household level characteristics. Formally,

$$C = C(X_j(p), Y^h, \Phi^f (Y^f/Y^h), \gamma^i, \gamma^h) \qquad (3.8)$$

4.0 DATA

4.1 Data Collection Procedure

Three states were selected out of the six states in South-western Nigeria. The three states selected are Ogun representing the Lagos/Ogun group; Oyo representing the Oyo/Osun group and Ondo representing the Ekiti/Ondo group. Historically, the three groups are more homogeneous within than between in terms of culture and tradition.

Four rural local government areas were selected in each of Ogun, Ondo and Oyo states. There are 3 main geopolitical divisions in each state called Senatorial Districts. Each senatorial district is in turn made up of Local Government Areas (LGAs). At least one L.G.A. was selected from the list of rural LGAs in each of the 3 senatorial districts in each state. The Headquarters of the selected rural local government areas were automatically selected for the survey. The headquarters were selected since the population in the headquarters is assumed to represent the best mix of the dwellers in the L.G.A. It will also allow the sampled households to exhibit enough variability in the major variables of concern in the study. A total of 12 LGAs were selected in all. The selected local government areas are as shown in Table 1. They are, Egbado-North, Obafemi-Owode, Remo-North and Ijebu-East from Ogun State; Ibarapa-North, Itesiwaju, Surulere and Saki-East from Oyo; and, Irele, Ondo-East, Akure-North and Akoko-North-West from Ondo State. All the selected local government headquarters can be classified either rural or semi-urban. None can be classified as urban.

A combination *of cluster and systematic random sampling* was used to select 40 households from each of the selected 12 rural/semi-urban communities. Thus, a total of 160 households per state and 480 households in all were selected.[16] However, the analysis used information from only 472 households, amounting to 2573 individuals who

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[16] One major requirement for the choice of Field Assistants for was that they must have been resident in the community for an appreciably long time and must be acceptable to the people. Before the commencement of operations in each LGA, the local government office, Traditional Rulers, and other popular community leaders were contacted for official permission and moral support during the period of the study. They were in the process intimated with the importance of the study. Letters of recommendation were obtained from the council office to give official backing to the study. Each selected community was divided into 4 clusters. Each cluster consisted of residential areas nearest to one another. From the list of major residential areas under each of the 4 clusters, one area is chosen by a simple random procedure. The lists of streets under each of the 4 selected residential areas were compiled and 2 streets were chosen by simple random sampling procedure. 5 houses were chosen from each of the 2 streets selected from each area. This was done by a systematic random sampling, using the random number table. A listing of the houses in the selected streets was made to get the approximate number of houses in the street. Let us assume that the number of the houses listed in the street is 50 houses and we want to pick 2 houses in the street. Our population (N) = 50 and our sample size (n) = 2. We calculate a sampling interval (S.I) of 25 through the formula: S.I. = N/n = 50/2 = 25. The random number table (RNT) was then used to get the random start (R.S). Random start (R.S.) is the first house to be picked in the community. The R.S. must not be greater than the S.I. It is either less than or equal to the S.I. 5 houses were chosen at the interval of the sample interval (S.I), 25. The 5 houses selected through the systematic procedure were then visited to make a list of the number of households. One household is then chosen by a simple random procedure if more than one household dwell in a selected housing unit. The total number of households selected was thus 10 for each of 4 areas, in each of 4 communities, in each of 3 States. The researchers then called on the head of the chosen household to introduce themselves and seek permission to conduct the study for six months. Efforts were made to obtain the full permission of the household head and cooperation of all household members. The list of the consenting households was subsequently made. (see Aromolaran, 2001.)

are at least 2 years of age (See Table 1).[17] The needed information was collected through the use of interview schedules/questionnaires that were personally administered by the field assistants and field supervisors. Food price data were obtained through community market surveys. [18]

Food consumption information was collected on individual basis from the households. Quantities of daily food intake were collected for each member of the household, using a 48-hour recall method.[19] Each household was visited at least once in two weeks. Data were collected over a period of 6 months (October 1999 – March 2000). Thus daily food intake quantities for each individual in the household were collected two times every month for a total of twelve times in 6 months. The analysis reported here was based on per capita daily food consumption averaged over the 6 months of data collection. This is designed to reduce measurement error in food consumption by smoothening day-to-day fluctuations in food intake. These quantities were then converted into kilogram units. The daily calorie intake level of the individual C_i , was computed through the formula:

$$C_i = \sum_{j=1}^{m} \omega_j F_{ij} \qquad (4.1)$$

[17] Children below 2 years were not considered in the analysis because many of them were still being breast-fed.

[18] Consequently, food prices only vary across the 12 local government areas.

[19] Individuals were asked about the amount of food they consumed in the last 24 hours, and then in the preceding 24 hours. There was no direct weighing of food quantities. The method used to obtain the measure of food quantities was indirect. A standard size of each major food item was prepared and weighed at the research office. These physical measures were taken as the unit of measurement on the field. Each survey personnel carried the physical measures with them and used them to assist the individuals in assessing the quantities of food items taken in the past 48 hours. For example, if one respondent says he consumed twice the field unit for a particular food item, then his intake of that item in kilograms will be the weight of the standardized field unit multiplied by 2.

Where: F_{ij} is the weight in grams of the average daily intake of food commodity j by individual i. ω_j is the standard measure of calorie found in each type of food commodity F_j . A total of 46 food items that were considered common food items in the area constituted our basket of food.[20] (i.e J=46).

Income from different occupational sources was obtained on a fortnightly basis for a period of six months. No distinction was made between labor and non-labor income in the computation of the income variable used in this analysis [21] and all income data were collected from each income-earning members of the household. Expenditure information by item was also collected every two weeks for each income-earning member of the household.[22]

4.2 Food Consumption Pattern and Calorie Intake in South Western Nigeria

According to FAO (1985), food consumption pattern is measured by the share of dietary energy supplies contributed by each major food group. The analysis under this subsection involved the computation of the percentage contribution of each major food group in the food basket of the households in the study area to total calorie intake. It

[20] The food items include Yam, Pounded Yam, Asaro (Mashed Yam Meal), Amala Isu (Dried Yam Dough) , Gari (fried fermented cassava granules), Eba (dough made from Gari), Fufu (Wet Cassava Flour Dough), Amala Lafun (dried cassava flour dough), Boiled Beans, Moinmoin (boiled bean dough) Akara (fried bean dough) , Boiled Rice, Ogi (Liquid Maize Pap), Eko (Solid Maize Pap) , Boiled Maize, Potatoes, Butter, Milk, Tea/coffee, Sugar, Beverages (e.g.Bournvita, Milo) Plantain/Dodo, Bread, Biscuit/snacks, Vegetables, Pomo (Cow Skin), Beef , Pork, Sheep/Goat Meat, Chicken, Eggs, Fish, Orange, Pawpaw, Banana, Vegetable,Oil , Pepper/Tomato, Palm Oil, Gari, Cocoyam, Melon, Okro, Groundnut, Cray Fish, Snail, Games (Bush Meat), Elubo Isu (yam flour).

[21] Given the possibility of reverse causality between calorie intake and labor income, the use of non-labor income instead of the sum of both labor and non-labor income on the right hand side would have been a good idea. However, this could not be done in this case because of non-availability of separate useable data on non-labor income.

[22] This implies that all consumption expenditures in the household were fully assigned to income earning members. For example if a teenage daughter who earns no income bought some cloths, the amount spent on the cloths is assigned to the income earning household member who transferred the amount to her.

shows the importance of each food item in the food calorie basket of the average individual in the study area.

Table 2 reveals that food consumption pattern is essentially the same among males and females, with roots and tubers supplying close to 60 percent of calorie intake.[23] Cereals provide only 17 percent of calorie intake while legumes contribute 7 percent. Less than 3 percent of energy intake comes from animal products, while oils and fats provide 10-11 percent. This food consumption pattern is a fair reflection of the farming patterns in the study area since roots and tubers are the dominant food crops followed by cereals and oil palm. The finding that low quality high carbohydrate foods are the major source of calories is an indication that adequate calorie intake may not imply adequate intake of other nutrients in the study area.

Table 3 shows that adults get a greater proportion of their calorie intakes from cereals, legumes and animal products than children do. On the other hand, children below the age of 6 years get 60 percent of the energy intake from roots and tubers alone, while adults get about 53 percent. Thus, children below the age of 10 years obtain proportionately more calories from low quality foods than adults. This has important implications for child welfare.

Table 4 shows that age is a very important determinant of the level of calorie intake. For both males and females average daily calorie intake increases with age. Secondly, children and adolescents, particularly males, do not consume enough calories to meet their daily minimum energy requirements. Even though, in absolute terms, males consume slightly more calories than females, calorie intake deficiency is more profound

[23] Roots and tubers are high carbohydrate foods which contain insignificant amounts of other nutrients apart from calories.

among males than females because of the lower minimum energy requirement by females.

The numbers in the first panel of Table 5 imply that per-capita daily calorie intake does not vary with formal educational status of household head, while the second panel shows that calorie intake is higher across age groups for individuals in households whose major source of income are the food sector compared with households who obtain most of their incomes from non-food related sources.

4.3 Socio-economic Characteristics of Households

From Table 6, we observe that average calorie intake per capita is 2204 kilocalories and note that this is below the 2500 kcal recommended by FAO as standard minimum daily requirement. This shortfall of 13.4 percent substantially understates the energy deficiency problem given the fact that poor families generated virtually all their incomes through direct labor efforts. Per capita consumption expenditure is estimated as 2135 Naira per month (or $US26).[24] Furthermore it is estimated that 57.4 percent of total value of food consumed at home is purchased from the market. The implicit cost of 1000 units of calories is 28.8 Naira ($0.36). Total asset possessed by the average household is valued as 810,506 Naira (or $US10,131), with a median value of 342,570 Naira ($4280).

The average household size in the sample consists of 7 persons. 12 percent of household heads and 8 percent of senior wives have some tertiary education, while 44 percent of household heads and 48 percent of senior wives have no formal education. The average husband in the study area has 5.1 years of schooling while the average senior

[24] The public service minimum wage at the time of data collection was 3000 Naira.

wife has 4.3 years of schooling. Thus the ratio of years of schooling of wife to the husband in the average household is 0.80.

Table 2 further shows that women's share of household income is about 0.353 and women's share of total household food expenditure is 0.321 percent. We also observe that the food share in total women's consumption expenditure is 0.32, indicating that women spend more of their income on non-food consumption items. [25] Women's share of own-farm produce consumed at home is 0.0736, showing that men supply most of the farm produce consumed at home. Women's ownership share of total acreage farmed is only 0.144.[26] Furthermore, while women's share of total farmland value is just 7 percent, women's share of business assets is about 0.304, implying a lower involvement of women in farming compared with non-farm businesses. This is supported by the fact that while 59 percent of household heads earn their income mainly from non-farm sources; 70 percent of senior wives earn their income mainly from this source. [27]

[25] Incomes earned were recorded separately for men and women. Expenditures made by men and women were also recorded separately. Both income and expenditure measures included farm produce consumed at home. Home production of non-marketable goods and services are not accounted for as a form of income and expenditure. This would certainly understate the full income of the household and may understate the income of wives relative to husbands. To avoid double counting, only expenditures made from own-income were recorded for an individual. For example a woman may expend 100 units of money on consumption during the month. If 80 percent of it were transfers from her husband, then her own expenditure is just 20 units of money.

[26] Not all plots are individually owned, since we have both individual and family farms. Yet all plots could be easily assigned to either the husband or the wife. All family farms are assigned to the household head (who are in 88% of the time males). This is because the men fully control the incomes and expenditure from these farms. Plots assigned to women are those that belong solely to the women; plots upon which they exercise a dominating control over income and expenditure patterns.

[27] About 23 percent of household heads and 9 percent of senior wives are wage earners.

5.0 EMPIRICAL MODEL

The major hypotheses to be tested by the empirical model specified here are that:

- Increases in household income would increase per-capita calorie intake in low income rural households in south western Nigeria.
- Increases in women income conditional on total household income would increase per-capita calorie intake in rural south western Nigeria.

The structural form equation derived from the individual preference model adopted as framework for this study is represented as

$$C = \alpha_0 + \alpha_1 X + \alpha_2 W + \alpha_3 I + \alpha_4 H + \alpha_5 P + \varepsilon \qquad (5.1)$$

Where:

C is natural log of individual or per capita daily calorie intake (Kilocalories).
X is log of per-capita consumption expenditure (Proxy for income).
W is women share of household gross income (range 0-1) [28]
I is the vector of individual level variables (age, sex etc)
H is the vector of household level variables (household composition variables, household's major income source)[29]
P is the vector of prices per kilogram in Naira of 10 food items that make up 95% of the sources of calorie intake in the study area.[30]

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[28] The women share of income is calculated as income earned by women in the household divided by incomes earned by the sum of incomes earned by men and women in the household.

[29] An important component of this household characteristics vector is the indicator variable for major source of household income or occupation of household head; 0 if farming and 1 if non-farming. This variable controls for unobserved heterogeneous consumption preferences which are either due to taste factors or prices. For example, farming households may prefer different kinds of food to non-farming household just because of the differences in labor energy needs. Secondly, farming households would want to consume products from their farms more than those purchased from the market because of the relatively cheaper cost of food obtained from own farm.

[30] The food items are yam, yam flour, cassava flour, cowpeas (beans), gari, rice, maize, palm oil, fish, and beef (see Table 2. The price vector used here consists of community market averages rather than household specific prices. This is because household specific prices may not be exogenous since variations in household-specific prices may be the result of measurement error and heterogeneity in quality choices.

ε is the disturbance or error term .

The two major parameters of interest in this study are α_1 and α_2. The former is the expenditure/income elasticity of per capita calorie intake while the later represent the marginal response of calorie intake to increases in the share of household income that is under the control of women. Based on evidence from empirical literature, we expect a positive α_1 with values ranging between 0.00 and 0.40. A non-linear specification of per-capita expenditure is generally accepted in both theoretical and empirical literature on calorie-income elasticity estimation. Since a log-linear specification of per capita expenditure would restrict the elasticity coefficient to be constant across income levels and theory suggests that this elasticity is likely to decline as income level increases (ie. that income/expenditure elasticity is an inverse function of income level), I estimate an alternative specification for which per capita expenditure is specified as a quadratic form.[31]

A positive α_2 would imply that a redistribution household income from men to women would result in increased per capita daily calorie intake in the household. A negative α_2 would imply that the redistribution of income from men to women (conditional on household income) would reduce per capita daily calorie intake and would suggest that more income in the hands of women relative to men may not be a effective strategy for increasing per capita daily calorie intake in the household.

To address this problem, Thomas (1997) used average market prices for 12 community groups. Ravillion (1990) on the other hand used average prices across households for the same district to reduce the bias due to household differences in taste for quality.

[31] Nutrition studies that use log-linear relationships assume constant elasticity. Many studies have however used forms that permit variable elasticities (e.g. Pitt,1984, Strauss 1984, Strauss 1990, Berman and Wolfe, 1984, Timmer and Alderman, 1979). Timmer and Alderman (1979) particularly found quadratic specification to have the best fit out of all the different forms of Engel specification that was tried. Engel specification implies that income elasticity or expenditure elasticity declines with income level.

6.0 ECONOMETRIC ESTIMATION ISSUES

Estimating equation (5.1) by the ordinary least square (OLS) regression procedure would imply an assumption that all the right hand side variables in the model are truly exogenous.[32] This may not be the case in this model with income and expenditure variables on the right hand side. Women's share of income is endogenous because the income variable used in this model is basically labor income, making its value an outcome of labor supply choices. The bias introduced into an OLS estimate of such elasticity coefficient is called omitted variable bias.[33]

There is also the problem of simultaneity which is due to the possibility of reverse causality between calorie intake and income.[34] This relationship is the central theme of the efficiency wage hypothesis (see Stiglitz, 1976). It proposes that higher income earning opportunities are open to those who are better nourished. However, Subramanian

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[32] That is if μ, υ and ε are the error terms in per capita expenditure, women income share and per capita calorie intake equations, the following conditions must hold for per capita expenditure and women share of income to be truly exogenous in the calorie intake model: $E(X\ \mu) = 0$; $E(W\ \upsilon) = 0$; where E implies mathematical expectation.

[33] This bias arises because labor income is a choice variable in the household decision model that allows for labor supply/leisure choices. If both labor supply and consumption decisions are driven by same unobserved factor such as 'taste for work', then some proportion of the estimated effect of income on calorie intake may be the result of spurious correlations between calorie intake and income rather than the evidence of a causative effect from income to calorie intake. the direction of the bias would depend on the exact direction of the relationship of the dominant source of bias to the endogenous left hand side and right hand side variables.

[34] One reason why it is difficult to assume at the onset of analysis that income and expenditure are exogenously determined in this study is that there exist a large amount of literature on farm household models which argue that if markets are incomplete, the production and consumption decisions of farm households are not separable and labor productivity/farm income is likely to depend on food consumption (see Udry, 199). If markets are incomplete as we have in many developing countries, productivity on farm is highly dependent on supply of family labor which in turn depends on energy from food produced on the farm. If there is perfect market, farm households can increase farm labor input without reference to consumption decisions of household. The second theoretical explanation for this reverse causality is the efficiency wage hypothesis by Stigliz (1976). In this latter case, labor productivity and consequently wages are thought to depend on the level of health and nutrition of the job seeker. So it is the calorie intake level of a non-landed farm worker that will determine whether he will be able to get a job and thus earn some wages at the going efficiency wage rate.

and Deaton (1996) ignored the possibility of reverse causation between calorie intake and income. They showed that in rural Maharashtra, south western India, it is implausible that income is constrained by nutrition because the cost of calories necessary for a day's activities is less than 5% of the daily wage. In the study area, the cost of calories necessary to satisfy the FAO minimum daily standard of 2500 kilocalorie is as much as 91 percent of the per-capita expenditure per day. If we follow the reasoning of Subramanian and Deaton (1996), it is plausible to think that income may be substantially constrained by nutrition in rural south western Nigeria.[35] Consequently we should expect an upward bias in the OLS estimate of α_1 and α_2 due to the violation of underlying assumptions of the OLS estimator.

Furthermore, per-capita expenditure is endogenous since the decision to expend is taken side by side with the decision to consume calories or purchase food items. This implies a correlation between X and ε, and introduces omitted variable bias. These potential problems of endogeneity of income due to omitted variable bias would result in a biased OLS estimate of α_1 and α_2. It is however difficult to determine the direction of this bias apriori.

Another potential source of bias in the OLS estimates of per capita expenditure and women income share coefficients in this investigation is the classical measurement error bias which is also referred to as attenuation bias. The presence of measurement error in the information collected on income and expenditure would result in a downward bias of the OLS estimate. Given the usual difficulty in getting accurate information on

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[35] The cost of 2500 kilocalories in the study area is 70.00 Naira and the average daily per capita expenditure is 77.00 Naira (This is about $1.00 at the time of data collection in 1999).

income and expenditure of individuals and households in developing countries, measurement error bias may be a very important source of bias in this study.

Attempts made in this study to reduce the effect of these potential sources of bias on the estimate of per capita expenditure and women's income share elasticity can be categorized into two. First are measures taken at the data collection stage, and second are measures taken at the estimation stage. Figures on food intake, income and expenditure used in the analysis are averages of data collected through multiple visits over a period of six months. This is expected to reduce classical measurement error since we use the mean of the distribution of quantities/values for each respondent over a period of time. Second, data on calorie intake was obtained directly from food quantity data and not indirectly from food expenditure data. This reduces the potential upward bias from non-classical measurement errors.[36] Third, values of time varying and time invariant assets of the household and individuals were collected at the beginning and end of the survey. The average values were used in the analysis.

The instrumental variable two stage least square (2SLS) estimation procedure is used to address the problems relating to measurement error bias, simultaneity and endogeneity of income/expenditure. With this procedure, expression 6.1 is estimated in place of expression 5.1.

$$C = \beta_0 + \beta_1 X^* + \beta_2 W^* + \beta_3 I + \beta_4 H + \beta_5 P + \varepsilon^* \qquad (6.1)$$

Where

[36] This non-classical measurement error is created if calorie intake quantity is computed from food expenditure data. In such cases, any measurement error in the expenditure on the right hand side is carried on to the calorie intake value on the left hand side. As a result the estimated coefficient of per-capita expenditure would potentially have an upward bias.

X* and W* are predicted values of the two endogenous explanatory variables and ε* is an error term that is uncorrelated with X* and W*. To obtain X* W* and ε*, expressions 6.2 and 6.3, called first stage regression equations are estimated.

$$X = \delta_0 + \delta_1 I + \delta_2 H + \delta_3 P + \delta_4 Z + \mu \qquad (6.2)$$

$$W_s = \Phi_0 + \Phi_1 I + \Phi_2 H + \Phi_3 P + \Phi_4 Z + \upsilon \qquad (6.3)$$

Where I, H, and P are as defined in expression 5.1 and Z is the 1xK vector of identifying instruments. Both μ and υ are assumed to be well behaved (i.e. independently and identically distributed, i.i.d.) with mean zero and constant variance, and $X^* = X - \mu$, while $W^* = W - \upsilon$.

For the set of instruments used in this study to be valid, δ_4 and Φ_4 would have to be identified. That is the following conditions must hold for each equation.

$$E(Z\ X) \neq 0\ ;\ E(Z\ W) \neq 0; \qquad (6.4)$$

$$E\ (C\ Z\ /\ X, W) = 0 \qquad (6.5),$$

Where E represents mathematical expectations.

Thus for an instrument to be valid it must be strongly correlated with per capita expenditure, X, or women's income share, W (expression 6.4) and should not be significantly correlated with per capita daily calorie intake when conditioned on per capital expenditure and women income share (expression 6.5). That is, after controlling for X and W, the effect of the Z-vector of instruments on per capita calorie intake should be close to zero.

Four such variables where found and used as instruments for per capita expenditure and women's income share in this study.[37] These variables are total value of

[37] The first task in the estimation was to find strong predictors for the endogenous variables on the right hand side of the specified calorie intake. 4 significant predictors were selected after for both log per capita

all household's assets[38], the couple's total number of years of schooling[39], ratio of the years of schooling of senior woman to the household head, and the share of household business asset controlled by women. [40]

Theoretically both total value of assets and total number of years of schooling is expected to be a fair indicator of the income earning capacity of the household. That is we expect per capita consumption expenditure to increase as households become wealthier in terms of farm and non-farm business asset ownership. Holding the total value of assets constant, it is expected that increases in women's share of household assets would increase per-capita consumption expenditure. Women's income share is expected to be predicted by women share of household business asset and the ratio of women's years of schooling to that of the household head. That is, as women get control over more business assets relative to men in the household, we expect their share of

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income and women's share of income after running a series regressions. These are sum of years of schooling of husband and wife, ratio of wife's years of schooling to husband's years of schooling, total value household asset, women's share of household's business asset.

[38] The total value of all household assets is the sum of the value of all business and non-business assets owned by the household. This includes land, farm implements, farm buildings, farm machinery, non-farm business machines and equipments. This estimate does not include farm supplies like fertilizer, seeds chemicals etc or inventories.

[39] This is the sum of years of education of husband and senior wife.

[40] Hopkins et al (1994), instrumented annual male income with the following variables: land area operated by males, the value of male livestock assets, a dummy variable for male literacy, the number of wives, the dependency ratio, a variable for single or multiple conjugal units within the household, the age of the household head, quadratics of several variables and interaction terms. The annual female income was instrumented using the land area operated by female, the value of female livestock assets, a dummy variable for female literacy, the number of infants in the household, the number of caretakers in the household (girls between the ages of ten and fifteen), a market village dummy, an ethnicity dummy, quadratics of several variables, and interaction terms. The instruments that were used to predict the log of per capita expenditure in Hoddinott and Haddad (1995) and Haddad and Hoddinott (1994) include: the amount of land owned by the household, the logarithm of the per capital value of holdings of consumer durable, the number of rooms per capita in the dwelling, the per capita floor area of the dwelling, and dummy variables equaling one; if the walls of the dwelling are cement, stone or brick; if the floor of the dwelling is cement, stone or brick; if the dwelling is owned by the household and is located in an urban cluster; if the household grows any major internationally traded cash crop.

household income to rise. Also, a decline in the schooling gap between household men and women is expected to lead to an increase in the share of household income under the control of women.

An important condition for the identification of δ_4 and Φ_4 in this study is that the amount of assets owned by the households, total years of schooling of couple, women's share of household business asset, and ratio of wife to husband years of schooling would only affect calorie intake indirectly through their (direct) effect on per capita expenditure and women's share of income. If this additional condition is satisfied, then these four variables would be acceptable as satisfactory identifying instruments for per capita income and women's share of income in the calorie intake model.

7.0 RESULTS AND DISCUSSION

7.1 Ordinary Least Square Estimates of Expenditure and Women's Income Share Elasticities

Results presented in the first row of the first panel of Table 11 shows a significant[41] ordinary least square (OLS) estimate of per-capita expenditure elasticity of calorie intake between 0.7 and 3.8 percent. This estimate supports the empirical school which argues that the response of calorie intake to marginal changes in income is close to zero (Wolfe and Behrman, 1983, Behrman and Deolalikar, 1987).

The OLS result presented in the third column of Table 9 suggests that expenditure elasticity of calorie intake is inversely related to income levels. That is calorie intake is

[41] The standard errors of the estimated coefficients were corrected for clustering within households by using the robust cluster command in STATA software package. The reason is that the simple estimates of standard errors become incorrect when we have multiple observations, which are not independent within a data. In the data set used for this analysis most of the income and expenditure variables, as well as household head and senior wife characteristics fall into this category of variables. All individuals that

likely to respond more to marginal income changes in households located at the lower percentile of income distribution compared with households located at the higher percentile. This result is fairly common in empirical literature (Behrman and Wolfe, 1984; Strauss, 1986) although some studies have also found that the log-linear model fits the calorie intake-expenditure data more satisfactorily (Ward and Sanders 1980, Wolfe and Behrman, 1983).

We observe from the first panel and first row of Table 11 that a 10 percent increase in women's share of household income would result in the lowering of per-capita daily calorie intake by between 0.15 and 0.19 percent. Even though this negative effect is small, it is an indication that redistribution of household income from husband to wife may not be an effective strategy for motivating increasing intake of food calories by low income rural households in south western Nigeria.

In addition, we observe an insignificant difference between the women's income share elasticity estimate from the log-linear expenditure and the non-linear expenditure calorie intake models. This is an evidence of the robustness of the women share of income estimate.

7.2 Two Stage Least Square (2SLS) Estimates of Expenditure and Women's Income Share Elasticities

As earlier discussed, ordinary least squares estimates of calorie-income and calorie-women's income share elasticity are likely to be biased if per-capita expenditure and income share are endogenous to the calorie intake model. If this assumption of

belong to the same household have the same values for these variables. This is referred to as clustering within households endogeneity of income and expenditure is true, then we would expect that the true elasticity estimates should be significantly smaller or larger than what the OLS estimate suggests. On the other hand, if measurement error is considered as a likely dominant source of bias, then the resulting attenuation bias would imply that the true elasticity estimates should be higher than what the OLS estimates suggest.

The proposed way of addressing these problems is to use an instrumental variable (IV) estimator to estimate the coefficients of per-capita expenditure and women's income share through a 2SLS procedure. I approach this by first running a first stage regression to generate reduced form estimates of the endogenous right hand side variables; to show how well the complete set of instruments predict the endogenous right hand side variables of the structural model; and to test for the joint significance of the set of identifying instruments. I then run a second stage regression using all the right hand side variables in the OLS results discussed above but replacing the observed values of per-capita expenditure and women's share of income with the predicted values from the first stage regression. The results are presented below.

7.2.1 First Stage Regression Results

The results of the first stage regressions for log per-capita expenditure, quadratic of log per capita expenditure and women's share of household income are reported in Table 7. We observe from the F-test results that all the 3 estimated reduced form equations are statistically significant at 0.000 α-level (see columns 1, 3 & 5 of Table 7). Furthermore, the set of identifying instruments is able to predict 4.5 percent of the variations in log per-capita expenditure, 4.6 percent of variations in the quadratic term of log per-capita expenditure and 23.0 percent of variations in women's income share (see columns 2,4 &

6 of Table 7). As expected, we observe that the couple's total years of schooling and the value of all assets owned by household are significant predictors of log per capita expenditure. After controlling for these two identifying instruments as well as wife/husband years of schooling ratio, women's share of household business assets has no significant effect on log per capita expenditure, while its effect on women's share of income was statistically significant at less than 0.00 percent α-level.[42] Women's share of household business asset turns out to be the main identifying instrumental variable for women share of income. That is, after controlling for other model variables, the higher the proportion of household business assets that belong to women, the higher the proportion of the household income that is under the control of women.

7.2.2 Second Stage Regression Results and Discussion

The first row of the second panel on Table 11 presents the expenditure and women's income share elasticity estimates derived from the 2SLS estimation results reported in the second panel of Table 9.[43]

Generally, we find consistency in the sign attached to the estimated coefficient of per capita expenditure and women's income share variables irrespective of the type of estimator (i.e. OLS or 2SLS) or the assumptions about the behavior of expenditure elasticity vis-à-vis household income level.

[42] Women's share of household income is significantly predicted by all four identifying instrumental variables namely total years of schooling of husband and wife, total value of household assets, wife/husband ratio of years of schooling, and women's share of household business asset.

[43]We also observe from Table 9 that individual daily calorie intake is dependent on age of individual with a quadratic form of relationship. Older individuals have higher intakes Calorie intake increases by 2.7 percent from age 2 to 3 and increases at a decreasing rate on till the age of 54.5 years when a decline sets in. The calorie intake level of the farming households is not significantly different from non-farming households. Thus, the occupational status of the household does not exact a significant influence on the level of calorie intake. Finally, males generally had about 4 percent more calorie intakes than females.

Per capita expenditure elasticity of calorie intake is estimated to be 3.0 percent under the linear expenditure model and 0.1 percent under the non-linear expenditure model. Theoretically, it is expected that income[44] increases would enable individuals in low income households to increase their food calorie intake. This in turn is expected to improve nutrition status, health and productivity of household members. The observed low calorie intake elasticity suggests that calorie intake does not get a substantial share of marginal increases in household income. This result is in line with the conclusion of Bouis and Haddad (1992) that most recent studies have reported calorie-income elasticity which are less than 0.2 in contrast to conventional wisdom that calorie-income elasticity for low income populations in the developing world ranges between 0.4 and 0.8. Thus, increasing household income may not be a very effective strategy for bringing about increased food energy intake among low income households in south western Nigeria.[45]

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[44] Income is proxied here by consumption expenditure. Consumption expenditure is widely used in place of income because of a number of reasons. One is that it is subject to less errors of measurement and second is that it is a better approximation of permanent income, if we assume that households smooth consumption over their life time.

[45] Ravallion (1990) argues that the low calorie income elasticity estimates in literature is counterintuitive and is likely to be the result of data imperfections. He further argues that if this low estimates were a true reflection of reality; it still does not support a conclusion that income increment is not a good policy strategy for reducing under-nutrition. According to him, if we think in terms of head count index of under nutrition, the marginal effect of a change in income of undernourished households on a headcount index of under-nutrition is determined by the product of the calorie income elasticity and the slope of the distribution function of intake. If the distribution function is very steep (ie a large proportion of the population are just above nutritional adequacy level), a small drop in intake resulting from income changes may move a large proportion of the people below the minimum nutrient intake line. So to assess the impact of income on under-nutrition, we must know the distribution of nutrient intake of the population. That is, we need to know the proportion of households that are close to the minimum nutrient intake line. The more households that are near to this line the more important is income increments in achieving improvements in under-nutrition. He argues that there is a clear difference between the concepts of nutrient intake (which most empirical literature has measured income effect for) and under-nutrition (which involves other factors such as minimum requirement and household and personal characteristics. His major goal in this study are to estimate calorie income elasticity and then use the elasticity estimates to simulate the effects of income changes on various measures of caloric under-nutrition such as head count nutrition index, nutrition deficiency depth index and nutrition deficiency severity index all based on FGT poverty index.

These 2SLS expenditure elasticity estimates are larger than the OLS estimates and are not statistically significant due to larger standard errors.[46] In addition, we observe that the 2SLS of the quadratic term of the log per-capita expenditure variable is not statistically significant.[47]

Women's share of income elasticity estimate is negative and between 3.63 and 5.10 percent, depending on the assumption about the behaviour of per capita expenditure elasticity as income level increases. Contrary to what we find in the case of per capita expenditure, these estimates are higher in absolute terms than the corresponding OLS estimates reported earlier. This may be an indication that classical measurement error bias is an important source of bias in this investigation since we were unable to empirically confirm the endogeneity of women's share of income in this study (see section 7.3.2 for discussion on the test of endogeneity).[48] Both estimates of women's share of income elasticity are statistically significant at 5 percent α-level. Thus, a doubling of the share of household income controlled by women from the current average of 0.31 to 0.62 will result in a 3.6-5.1 percent decline in per capita calorie intake of the household from the current average of 2204 kilocalories.

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[46] The 2SLS estimator is a less efficient estimator compared with the OLS even though the former is more consistent.

[47] This statistical insignificance of the quadratic term in the 2SLS estimation in spite of its significance in the OLS estimation may be due to a number of things. First, the assumption may not be true in the population that the income elasticity varies with income levels of households. Second, the data may consist of only households within the same response bracket. Third, the quadratic term of the expenditure variable is not adequately identified. I would think the available evidence supports the third explanation. Table 7 shows that the linear and quadratic terms of the per-capita expenditure variable are not adequately identified. That is there is none of the four identifying instruments that identifies the linear term separately from the quadratic term.

[48] Thus even though the use of 2SLS may have resulted in the inability to reject the null hypothesis of zero effect of expenditure on calorie intake due to larger standard error estimates compared with OLS, the higher estimates of elasticity coefficients would suggest that using the 2SLS approach could have at least achieved significant reductions in the effect of classical measurement error bias on elasticity estimates.

As implied by the OLS estimates, the 2SLS estimates clearly reject the hypothesis that per capita calorie intake responds positively to increasing women's share of household income, and suggests that income redistribution from men to women would not increase per capita food energy intake in this population.

However, it can be argued that the observed non-positive response of per capita calorie intake to changes in women's share of household income may be evidence of female preference for more expensive foods with less energy content. To check this, I estimate the effect of women's share of income on food calorie price.[49] The elasticity estimates as presented in the second row of the first and second panels of Table 11, show that the unit cost of calorie consumed does not vary positively with changes in women's share of income, suggesting that women do not seem to reallocate expenditures towards more expensive calorie sources as their income share increase.

Another plausible explanation for the negative sign of the women's income share coefficient is the issue of transaction costs. Since the estimate of the effect of women's share of income conditions on household income, increasing women's share of income would, by definition, be associated with decreasing share for men. Even if household resources are not reallocated to more expensive foods with less calorie content, calorie intake could still decline if it is more expensive to get a unit of calorie with women's income (largely from non-farm business) than with men's income. Consequently, the household will expend more to consume the same quantity and quality of food if income

[49] Food calorie price here is a proxy for how expensive the calorie being taken is. A higher value of food calorie price/cost implies higher quality calorie source. It is computed as the ratio of per capita food expenditure to per capita food calorie intake. i.e. calorie price (Naira/kcals) = per capita food expenditure (Naira) / per capita calorie intake (kcals) A significant and positive coefficient of women share of income would imply that women actually reallocate towards more expensive calorie sources which may have less calorie content.

is redistributed from men to women. The notion of transaction cost here refers to the difference between the price of a food bundle obtained from the husband's largely agricultural income and the cost of the same bundle of food obtained from the woman's largely non-farm business income. This situation can arise if food consumption from men's income is mainly from his farm and food consumption from female income is mainly from the non-farm business activities.[50]

To check if it is the case in the study area that food consumption from women's income comes more from the non-farm sources relative to food consumption from men's income, I estimate an equation whose dependent variable is the share of purchased food in total food expenditure and the right hand side variables are the same as the calorie intake equation in expression 6.1. A positive and significant coefficient of women's share of income in this equation would suggest that households purchase more of their food from the market as women's income share increases.

This however does not guarantee that the same quality and quantity of food is obtained at higher cost in the market. To check this, I estimate an equation with log per capita food expenditure as the dependent variable and the same right hand side variables as the three previous equations. A significant and positive women's share of income coefficient would suggest that intra-household income redistribution to women would make the households spend more per capita on food.

A positive sign for women's share of income in both equations would suggest that the negative sign on the calorie intake equation coefficient may be due to transaction costs. Otherwise, we would not have enough evidence to infer transaction cost as the

[50] It is assumed here that the same quality and quantity of food purchased in the market would cost more than if obtained from own farm due to positive marketing margins/markups.

cause of the negative sign of the women's income share coefficient in the calorie intake equation.

Row 3 in the first and second panels of Table 11 show the elasticity estimates for the share market food purchase in total household food expenditure, while row 4 of the two panels reports the elasticities for the per capita food expenditure equation. The women share of income elasticity estimate for the share of food purchases in total food expenditure is significant and positive, while that for the log of per capita food expenditure is negative, implying that transaction cost would not be a sufficient explanation for the negative sign on the women's share of income coefficient in the calorie intake equation.[51]

Thus, the negative sign on the women's share of income coefficient is more likely to be an indication that food calorie intake would respond negatively to a reallocation of household income from men to women, rather than a consequence of a reallocation of income towards more expensive and lower calorie foods or evidence of positive transaction cost in substituting female for male income to obtain household food consumption. Thus, more income in the hands of women relative to men would not increase calorie intake of household members in the study area.

7.3.2 Endogeneity and Over-identification Tests

One of the major reasons for the use of 2SLS in this study is the assumed endogeneity of per-capita expenditure and women's share of income in the calorie intake

[51] Elasticity for women's share of income in the calorie intake, calorie price and food expenditure equations are calculated as the product of the estimated coefficient and the mean value of women's share of income in the sample (0.31). Income Elasticity for the share of food purchased from market is calculated as the ratio of the estimated coefficient to the mean value of log per capita expenditure, the women's share of income elasticity is computed as the product of the estimated coefficient and the mean value of women's share of income, divided by the mean value of market purchased share of food expenditure

model. To test whether these two right hand side variables are truly endogenous I execute a regression based test of endogeneity (Wooldridge, 2003). The residuals from the OLS estimated log per capita calorie intake structural model are regressed on the residuals from the reduced form first stage regressions of individual right hand side endogenous variables on the complete set of controls and instruments. The result which is reported in Table 8 fails to reject the null hypothesis that per-capita expenditure and women's share of income are exogenous to this model. The p-value for the joint F-test shows that the null hypothesis can only be rejected at an α-level as high as 67 percent. The implication of this is that both per-capita expenditure and women's share of income can be taken as exogenous to this model given the sample[52] and suggests that the OLS estimates is a consistent estimate of the coefficients of per-capita expenditure and women's share of income.

Secondly, since the set of identifying instruments used in this study contains four elements while the set of endogenous right hand side variables contain just 2 or 3 elements (depending on the assumptions of the linear or quadratic response of per-capita income elasticity), we have a case of over-identification. To test for the validity of this over-identifying restriction, I follow the regression based standard testing procedure (Wooldridge, 2003). I regress the residual from the 2SLS estimate of per-capita calorie intake on the complete set of instruments and test for the joint significance of the four

[52] The Hausman test for exogeneity of endogenous variables was also carried out. The test was aimed at finding out whether there is sufficient difference between the coefficients of the instrumental variable two stage least square regression (IV-2SLS) and the standard ordinary least square regression (OLS), to indicate that OLS would be inconsistent for our model. The results showed that we do not have sufficient statistical grounds to reject the null hypothesis that "differences between coefficients of the OLS and the instrumental variables regression estimates are not systematic". The implication is that OLS is also a consistent coefficient estimator for the estimated equations. However the estimated coefficients of the endogenous variables (women share of household income, per capita income, and per capita expenditure were consistently larger in the 2SLS compared with the direct OLS.

identifying instruments.[53] The result as reported in the last column of Table 3 indicates a rejection of the null hypothesis which states that the over-identifying restrictions are valid. The chi square calculated is 33.28 and is larger than that the critical value of 5.99. Thus at least one of the instruments in not sufficiently exogenous to the calorie intake equation and is thus not a satisfactory identifying variable.

In spite of the failure to empirically confirm the endogeneity of per-capita income and women share of income in this study, the use of 2SLS is still justified based on two arguments. First, there exist a theoretical basis for assuming that reverse causality between calorie intake and measures of income and income distribution. Second, data collection on income and expenditure in developing countries is subject to higher levels of measurement error and the IV estimator is an effective way to reduce the bias that this type of error may introduce into the estimation of income and expenditure elasticities. [54] This later argument is supported by the finding that the 2SLS estimates of the coefficients of women's share of income are consistently higher than the corresponding OLS estimates.

8.0 CONCLUSION

This study investigates how per capita calorie intake in low income households of rural south western Nigeria responds to changes in total household income and women's share of household income. I utilize data collected with multiple visits over a period of

[53] The null hypothesis in this case is that the coefficients of the set of 4 identifying instruments are not jointly significant. If the set of identifying instruments do not directly predict variations in the calorie intake other than indirectly through its effects on income, the over-identification test accepts the added IV restrictions.

[54] Thus even though the use of 2SLS may have resulted in the inability to reject the null hypothesis of zero effect of expenditure on calorie intake due to larger standard error estimates compared with OLS, the higher estimates of elasticity coefficients for women's share of income would suggest that using the 2SLS

six months from 2573 individuals in 480 randomly selected households. The study addresses two major questions. First, is calorie-income elasticity large enough to justify the use of income increases as a good food/nutrition policy strategy for increasing calorie intake among low income households? Second, holding household income constant, in what way and to what extent is intra-household redistribution of income from men to women likely to increase per capita calorie intake of household members?

The results of the study show that per capita expenditure elasticity of calorie intake is positive and less than 0.04, while the elasticity of calorie intake with respect to changes in women's share of household income is negative and lies between 0.02-0.05. I showed that the negative effect of women's income share on calorie intake of household members cannot be said to be due to a higher cost of obtaining same quantity/quality of food from women's predominantly off-farm income and men's predominantly farm income (called transaction cost in this paper). I also show that the estimated negative effect of increasing women's share of income on calorie intake is not the consequence of reallocation of women's income from low quality/high calorie foods to high quality/low calorie foods.

The findings of the study support the following major conclusions.

First, the response of calorie intake to increases in household income is small and close to zero, implying that income policies may not be the most effective way to achieve substantial improvements in calorie intake levels in the study area.

Second, increases in women's share of household income are likely to result in marginal declines in food calorie intake by individual household members. This result

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approach could have at least achieved significant reductions in the effect of classical measurement error bias on elasticity estimates.

does not support the general thinking that intra-household resource reallocation from men to women would increase food energy intake. Rather it would imply that food calorie intake by household members is enhanced with more income in the hands of men relative to women

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Table 1: Summary of Sample Design

State	Selected Rural Local Government Areas.	Name of Selected Local Community	No of Households Sampled	No of Individual Sampled	No of Households Retained for Analysis	No of Individual Retained for Analysis
OGUN	Egbado North	Aiyetoro	40	207	40	191
	Obafemi Owode	Owode	40	194	39	175
	Remo North	Isara	40	211	39	171
	Ijebu East	Ogbere	40	202	40	187
ONDO	Irele	Irele	40	348	38	196
	Ondo East	Bolorunduro	40	254	36	206
	Akure North	ItaIju/Ogbolu	40	229	40	228
	Akoko North west	Oke-Agbe	40	236	40	230
OYO	Ibarapa North	Ayete	40	278	40	250
	Itesiwaju	Otu	40	322	40	309
	Surulere	Iresa	40	241	40	226
	Saki East	Ago Amadu	40	201	40	204
Total			480	2923	472	2573

Source: Aromolaran (2001).

Table 2: Percentage Contribution to Calorie Intake by Sex of Individual Household Members

Food group	Group Members	Percentage Contribution to Calorie Intake	
		Male	Female
Roots	Eba, fufu, Amala Lafun, Gari	40.29	40.91
Tubers	Yam, Pounded Yam, Elubo-Isu, Potatoes, Porridge	16.86	17.22
Cereals	Rice, Ogi/Eko/Custard, Maize Bread (Wheat) Biscuits	17.36	17.39
Legumes	Beans, Moinmoin, Akara	7.48	7.56
Vegetable	Vegetables (Ewedu), Okro, Melon.	2.89	2.97
Beverage	Tea, Coffee, Bournvita/Milo, Sugar.	0.69	0.63
Fruits	Pawpaw, Orange Banana	1.35	1.41
Oils and fat	Palm Oil, Vegetable oil, Butter	10.71	9.56
Meat	Pork, Sheep/Goat Meat, Cowskin, Chicken, Games (Bush Meat)	0.80	0.79
Fish	Fish	1.18	1.20
Other Animal Products	Milk, Eggs	0.39	0.36

Source: Field Survey, September 1999 – April 2000

Table 3: Percentage Contribution to Calorie Intake by Age Group of Individual Household Members

	Age Groups (years)				
	< 6	6-10	11-18	19-59	> 60
Food Groupings					
Roots	44.45	41.80	37.65	36.15	31.33
Tubers	15.44	16.81	17.23	17.08	18.53
Cereals	16.84	15.62	16.42	18.49	17.38
Legumes	6.51	6.79	7.35	7.64	6.77
Vegetable	3.05	2.73	3.13	2.94	2.58
Beverage	0.33	0.48	0.60	0.80	0.75
Fruits	1.70	1.30	1.12	1.35	1.97
Oils and fact	8.02	10.36	11.09	9.38	13.47
Meat	0.64	0.56	0.71	0.91	0.98
Fish	1.53	1.13	0.84	1.29	1.31
Other Animal products	0.29	0.32	0.33	0.40	0.53

Source: Field Survey, September 1999 – April 2000

Table 4: Estimates of Per Capita Daily Energy Intake by Sex and Age of Individuals

Sex/Age	No of Respondents	Standard Minimum Requirement (or RDA)	Actual Intake	% of Satisfaction
Male				
Less than 6	122	1473	1298	88.1
6 – 10	178	1970	1696	86.1
11- 18	300	2488	2105	84.6
19 – 59	513	2550	2569	100.7
60 and above	143	2355	2853	121.5
Female				
Less than 6	125	1355	1373	101.3
6 –10	190	1740	1671	96.0
11 –18	261	1978	1947	98.4
19 –59	658	1920	2515	130.9
60 and above	81	1900	2430	127.9

Source: Field Survey, September 1999 – April 2000

* RDA is recommended daily allowance. This is the amount required to maintain regular body functioning and engage in required minimum activity related to good health and hygiene. Additional energy intake would be required to carry out productive activities such as farm labor supply. Source: FAO/WHO/UNU (1985)

Table 5: Per Capita Calorie Intake by Education and Occupation of Household Head

A: Per Capita Calorie Intake by Age of Individual and Education level of Household Head				
	No of Respondents	Minimum Calorie Requirement per Day (Kilocalories)	Actual Intake (Kilocalories)	% Satisfaction of Minimum
Below Secondary School				
Less than 6	140	1415.25	1385	97.86
6 – 10	255	1855	1732	93.40
11 – 18	410	2232.5	2019	90.44
19 – 59	818	2232	2568	114.90
60 and above	204	2070	2710	130.92
Secondary School & Above				
Less than 6	107	1415.25	1275	89.88
6 – 10	143	1855	1607	86.63
11 – 18	151	2232.5	2066	92.54
19 – 59	353	2235	2471	110.56
60 and above	20	2070	2603	125.75
B: Per Capita Calorie Intake by Age of Individual and Occupation of Household Head				
Food Sector				
Less than 6	118	1415.25	1423	100.55
6 –10	187	1855	1785	96.23
11 – 18	358	2232.5	2106	94.29
19 – 59	670	2235	2619	117.18
60 and above	168	2070	2721	131.45
Non- food sector				
Less than 6	128	1415.25	1261	89.10
6 –10	180	1855	1583	85.34
11 – 18	200	2232.5	1900	85.11
19 – 59	492	2235	2438	109.08
60 and above	56	2070	2636	127.34

Source: Field Survey, September 1999 – April 2000

Table 6: Description of Model Variables

Variable	Mean	Std Deviation
Left hand side endogenous variables		
Natural log of Individual daily calorie intake	7.591	0.486
Natural log of Individual daily food expenditure	3.998	0.509
Natural log calorie price	1.012	0.279
Cash purchase share in total food expenditure (ratio)	0.574	0.327
Right hand side endogenous variables		
Natural log of per capita consumption expenditure	7.291	0.901
Women's share of household income (ratio)	0.305	0.272
Right hand side controls		
Age	26.7	19.4
Number of wives	1.30	0.810
Number of female aged in household (60+)	0.170	0.450
Number of male aged in household	0.350	0.550
Number of female adults in household (19-59)	1.59	1.000
Number of male adults in households (19-59)	1.26	1.23
Number of female adolescents in household (11-18 years)	0.690	1.000
Number of male adolescents in household (11-18 years)	0.810	0.920
Major occupation of household head (Non-Farming =1, Farming =0)	0.587	0.492
Major occupation of senior wife (Non-Farming =1, Farming =0)	0.703	0.457
Yam price (N/kilogram)	13.0	7.46
Cassava flour price(N/kilogram)	27.7	20.0
Yam flour price (N/kilogram)	60.3	34.7
Cowpeas price (N/kilogram)	48.5	9.30
Rice price (N/kilogram)	56.1	4.25
Maize price (N/kilogram)	30.1	8.71
Gari price (N/kilogram)	14.6	3.97
Palm oil price (N/kilogram)	102.1	17.1
Beef price (N/kilogram)	249.3	138.1
Fish price (N/kilogram)	152.6	115.8
Exclusion restrictions used to identify 2SLS		
Total Years of schooling of husband and wife	9.40	9.60
Ratio of senior wife's to husband's education	0.420	0.580
Value of total assets of households in Naira value ($1= 80 Naira)	810506.0	1941756.0
Women's share of total business asset (ratio)	0.304	0.341
Other interesting variables not in final model		
Individual daily calorie intake	2204.0	969.0
Unit cost of calorie intake (Naira/100 kilocalories)	2.857	0.769
Per capita consumption expenditure (N/month)	2135.0	1894.0
Household size (no of persons)	7.11	3.26
Value of farm assets of households (Naira)	124533.0	269392.0
Women's share of farm size (ratio)	0.144	0.294
Years of education of household head	5.08	5.43
Years of education of senior wife	4.31	5.02
Women's share of household farmland value (ratio)	0.0703	0.180
Women's share of food expenditure (ratio)	0.321	0.301
Women's food share in total women expenditure (ratio)	0.320	0.246
Women's share of home consumed farm produce. (ratio)	17.0	30.5
Women's share of value of crops on farm. (ratio)	11.1	26.8

Source: field survey, August 1999-April 2000

Table 7: First Stage Regressions, Identification of Instruments and Over-Identification Tests

Dependent Variables (Columns)	Log of Per Capita Expenditure		Quadratic of log Per Capita Expenditure		Women Share of Income		Residual from 2SLS Estimate of Log Per-Capita Calorie Intake [55]
Explanatory variables	With all Controls	Without Controls	With all Controls	Without Controls	With all Controls	Without Controls	
Total years of Schooling of Husband and Senior Wife	0.0156 (9.32)	0.0118 (5.47)	0.217 (9.10)	0.150 (4.78)	-0.00280 (3.88)	-0.00142 (-2.09)	0.00104 (1.00)
Wife/Husband Years of Schooling Ratio	0.187 (9.20)	-0.235 (7.28)	-2.779 (9.70)	-3.51 (7.61)	0.0256 (2.74)	0.0184 (2.01)	-0.0410 (2.05)
Total Asset of Household	3.27e-08 (10.2)	8.11e-08 (9.96)	4.98e-07 (10.8)	1.18e-06 (9.81)	-2.56e-09 (2.83)	-3.87e-09 (3.13)	-1.00e-08 (-2.20)
Women's Share of Household Business Asset.	0.0326 (0.91)	0.0285 (0.59)	0.0257 (0.52)	0.162 (0.23)	0.390 (22.8)	0.381 (21.4)	-0.0314 (1.53)
All control variables in original equation *	Included	Excluded	Included	Excluded	Included	Excluded	Included
Constant	8.0804 (20.3)	7.203 (211.3)	65.11 (11.7)	53.0 (109.6)	-1.0269 (-6.19)	0.197 (26.7)	0.247 (1.08)
F(4, N)	57.17	40.49	59.71	40.65	134.9	121.62	
Prob >F [56]	0.000	0.000	0.000	0.000	0.000	0.000	
R^2	0.711	0.045	0.733	0.046	0.497	0.232	0.0141
No of Observations	2360	2360	2360	2360	2360	2360	2360
$nR^2 \sim \chi^2$							33.28
χ^2 (2, 0.05α-level)							5.99

* Figures in parenthesis are t-values and n is number of observation.

[55] The 7th column is the regression-based test of validity of over-identifying restrictions. The dependent variable here is the residual from the 2SLS estimated log per capita calorie intake equation. The test statistic is computed as nR^2 where n is number of observations, and this statistic is distributed chi-squared. The test rejects "Ho: over-identifying restrictions are valid". Thus at least one of the instruments is not exogenous to the calorie intake equation.

[56] The p-value given here is for the joint significance of the four identifying instrumental variables. The list of control variables is as presented in Table 6.

Table 8: Results of Test of Endogeniety of Per-Capita Expenditure and Women's Share of Income

Dependent Variables[57]	**Residuals from OLS Estimated Log Per-Capita Calorie Intake Equation**	
	With log-linear Per-Capita Expenditure	With Quadratic Per-Capita Expenditure
Explanatory Variables		
Residual from first stage regression for log per capita expenditure	0.00455 (0.39)	-0.00296 (0.03)
Residual from first stage regression of per capita expenditure squared		0.000446 (0.0.06)
Residual from first stage regression of women's share of household income	0.242 (0.81)	0.0297 (1.00)
Constant	-0.000421 (0.07)	-0.000286 (0.05)
Prob > F [58]	0.665	0.782

* * Figures in parenthesis are t-values.

[57] The dependent variables are residuals from the OLS estimate of the full structural equation as presented in the second and fourth column of Table 9.

[58] The p-values of 0.665 and 0.782 imply an inability to reject the null hypothesis that per capita expenditure and women's share of income are exogenous in this model.

Table 9: Results of Regression of Log Per Capita Daily Calorie Intake on Per Capita Expenditure and Women's Share of Household Income.

	Linear in Per-Capita Expenditure		**Quadratic in Per-Capita Expenditure**	
Estimation Method	**OLS**	**IV- 2SLS**	**OLS**	**IV- 2SLS**
Log Per Capita Consumption Expenditure	0.0376 (0.0122)	0.0300 (0.0596)	0.479 (0.0850)	1.281 (0.910)
Quadratic of Log Per Capita Consumption Expenditure			-0.0324 (0.00608)	-0.0878 (0.0651)
Women Share of Household Income (Ratio)	-0.0508 (0.0250)	-0.117 (0.0545)	-0.0599 (0.0250)	-0.163 (0.0669)
Age of Individual	0.0277 (0.00129)	0.0282 (.00144)	0.0279 (0.00128)	0.0281 (0.00142)
Quadratics of Individual's Age	-0.000259 (0.0000184)	-0.000266 (.000027)	-0.000262 (0.0000184)	-0.000265 (0.0000197)
Sex of Individual	0.0388 (0.0121)	0.0348 (0.0125)	0.0386 (0.0120)	0.0352 (0.124)
No of Aged Females in Household (60+)	-0.0323 (0.0126)	-0.0266 (0.0137)	-0.0422 (0.0128)	-0.0324 (0.0176)
Number of Aged Males in Household	-0.0655 (0.0117)	-0.0672 (0.0126)	-0.0603 (0.0120)	-0.0648 (0.134)
Number of Adult Females in Household (19-59)	-0.0467 (0.00704)	-0.0562 (0.00810)	-0.0532 (0.00710)	-0.0574 (0.00910)
Number of Adult Males in Households (19-59)	-0.0158 (.00548)	-0.0201 (0.00567)	-0.0204 (0.00547)	-0.0219 (0.00737)
Number of Adolescent Females in Household (11-18 Years)	0.00471 (0.00639)	0.00426 (0.00653)	0.00226 (0.00631)	0.00262 (0.00728)
Number of Adolescent Males in Household (11-18 Years)	0.0215 (0.00704)	0.0183 (0.00789)	0.0194 (0.00710)	0.0165 (0.00892)
Household Head Major Occupation (Non-Farming =1, Farming =0)	0.0116 (0.0159)	0.0220 (0.0217)	.0231719 .0155379	0.0324 (0.0210)
Senior Wife Major Occupation (Non-Farming =1, Farming =0)	0.0664 (0.0153)	0.0694 (0.0171)	.0651072 .015165	(0.0640) (0.0180)
Control for prices of seven most important staple food items (Yam, cassava flour, yam flour, cowpeas, rice, maize, gari, palm oil, and beef)	Included	Included	Included	included
Constant	5.882 (0.257)	6.126 (0.654)	4.415 (0.400)	4.323 (3.209)
R^2	0.636		0.638	
Joint standard error estimate for linear & quadratic expenditure terms			0.0166	0.0136
No of Observations	2360	2360	2360	2360

* Figures in parenthesis are standard errors

*Since the left hand side variables are individual observations, while a number of the right-hand side variables are observed at household level, we are faced with the problem of understating the standard error of the estimated coefficients due to cluster effects. We correct for this in all equations estimated in this paper by using robust standard error estimates (The Stata software package used for this analysis has a robust cluster command that adjusts for cluster effects).

Table 10: Regression Results for Supplementary Models.

A. OLS Ordinary Least Squares

	Linear Per-Capita Expenditure Model			**Quadratic Per-Capita Expenditure Model**		
Dependent variables	Log of implicit unit price of 100kcals of calories	Log of per-capita food expenditure	Share of Market Food Purchases in Total Food Expenditure	Log of Implicit Unit Price of 100kcals of Calories	Log of Per-Capita Food Expenditure	Share of Market Food Purchases in Total Food Expenditure
Log Per Capita Consumption Expenditure	0.103 (0.00971)	0.141 (0.0132)	0.0833 (0.0104)	-0.0588 (0.994)	0.444 (0.104)	0.448 (0.0901)
Quadratic of Log Per Capita Consumption Expenditure				0.0117 (0.00692)	-0.0218 (0.00730)	-0.0262 (0.00611)
Women's Share of Household Income	-0.0127 (0.0172)	-0.0635 (0.0263)	0.283 (0.0208)	-0.00863 (0.0172)	-0.0693 (0.0262)	0.276 (0.0210)
Constant	-0.0288 (0.161)	1.785 (0.260)	2.255 (0.181)	0.527 (0.389)	0.139 (0.457)	1.005 (0.394)
R^2	0.603	0.683	0.579	0.604	0.685	0.579
No of Observations	2360	2360	2360	2360	2360	2360
Joint standard error estimate for linear & quadratic expenditure terms .				0.0100	0.0134	0.00954

B. Instrumental Variables Two-Stage Least Squares (2SLS)

	Linear Per-Capita Expenditure Model			**Quadratic Per-Capita Expenditure Model**		
Dependent variables	Log of implicit unit price of 100kcals of calories	Log of per-capita food expenditure	Share of Market Food Purchases in Total Food Expenditure	Log of implicit unit price of 100kcals of calories	Log of per-capita food expenditure	Share of Market Food Purchases in Total Food Expenditure
Log Per Capita Consumption Expenditure	0.190 (0.0296)	0.220 (0.0647)	0.105 (0.0302)	2.743 (0.688)	4.025 (1.145)	0.609 (0.555)
Quadratic of Log Per Capita Consumption Expenditure				-0.179 (0.0477)	-0.267 (0.0815)	-0.0354 (0.388)
Women's Share of Household Income	-0.0296 (0.0352)	-0.147 (0.0536)	0.309 (0.0362)	-0.124 (0.0479)	-0.287 (0.0752)	0.290 (0.0434)
Constant	-0.701 (0.304)	0.303 (0.689)	2.041 (0.313)	-9.987 (2.518)	-13.53 (4.122)	0.208 (2.032)
No of Observations	2360	2360	2360	2360	2360	2360
Joint standard error estimate for linear & quadratic expenditure terms				0.226	0.0793	0.0191

*Figures in parenthesis are standard errors.
*The complete set of controls in Table 9 is included in each equation.

TABLE 11: Income Elasticity Estimates for Calorie Intake Quantity, Calorie Price, Market Purchased Share of Food Expenditure, and Food Expenditure.

A .	Ordinary Least Squares (OLS)			
	Linear Expenditure Model		Non-Linear Expenditure Model	
	Log Per-Capita Expenditure	Women's Share of Income	Log Per-Capita Expenditure	Women's Share of Income
Dependent Variable				
Log per capita calorie intake	0.0376 (0.0122)	-0.0157 (0.00775)	0.007 (0.0166)[59]	-0.0186 (0.00775)
Log calorie price	0.103 (0.00971)	-0.00394 (0.00533)	0.111 (0.0100)	-0.00299 (0.00533)
Market Purchased Share of Food Expenditure	0.145) (0.0181)	0.283 (0.0208)	0.115 (0.00831)	0.276 (0.0210)
Log per capita food expenditure	0.140 (0.0132)	-0.0197 (0.00815)	0.123 (0.0134)	-0.0215 (0.00812)

B.	Instrumental Variable Two Stage least Squares (2SLS)			
	Log-Linear Expenditure Model		Non-Linear Expenditure Model	
	Log Per-Capita Expenditure	Women's Share of Income	Log Per-Capita Expenditure	Women's Share of Income
Dependent Variable				
Log per capita calorie intake	0.0300 (0.0622)	-0.0363 (0.0169)	0.00100 (0.0136)	-0.0510 (0.0204)
Log calorie price	0.190 (0.0296)	-0.00918 (0.0109)	-0.131 (0.226)	-0.0446 (0.0148)
Market Purchased Share of Food Expenditure	0.183 (0.0527)	0.309 (0.0362)	0.162 (0.0539)	0.290 (0.0434)
Log per capita food expenditure	0.188 (0.0647)	-0.0456 (0.0166)	0.132 (0.0793)	-0.0874 (0.0233)

*The complete set of controls in Table 9 is included in each equation.
*Figures in parenthesis are standard errors.
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[59] Since the expenditure elasticity coefficients in Table 11 (say $\hat{E} = f(\mathbf{\hat{a}_n})$) are estimated at the mean value of per capita expenditure, X*, the applicable standard error estimate needed to evaluate statistical significance must be derived from the joint distribution of estimated linear (say $\hat{a}_0$) and quadratic terms (say $\hat{a}_1$) in the non-linear expenditure equations. These joint standard error estimates are reported in the last rows of the last 3 columns of panels A & B in Table 10. To compute these joint standard errors, I adopt the statistical concept called "Delta Method", which is a lemma that allows us to test non-linear hypothesis given the asymptotic distribution of the estimator. (see Hayashi (2000) for detailed description of the lemma). Deriving from the lemma, if we assume that we have a set of 2-dimensional random vector $\mathbf{\hat{a}_n} = [\hat{a}_0 \; \hat{a}_1]$ that converges in probability to $\mathbf{\Phi}$ and converges in distribution to $\mathbf{Z}$; and suppose that $f(\mathbf{\hat{a}_n})$ is a function which has continuous first derivatives with $\mathbf{g(\hat{a}_n)}$ denoting the matrix of first derivatives, ie. $[\delta f/\delta \hat{a}_0 \; \delta f/\delta \hat{a}_1]$; then $f(\mathbf{\hat{a}_n})$ will converge in distribution to $\mathbf{g(\hat{a}_n)Z}$ **.** Thus, for the calorie intake non-linear expenditure elasticity coefficient, if $\mathbf{\hat{a}_n} = [\hat{a}_0 \; \hat{a}_1]$ converges in distribution to $N(\mathbf{0}, \sum)$, then it must be the case that $f(\mathbf{\hat{a}_n}) = \hat{a}_0 + 2\hat{a}_1 X^*$ would converge in distribution to $N(\mathbf{0}, \mathbf{g(\hat{a}_n)} \sum \mathbf{g(\hat{a}_n)'})$. Where $\sum$ **is** the estimated variance-covariance matrix of $\mathbf{\hat{a}_n}$ and $\{\mathbf{g(\hat{a}_n)} \sum \mathbf{g(\hat{a}_n)'}\}$ is the variance of $f(\mathbf{\hat{a}_n})$ given the joint distribution of the $\hat{a}_0$ and $\hat{a}_1$. The standard error of $f(\mathbf{\hat{a}_n})$ is just the square root of the calculated variance. In this study, $f(\mathbf{\hat{a}_n})$ represents the various non-linear expenditure elasticities tabulated in Table 11. For the case of the double log functions, $\mathbf{g(\hat{a}_n)} = [1, 2X^*]$ since $\delta f/\delta \hat{a}_0 = 1$ and $\delta f/\delta \hat{a}_1 = 2X^*$. An adaptation of this concept was used to calculate all the standard error estimates reported in Table 11.