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## The impact of food prices on household welfare and poverty in rural Tanzania

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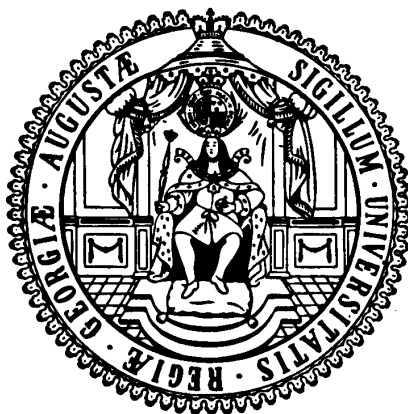
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**No. 216**

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and Poverty in Rural Tanzania**

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# The Impact of Food Prices on Household Welfare and Poverty in Rural Tanzania

Tukae Mbegalo\* and Xiaohua Yu†

## Abstract

The effects from the change in food prices on household welfare is a topical issue among policy makers and scholars in Tanzania. However, relatively little is known about the quantitative effects of rising food prices on household welfare and poverty. This paper intends to quantitatively assess the welfare implications of rising food prices in rural Tanzania, by using household budget data from 2008/2009 and 2010/2011. We analyse the food Engel curves using a semi-parametric approach. This has revealed that a quadratic parametric fit can approximate the non-parametric food Engel curves. We then estimate the complete demand system using the QUAIDS model, and calculate welfare and poverty indices. Our results indicate that net sellers tend to show an improvement in welfare and net buyers tend to show a loss in welfare due to a food price increase. The effect of rising food prices varies across household characteristics and by region. For example, poor households are more affected than middle-income and rich households. The food prices have a major impact on overall poverty and across households. In particular, the poverty effect is much stronger for poor households than for middle-income and rich households. However, in the long-run, the poverty headcount ratio declines across all households due to the substitution effect. Thus, reformulation of food policy to counterbalance intermediate and long-term food price shocks is crucial in achieving a reduction in poverty and food security. Policies, such as improving domestic agricultural markets and lifting tariffs on imported food, are instrumental in addressing these issues.

**Key words:** Food Engel Curves, Food Price, Net Benefit Ratio, Poverty, QUAIDS, Semi Parametric and Welfare

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## 1.0 Introduction

Since the Food and Agriculture Organisation (FAO) started to record the food price index, world food prices have fluctuated periodically. The rate of the rise in world food prices has shot up, and was reportedly still rising, even at the peak between January 2007 and 2008 (Leyaro et al. 2009). The situation changed and prices started falling but then greatly started to increase in June 2010 and reached their peak in 2011. According to the FAO, during the food prices crisis of 2011, the food prices index was even higher than the recorded food prices index of 2008. Minot (2010), points out that the global food price is partially transmitted in the domestic markets in sub-Saharan Africa, particularly in Tanzania.

Tanzania has experienced higher prices since early 2004. Between 2003 and 2008 domestic prices of important food items, which include maize, fresh cassava and dry cassava, increased by 44%, 50% and 44% respectively (Andrea and Thadeus, 2010). According to the National Bureau of statistics report (2012), food prices increased by 22% between October 2008 and December 2012. The sharp rise in global food and fuels prices in 2008 and again in 2011 has caused a significant rise in headline inflation in Tanzania. At their peak, in December 2011, year-on-year inflation in the food and energy sub-indices reached 25.6% and 41.0% respectively (NBS, 2011). These global crises were expected to have a powerful impact on overall inflation, both directly, and in the case of energy prices, indirectly through the large share of transport and distribution costs that make up retail prices (Adam et al. 2012).

The food price crises placed an extra burden on consumers by reducing their purchasing power and consumption basket, because most of the household expenditures are food in urban and rural Tanzania. The average share of food expenditure in the total household's expenditure, stood at 69.5% in 2001 and declined marginally, hitting 66.6% in 2007, reflecting a small decline in the poverty level during this period (PHDR, 2009). The price of goods and services have a major impact on the livelihood of consumers; food price has a major impact on non-food items and inflation trends as it accounts for 51% of the consumption basket in Tanzania with energy and transport costs accounting for a further 60% each (Adam et al. 2012).

Tanzania is a low-income country but it has been experiencing steady economic growth, which grew to an average annual growth rate of 7% in GDP terms over the past decade (ESRF, UNDP and, 2014). As income rises, households may shift to more nutrient rich foods. This leads to an increase in demand for food and an expected rise in food prices. Nevertheless, the rise in food and energy prices have a great impact on poverty and food security, especially within low-middle income groups, who spend a larger proportion of their income on food. Food price increases reduce the real income of households, thereby reducing their purchasing power and shifting more of their available income to the purchase of food.

On the other hand, the rise in prices can benefit food producers. However, the scale of this benefit depends solely on the products involved, the patterns of household incomes and expenditures and the policy responses of the government (Mafuru and Marsh, 2003). In Tanzania, policy makers made efforts to meet the challenges of the soaring food prices, which posed an obstacle in addressing hunger and undernourishment in the country. Some of the feasible policy measures, which the Government adopted were grain export and trade policy reforms<sup>1</sup>. For example, in 2008/2009, the VAT for food commodities that were subject to the East Africa Community (EAC) Customs duty was reduced to 18%. This reform has to some extent reduced the welfare loss of the rural poor between 2000 and 2007, which saw a rise in food prices at the same time (Leyaro, et al. 2009). Moreover, Tanzania has periodically banned the export of staple crops in an attempt to ensure sufficient domestic food supply. In principle, this policy reduces producer prices locally and can also cause significant market uncertainty for farmers and the private sector, resulting in market players to decrease their future expectation for the trade and supply of these goods. Consequently, the grain export ban ends up hurting rural poor households and thus increasing national poverty (Diao et al. 2013). Price stabilization should be carried out with a consensus among the key players in the food trade, consumers and the government.

Indeed, formulation of any policy that can address soaring prices in Tanzania requires quantitative estimation. It is important to quantify the extent in which the changes in food prices affect the welfare of Tanzanian households. In Tanzania, the effects of food price changes on household welfare is a topical issue among scholars and policy makers and yet relatively little is known about the quantitative effects of rising food prices on household welfare. The objective of this study is to quantitatively assess the welfare implications of rising food prices in Tanzania from 2008 to 2012.

Our contribution to the existing literature are as follows. First, we model a complete demand for all food groups, instead of using a partial demand modeling approach, which has been often adopted in previous studies. Second, we model separate elasticities for producers and consumers. These groups are often regarded as one group in the most common demand system, which creates a flaw in consumer demand theory.

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<sup>1</sup> Trade policy reform-tax has been a vital recipe constituent of Tanzania's structural reform programmers since the 1980s. Trade policy reforms aimed at rationalized import tax and revoke import restrictions; exchange rate liberalization has been a major revolution in trade regime. Such reforms objectives geared to increase export performance and agricultural prices, details see( Leyaro, Morrissey and Owens, 2009)

Third, most of the previous demand studies in Tanzania used the Almost Ideal Demand System (AIDS) model. The AIDS model assumes linear Engel curves and constant expenditure elasticity, which is too restrictive to use when modeling in developing countries (for examples see: Meenakshi and Ray, 1999 and Abdulai and Aubert, 2004 cited in Bopape, 2006).

Lastly, most previous studies on food demand, with the exception of Banks et al. (1997), employ prior specification of the demand system. Prior specification of the demand system can lead to a bias in the estimates for welfare whenever there is a slight deviation of the selected functional forms from that of the data.

Therefore, we analyse the shape of the food Engel curves using a semi-parametric approach. This has revealed that a quadratic-parametric fit can approximate the non-parametric Engel curves. Henceforth, we estimate the complete demand system using the QUAIDS<sup>2</sup>. Then, we calculate the welfare and poverty indices. Thus, our QUAIDS model is not a prior-specified model, but instead is based on a tractable semi-parametric specification. Our results indicate that net sellers tend to see an improvement in their welfare and net buyers tend to lose welfare due to a food price increase. The effect of rising food prices varies across household characteristics and by region. For example, poor households are more effected than middle-income and rich households. The estimated expenditure elasticities outweigh price elasticities, meaning that income is more relevant than price policy. The food prices have a major impact on overall poverty and across households. In particular, the poverty effect is much stronger for poor households than for middle-income and rich households. However, in the long-run, the poverty headcount ratio declines across all households due to the substitution effect.

The rest of the paper is structured as follows: section 1.1 presents a detailed literature review, Section 2 provides a description of the data and section 3 presents the estimation strategy and methodology. Sections 4 discusses the results and Section 5 presents the final conclusion and recommendations going forward.

## **1.1 Literature Review**

One major effect of the global food price upsurge, which occurred between January 2007 and December 2008, was a rise in hunger and malnutrition in different parts of the world. The food price and the financial crisis in 2008 caused a further 115 million people to become

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<sup>2</sup> The QUAIDS model has income flexibility and can allow good to be inferior when income fall and superior when there is rise of income.

undernourished. As a result, the global total of undernourished exceeded 1 billion for the first time in 2009 (FAO, 2009). The food crisis challenged the efforts of the Millennium Development Goals (MGDs), now SDGs, which aimed to reduce the number of people who suffer from hunger by half by 2015 (FAO, 2011). The FAO forecast suggested that 600 million people would be undernourished by 2015 even if the MDGs (now SDGs) were to be achieved. Such estimates illustrate the need for the international community to react immediately to address food insecurity across the world. The number of undernourished people in the world increased from 854 million in 2006 to an estimated 1.02 billion in 2009, representing the greatest amount of hungry people in nearly half a century (FAO 2009). The FAO (2009) reports that the simultaneous economic crisis and the upsurge in food prices played a major role in the escalation of hunger and undernourishment. Consequently, there is a prevalence of energy and nutrition deficiencies in many households around the globe particularly those who live in poverty. This in turn increases chronic diseases resulting from insufficient energy and nutritional intake. In developing countries, childhood malnutrition has also been associated with insufficient energy intake and micro-nutrient deficiencies. In a broader sense, price and income shocks are major determinants in addressing undernourishment and malnutrition.

The global food and energy spikes in the past five years have been a focal point of the media and has partially captured public attention. Global leaders and policymakers have been concerned by the impact of sharp price increases in food commodities, such as rice, corn (maize), wheat and soybeans, can have on household welfare and global food security. Furthermore, major concerns include the implications of the rise in food prices on macroeconomic indicators, as well as the impact on poverty reduction in low-income countries and on the political and social stability of poor countries and food-importing countries. Indeed, the rise in food prices adversely affected countries that are solely food importers, with emphasis on low-income countries. Many countries in the sub-Saharan region relied on food aid and food imports during the crisis. Hence, it was the region most affected by the global food price increase and financial crisis due to its strong dependence on food imports.

In addition, the effect of food price at the household level depends on an individual's income and where they lie in the distribution. Low-income households are expected to experience greater welfare losses from food price increases because food is a larger share of their budget, and they have fewer substitution options (Wood et al. 2009). Robles and Keefe (2011) found that rural households in Guatemala are more vulnerable to food price increases than urban households. The effect of the increase in food prices raised the national poverty rate by 1.1%. The magnitude of households who become trapped by poverty is more than those who escaped from poverty. Similarly, the rural welfare loss in Ethiopia, due to rising food prices is found to be

0.6, 0.8 and 1.3 for higher, middle and lower income groups respectively (Nigussie, Tefera et al. 2012).

Furthermore, the effect of food price changes on welfare depends on which food commodity has been hit by the price shocks. Ivanic and Martin (2008) indicate that in Cambodia, the commodity price changes which have greatest impact on poverty are price changes on staple foods. A price increase for rice by 10% increases the national poverty rate by 0.5% in both rural and urban areas. Moreover, households normally tend to respond to a price shock. As a price shock hits, a household tends to shift its consumption pattern to cheaper food items, which impacts nutritional outcomes in the long-run. In case of a positive income shock, a household may switch to more preferable food commodities, which are not necessarily high in nutrients. Hence, discussion of the price effect on welfare can be better done in demand systems, which capture these consumer behaviour responses.

The demand system models are vital in studying the welfare and nutritional impact of price and income shocks on households. Therefore, decisions regarding the form of the demand systems are crucial in quantifying the impacts of shocks related to income and prices. In the literature, the assumption that has persisted is that one ought to use a parametric model to relate, for example calorie intake and household income. Harttgen and Klasen (2011) used a simple linear model to simulate price and income shocks and account for nutritional impacts in Malawi and Uganda. They showed that price shocks for staple foods have a very large impact on food security in both countries, while the impact of income shocks is considerably smaller. Although the analysis showed that it is possible to estimate food security in a more straight forward way, the functional form of calorie intake has been specified parametrically.

Orewa and Iyangbe (2009) investigated socio-economic and household characteristics that determine daily food calorie intake among rural and low-income urban households in Nigeria. By using the parametric model based on linear, semi-log and double-log estimates, income was found to be positively related to calorie intake in Nigeria. Based on these findings, we may argue that a unit increase in income proportionally increases daily household calorie intake. However, in developing countries, a large portion of income is devoted to food consumption, hence any additional income of the household tends to be spent on food rather than on any other form of consumption such as human capital investment, or service and recreation. However, as household income increases to a certain level, households tend to spend proportionally less on food. Thus, the linearity assumption between nutrient intake and income is too restrictive (Gibson and Rozelle, 2002; skoufias, 2003).

Ecker and Qaim (2008) estimate nutritional elasticity based on a consumer demand model for study in Malawi. The parametric demand systems adopted have been specified in



advance. As we have previously noted, there is a potential for non-linearity between food consumption and income for poor households. Although caloric intake is positively related to income in developing countries, the elasticity will decline to zero, or even to a negative value at higher levels of income as income increases. This suggests that non-parametric specifications of food consumption and caloric intake in households in the developing countries, is an important step in availing selection of the demand model. On the contrary, Abdulai and Aubert (2004) used a non-parametric specification of caloric intake in relation to income. By using data from Tanzania, they showed that the shape of the logarithm of the caloric–expenditure curve does not indicate any nonlinearity. The linearity is also observed in the case of the relationship between the log of calories prices and the log of per capita expenditure indicating that higher per capita expenditures are associated with higher calorie prices. Although, Abdulai and Aubert (2004) provide alternatives to the non-parametric specification of caloric intake on food demand, the specification doesn't consider different scales for households. The shape of the caloric consumption curve, may vary considerably with different specifications for household size.

In the existing body of literature, the welfare impact and overall poverty effect of households due to an increase in the food price index are estimated based on survey data through the analysis of the demand for food intake. Since the elasticity obtained in the demand system plays a major role in establishing food security or nutritional deficiencies in a household, it is crucial to establish a compact demand system which considers the relationship between income and dietary intake. Salois et. al (2010) argue that a large elasticity suggests a policy designed to increase the income of the poor and promote economic growth an effective long-term strategy. On the contrary, a small elasticity suggests limited scope for income enhancing economic policies.

Likewise, the estimation of the demand function consistent with economic theory has been cutting-edge in published studies for the last forty years. Among many demand system specifications, the Generalized Leontief (Diewert, 1971), Translog (Christensen et al. 1975), Rotterdam (Theil, 1965; Barten, 1964, 1968, 1977), and the Almost Ideal Demand System (Deaton and Muellbauer, 1980a and 1980b) are often applied in demand analysis. In application, their functional forms are locally flexible implying no priori restrictions on the possible elasticities at a given point. These models possess enough parameters to approximate any elasticities at said given point. But locally flexible functional forms often permit small, regular regions, consistent with microeconomic theory. As a result, a number of alternative flexible functional forms with larger regular regions have been applied in practice. A few examples are the QUAIDS pioneered by Banks et al. (1997), the Laurent model and the Generalized Exponential Form (Barnett and Seck, 2008). Nevertheless, these models are adopted with prior selection of the functional forms

of demand systems (see Gahvari and Tsang, 2011; Pangaribowo, 2010; Pangaribowo and Tsegai, 2011; Yeong et al. 2009; Mittal, 2010 and Bopape, 2006). Indeed, if there is any deviation of the functional form, the welfare impact can be overstated.

Banks et al. (1997) compared the welfare losses between the AIDS and QUAIDS models based on selecting Engel curves through non-parametric regression. Their result shows that AIDS always overstates the welfare losses due to price changes. Also, the stipulation of the rank test in their analysis confirmed that the QUAIDS model is best at capturing the many curvatures of the food demand systems in the United Kingdom. More recently, such specifications have been adopted in countries such as the Czech Republic and Bangladesh etc. (Dybczak et al. 2010; Hasan, 2012). In sub-Saharan Africa, developing countries, where typical linear food Engel curves have been contested, such a specification is certainly viable for the reasons we have previously mentioned. Nevertheless, Nigussie and Tefera et al. (2012) used Ethiopian panel data to estimate demand systems through adopting the QUAIDS model, but allowed QUAIDS to be chosen parametrically. Similarly, Leyaro et al. (2009) investigate the effects of a rise in food price on welfare changes in Tanzania with a prior functional form specification. In addition, both food consumed and self-produced food are in principle aggregated in the demand estimation. Such aggregation undermines the short-term and potentially the long-term effect of food prices on household welfare at the supply side, simply because producers are more likely to maximize their profit function while consumers prefer to maximize utility.

In a nutshell, few previous studies, in particular those found in developing<sup>3</sup> countries, attempt to employ suitable functional forms in the demand system for modeling food consumption.

## **2.0 Data**

This paper uses national panel data from two waves collected from 2008 to 2011. Sampling in the panel was constructed based on the national master sample frame of a list of all populated enumeration areas (EAs) in the country, such EAs were developed from the 2002 population and housing census. The sample includes a partial sub-sample of households interviewed during the 2006/2007 household budget survey. In the first wave, the panel data was collected between October 2008 and October 2009. A total sample size of 2,063 households in rural areas was collected in EAs. In rural areas, an EA is a cluster defined as an entire village. In the second

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<sup>3</sup> In sub-Saharan Africa, see (Ulimwengu et al. 2012) adopted the QUAIDS model upon thorough investigation of the shape of Engel curves in the direction of Banks et al. (1997).

wave, data collection started in October 2010 and was completed in September 2011 and the sample grew to 2,121 households. The panel consists of household, agricultural and community data. In the household data, there are more than 50 food items on which information on the quantity purchased and produced by the household was collected in the field. At the community level, information on food prices was collected by village cluster. We use the community food price as our second option during the imputation of missing food prices. The first option is the closest purchase price within village clusters. These are cluster prices for food groups and median prices for food groups within the cluster.

## **2.1 Food Groups**

Indeed, it is impractical in demand analysis to deal with all goods consumed by all of the households. To facilitate the empirical analysis of food demand, we aggregate the major components of food consumption into twelve groups as indicated in Table 1. In addition, we assumed the separability of preferences as found in most of the existent literature (Béké, 2013). Under this assumption, the preference within a given food group is independent of the choices in other groups. The separability of preference also implies independence between the choice of food items and non-food items. The grouping of the food products are closely related to the classification adopted by the NBS.

## **2.2 Estimation of Cluster Food Prices**

The available data from the National Bureau of Statistics (NBS) includes questionnaires on consumer market prices, but only a few community prices are available. Regional price data is available from the official statistical office and can serve in the construction of a consumer price index to facilitate our demand analysis. However, this regional data is only available for urban households and is designed to compute the inflation index in the country. On the other hand, there are a few sites where price data can be collected. This can cause inaccurate estimates of prices for some households. However, during the survey, households usually responded with the quantity of food consumed in the weekly recall period. These responses provide useful information on price data. Then, the ratio of total expenditure can be divided by the total quantity purchased, for each good, giving a measurement of price or more accurately of unit value.

The unit value of a purchase can be seen as the highest acceptable price or simply a 'subjective price'. However, unit values are not the same as prices, as unit values reflect both quality and price variations (Deaton 1988, 1997). Thus, Deaton (1988) developed a method which takes into account both quality and measurement errors when unit price is used as a proxy

for the market price. The method is widely used in the existing literature. For this reason, this paper uses the same method. The median unit value for each cluster is used as a measure of the price of a given good for each locality.

To correct prices for quality and measurement error, we follow the approach in Deaton (1997).

$$\ln(p_i) - \ln(\bar{p}_{ic}) = \alpha_i + \beta_i \ln(y) + \gamma_i z + \sum_{c \in C} \phi_{ic} D_c + \varepsilon_i$$

Whereby  $\bar{p}_{ic}$  is the cluster median price for a food group, whereas  $y$  is household expenditure, whereas  $D_c$  are cluster dummies and  $z$  represents explanatory variables including age, gender and household size. The corrected quality cluster median price is shown by:

$$\ln(\bar{p}_{ic}^m) = \ln(\bar{p}_{ic}) + \varphi_i \hat{g}(\cdot)$$

Whereby  $\varphi_i \hat{g}(\cdot)$  is the predicted difference between the unit price  $p_i$  and the median price of the cluster  $\bar{p}_{ic}$ .

As already highlighted, it is impractical to deal with all of the food items consumed in all of the households, as such we aggregate food items into food sub groups. The weighted price for each food sub group is the sum of the weighted prices of each item in that food group. Hence for any particular group (k) consisting of n items, the price  $p_k$  is defined as:

$$p_k = \sum_{i=1}^n \bar{p}_{ic}^m (w_i / \sum_{i=1}^n w_i) \text{ whereas } w_i \text{ is the share in the group being made.}$$

On the other hand, the data includes self-produced food. This food has never been purchased and thus has no directly observable market price. To construct a monetary measure of welfare, it is necessary to assign a monetary value to this self-produced food. There are a number of methodologies commonly used to do this, none of which are perfect. Nevertheless, in the field, respondents were asked to report a value for all food consumed, whether it was purchased or self-produced food. For purchased food this should be the purchase price, but for self-produced food it is a subjective assessment of the food's value. The consumption aggregate lies on these subjective assessments of self-produced food to measure food consumption.

However, these subjective valuations are not solicited in the data. Rather, self-produced food is assigned a value by relying on prevailing prices in the geographic stratum as reported by other households who reported purchasing the item. This approach, relying on locally reported 'unit values' is increasingly common in poverty analysis. The NBS used this approach to provide a new, annual, poverty series for 2008/9 and 2011/2012 in Tanzania. However, as we have previously seen, the unit value is not the same as price. We assigned the adjusted unit prices of

the purchased food items to the self-produced food items. Therefore, it should be noted that our price classification and aggregate consumption is not directly comparable with the classification in the official report of the NBS (2008/2011), due to the differences resulting from adjusting the data.

### 3.0 Theories and Estimation Strategy

#### 3.1 Testing the Curvature of the Engel Curve

The long-run effect of prices on consumer household welfare is commonly done through consumer demand models. While there are a variety of consumer demand models, the question is which one is suitable for the data on hand. One approach is to use a parametric specification, which in principle assumes the functional form of the household expenditure. In so doing, the elasticities from the parametric model might be biased when data deviates from the prior specification of the functional form of the expenditure function. To avoid this problem, we adopt the non-parametric specification of the food Engel curve. There are several important issues to address, however, before we implement the non-parametric estimation. The non-parametric has a lower convergence rate than root  $n$ , meaning that its convergence rate is much slower than the parametric model. Hence its estimators require a large data set, as a bias can arise when estimations are made through smaller data sets. Similarly, there is an issue of “curse of dimensionality” when many covariates are included in the non-parametric. To avoid such problems, we adopt the semi-parametric approach proposed by Robinson (1988), specified as the double residual semi-parametric estimator:

$$y_{gi} = \beta_i x_{gi} + f(z_{ig}) + \varepsilon \quad 1$$

Where  $z_{ig}$  is the natural logarithm of per capita expenditure and only included in the non parametric part, whereas  $x$  is a vector of demographic variables and other explanatory variables included on the parametric side. These are logarithm of the household size, the highest education, age, gender and occupation of the household head, iron sheet roofing, dummies for the interview quarter and regional dummies.  $y_{gi}$  is the budget share of the food commodity  $g$  in  $i$  household.

In order to ensure that we have enough data to carry out our estimation, bearing in mind that not all food items are consumed by households, we estimate food consumption as a share of the total expenditure. This means that our Engel curves are the first stage of the budget share, whereas the demand analysis is based on the second stage of the budget shares for the twelve food items.

By applying the conditional expectation to both sides of equation 1, we obtain the expression:

$$y_{ig} - E(y_{ig} / z_{ig}) = (x_{ig} - E(x_{ig} / z_{ig}))\beta + \varepsilon_{ig} \quad 2$$

Since the conditional expectation is unknown, we estimate by referring to consistent estimators:

$$y_i = m_y(z_i) + \varepsilon_{1i} \text{ and } x_{ki} = m_{xk}(z_i) + \varepsilon_i \quad 3$$

Hence, the Robinson's (1988) double residual estimator is the OLS estimation of the following

model: 
$$y_i - \hat{m}_y(z_i) = (x_i - \hat{m}_x(x_i))\beta + \varepsilon_i$$

We also adopt the Härdle and Mammen (1993) test to compare the non-parametric and parametric regression fits given as:

$$T_\theta = N\sqrt{h} \sum_{i=1}^N (\hat{f}(z_i) - \hat{f}(z_i, \beta))^2 \pi(\cdot)$$

Where  $\hat{f}(z_i)$  is the estimated non parametric function,  $\hat{f}(z_i, \beta)$  is the estimated parametric function,  $\pi(\cdot)$  is the weighted function and  $h$  is the bandwidth. The null hypothesis of the test is that the non-parametric model can be approximated by parametric model.

### 3. 2 Consumer Demand Systems

We analyse the complete demand model, which takes into account the interdependence of the number of commodities in the consumption patterns of the households. The Almost Ideal Demand System (AIDS) model is the most commonly used functional form to model demand behaviour during the last two decades. The AIDS model is derived from a specific class of preferences known as the PIGLOG class, which permit exact aggregation over consumption (Deaton and Muellbauer 1980a). However, in the present paper we extend the PIGLOG specification into the QUAIDS demand model, which has the advantage over the AIDS model because it captures non-linearity in log total expenditure. Lewbel(1991) defined the rank of QUAIDS as 3, implying that it provides little to no gain to add another term in the quadratic model as the maximum possible number of independently column vector of prices is three. The indirect utility function of QUAIDS is defined by:

$$\ln V(p, m) = \left[ \left( \frac{\ln(m) - \ln a(p)}{b(p)} \right) + \lambda(p) \right]^{-1} \quad 4$$

Whereby  $\frac{\ln(m) - \ln a(p)}{b(p)}$  is the indirect utility function of a PIGLOG demand systems

and the extra term  $\lambda$  is a differentiable, homogenous function of degree zero with prices  $p$ .  $\lambda(p)$  is independent of prices, the indirect utility function reduces to a form observationally equivalent to the PIGLOG class(Banks et al. 1997), which includes the Almost Ideal model and

the translog model of Christensen et al. (1975). The  $\ln a(p)$  and  $b(p)$  are price indexes from AIDS model given as:

$$\ln a(p) = \alpha_0 + \sum \alpha_i \ln p_i + 1/2 \sum \sum \gamma_{ij} \ln p_i \ln p_j$$

$$b(p) = \prod_{i=1}^n p_i^{\beta_i} = \exp\left(\sum_i \ln p_i\right)$$

Banks et al. (1997) constructed Engel curves in a way that is similar to the AIDS model while allowing for more general Engel curves, which has quadratic terms through the investigation of the shapes of the non-parametric specification. The indirect utility function (V) is defined as:

$$\lambda(p) = \sum_{i=1}^n \lambda_i \ln(p_i) \quad \text{where} \quad \sum_{i=1}^n \lambda_i = 0$$

Substituting the AIDS price indexes and  $\lambda(p)$  into QUAIDS indirect utility function  $v(p, m)$  gives:

$$V(p, m) = \left[ \left( \frac{\ln m - (\alpha_0 + \sum_k \alpha_k \ln p_k + \sum_k \sum_j \gamma_{kj} \ln p_k \ln p_j)}{\prod_i p_i^{\beta_i}} \right)^{-1} + \sum_i \lambda_i \ln p_i \right]^{-1}$$

The corresponding cost function is as follows:

$$c(u, p) = \alpha_0 + \sum_k \alpha_k \ln p_k + \frac{1}{2} \sum_k \sum_j \gamma_{kj} \ln p_k \ln p_j + \frac{u \prod_i p_i^{\beta_i}}{1 - u \sum_i \lambda_i \ln p_i} \quad 5$$

Whereby  $\alpha_0$ ,  $\alpha_k$  and  $\gamma_{ki}$  are parameters.  $c(p, u)$  is the linear cost, homogenous in price p. Deaton and Muellbauer's AIDS model can be derived from the cost function above when all  $\lambda_i = 0$ .

By Roy's identity and substituting  $u$  for the indirect utility function into the cost function 5, Banks et al. (1997) obtain the QUAIDS budget share equations:

$$w_i = \alpha_i + \sum_{j=1}^n \gamma_{ij} \ln(p_j) + \beta_i \ln \frac{m}{a(p)} + \frac{\lambda_i}{b(p)} \left[ \ln \left( \frac{m}{a(p)} \right) \right]^2 \quad 6$$

Other theoretical restrictions, adding up and homogeneity are given as:

$$\sum_{i=1}^n \alpha_i = 0 \quad \sum_{i=1}^n \beta_i = 0 \quad \sum_{i=1}^n \gamma_{ij} = 0 \quad \sum_{j=1}^n \gamma_{ij} = 0$$

and the slusky symmetry as  $\gamma_{ij} = \gamma_{ji}$  for  $i \neq j$

The QUAIDS model has income flexibility and rank 3 as suggested by (Banks et al. 1997) the Engel curves, meaning that it has the same degree of price flexibility as the usual AI and translog models. AI model nested within it are a special case.

Banks et al. (1997) calculated the QUAIDS model elasticities by differentiating equation 6 with respect to substituting the price indexes,  $\ln(m)$  and  $\ln(p)$  respectively to obtain:

$$\mu_i \equiv \frac{\partial w_i}{\partial \ln(m)} = \beta_i + \frac{2\lambda_i}{b(p)} \left[ \ln\left(\frac{m}{a(p)}\right) \right]$$

$$\mu_{ij} \equiv \frac{\partial w_i}{\partial \ln(p_j)} = \gamma_{ij} - \mu_i \left[ \alpha_j + \sum_k \gamma_{ij} \ln(p_k) \right] - \frac{\lambda_i \beta_j}{b(p)} \left[ \ln\left(\frac{m}{a(p)}\right) \right]^2$$

The expenditures elasticities are given by  $e_i = \mu_i / w_i + 1$  and with positive  $\beta$  and a negative  $\lambda$ . The expression of Marshallian or the uncompensated price elasticities can be written as:  $e_{ij}^u = \mu_{ij} / w_i - \delta_{ij}$ , where  $\delta_{ij}$  is the kronecker delta. Therefore, one can use the Slutsky equation, the Hicksian or compensated price elasticities

as:  $e_{ij}^c = e_{ij}^u + e_i w_j$ . It is important to note that demand for food may depend on the amount of substitution between goods, demographic composition of household and labour market status of the household (Blundell et al. 1994). Hence we include household characteristics in the QUAIDS model by applying the demographic translating method to incorporate socio-demographic characteristics of the household (Agostini, 2014). These are the age and gender of the household head and Household size.

### 3. 3 Welfare Analysis

In this section, we investigate the effect of food prices on household welfare. There are several useful methods which exist in the literature for welfare analysis. These are consumer surplus (CS), Equivalent variation (EV) and compensated variation (CV). We focus on the CV approach, as it is simple to apply because the approach requires only the pre-budget information to estimate welfare. For this reason, the CV is mostly used in the literature (see, Deaton A., 1989, 1997; Friedman and Levinsohn, 2002; Ackah and Appleton, 2007). The CV focuses on the money metric at a fixed income while consumer prices change, implying that when a change in price occurs, there is a certain amount of money that the consumer can accept to compensate for this price change.

However, during the data collection, respondents reported both food purchased and produced at home. In order to capture these two scenarios, we adopt Deaton's (1989) methodology, based on the net benefit ratio (NBR) combined with the compensated variation approach. We construct a separate CV for each case. For purchased food, CV is based on utility maximization, whereas for self-produced food, it is a profit maximization. Hence, the money



needed to maintain the previous level of household utility given a change in prices for the household as a consumer, is the compensated variation expressed here as:

$$CV = e(p^0, u^0) - e(p^1, u^0) \quad 7$$

Following Friedman and Levinsohn(2002) and Robles and Maximo(2010)  $e(p^1, u^0)$ , can be approximated by the second order Taylor expansion and CV can be expressed as:

$$CV \approx \sum q_j^0 \Delta p_j + 1/2 \sum \sum \partial^2 C(p^0, u^0) / \partial p_j \partial p_i \Delta p_i \Delta p_j \quad 8$$

The derivative of the cost function  $C$  is the Hicksian demand for food  $j$ . In practice, the concern is on the price change of the group of food items, such as meat products, while the prices of other food groups are fixed (Yu, 2014). Hence, the CV when the prices of a food group changes while other food groups are fixed can be expressed as:

$$CV \approx \sum q_j^0 \Delta p_j + 1/2 \sum \sum (\partial^2 C(p^0, u^0) / \partial p_i) (\Delta p_i)^2 \quad 9$$

The CV here is deflated by the initial expenditure  $x_0$  so that the compensated money metric entails a constant utility when prices change. The simplification of equation 9 is given as money metric:

$$CV / x_0 = \sum CR_i \Delta p_i^c + 1/2 \sum \sum \varepsilon_{ip} (\Delta p_i^c)^2 \quad 10$$

Where  $CR_i$  is the share of purchases over the total consumption of each food  $j$  before the price change,  $p_i^c$  the purchase price of an item and  $\varepsilon_{ip}$  is the compensated own price elasticity. If we ignore the last term in equation 10, a short-term or income effect is estimated. Hence, economic welfare changes for the consumer can be measured only by the information of price and budget shares.

Similarly, we use CV for households as producers by replacing the cost function with the profit function. Hence profit maximization is given by:

$$\Delta \pi = \pi(p^1, w^0, y) - \pi(p^0, w^0, y) \quad 11$$

Where  $\Delta \pi$  is the change in profit,  $\pi$  is the profit function,  $W$  is vector of input prices for production.  $P$  is a vector of output price,  $p_0$  and  $p_1$  is the initial output price and price after the change respectively,  $Y$  is the vector of fixed factors of production. Hence, the profit maximization is approximated by the Second Order Taylor expansion and deflated by its initial value of production given by:

$$\Delta \pi / x_0 = \sum PR_i \Delta p_i^r + 1/2 \sum \sum \psi_{ip} (\Delta p_i^r)^2 \quad 12$$

Whereby  $PR_i$  share of the sales,  $P_i^r$  the self-produced price and  $\psi_{ip}$  is the own-price elasticity of supply. The money metric M is the compensated variation of equations 10 and 12, combined with the net benefit ratio approach. Hence the net welfare effect M is given by:

$$M = \sum (PR_i \Delta p_i^r - CR_i \Delta p_i^c) - 1/2 \sum \sum \varepsilon_{ip} (\Delta p_i^c)^2 + \sum \sum \psi_{ip} (\Delta p_i^r)^2 \quad 13$$

There are two major issues in computing the money metric M, as derived by equation 13. The first is the relationship between producer and consumer prices. The second is the appropriate use of demand and supply elasticities. The first issue is related to the fact that it is difficult to obtain the self-produced price for products in developing countries particularly sub-Saharan countries. To overcome this problem, most of the studies suppose that producer and consumer prices are the same and that prices increase in the same proportion, which correspond to assuming a marketing margin that is a fixed proportion of the consumer price (see, Badolo and Traore, 2015). We adopt the same approach by assuming that purchase and self-produced prices are the same. Thus, we use purchase price within a locality to impute the self-produced price. Similarly, we assume that there is a uniform increase in production and consumption prices.

Regarding the second issue of the price elasticities, most of the studies assume no household responses (for example, Deaton, 1989; Ivanic and Martin, 2008), which means that the elasticities are equal to zero. However, in the long-run, households may be able to respond on food price increase both as consumers and as producers. In this paper, we consider the welfare changes when no household responds, meaning that the elasticities are all zero and when household are both consumers and producers. We estimate price elasticities as discussed in section 3.2 above for the consumer responses. But, we use supply elasticities ranging from 0.216 to 0.621, taken from the study of Magrini et al. (2016) conducted in sub-Saharan African countries including Tanzania. We simulate the price elasticities of supply for individual rural households in this given range with a uniform distribution. Therefore we estimate the reduced form of equation 13 given by:

$$M = \sum (PR_i - CR_i) \Delta p_i - 1/2 \sum \sum \varepsilon_{ip} (\Delta p_i)^2 + \sum \sum \psi_{ip} (\Delta p_i^r)^2 \quad 14$$

Where  $NBR=PR-CR$  is the net benefit ratio defined as the sales value of commodity  $i$  as a proportion of household income. NBR is positive when a rural household is a producer, and negative when a consumer. A positive sign for M means that price shocks increase the initial income relatively more than before the shocks (welfare gain) and a negative sign when there is

welfare loss. Deaton (1989) interpreted the NBR as the short-term elasticity of household welfare with respect to the price of commodity  $i$ .

The welfare effect proposed by Deaton (1989) and used in most applications is a simplification of equation 14 by eliminating the last two terms. Hence we have the expression:

$$M = \sum (PR_i - CR_i) \Delta p_i \quad 15$$

This expression is quite useful in applied policy analysis, particularly since it does not require any information on household responses to price changes. We use this expression to examine the short-term effect of price changes for both producing and consuming rural households.

### 3.4 The Impact of Food Price on Poverty

In this section, we estimate the impact of rising food prices on poverty by using the approach developed by Minot and Daniels (2002) through its extended version of Badolo and Traore (2015), which was used to examine the impact of price increases in Burkina Faso. We compare rural household poverty before and after the price change by calculating the change in household expenditure as given by the expression:

$$x_{i1} = x_{i0} + \Delta \pi - CV$$

Where  $x_{i1}$  and  $x_{i0}$  are the consumption expenditures of a household before and after the price change respectively,  $\Delta \pi$  is the profit variation and  $CV$  is the compensated variation. With equations 10 and 12, we obtain the following consumption expression:

$$\begin{aligned} x_{i1} = x_{i0} + \sum (q_{si}(p^0, w^0, y) - q_{di}(p^0, x^0)) \Delta p_i \\ - 1/2 \sum \sum \varepsilon_{ip} q_{di}(p^0, x^0) (\Delta p_i)^2 \\ + \sum \sum \psi_{ip}(p^0, w^0, y) (\Delta p)^2 \end{aligned} \quad 16$$

Where  $q_{di}$  and  $q_{si}$  are the quantity demanded and supplied before a price change for good  $i$ . Hence, we examine the impact of food price on poverty by using the poverty measures developed by Foster, Greer, and Thorbecke (1984) defined by:

$$p_\alpha = 1/N \sum ((\bar{x} - x_i) / \bar{x})^\alpha \quad 17$$

Where  $p_\alpha$  is the measure of poverty,  $N$  is the number of households,  $\bar{x}$  is the poverty line.  $x_i$  is the consumption expenditure of household  $i$ .

Foster et al. (1984) measures the poverty headcount  $p_0$  for  $\alpha = 0$  as the incidence of poverty, meaning that the proportion of households with an expenditure level below the poverty

line. The poverty gap:  $p_1$  for  $\alpha = 1$ , is the incidence of poverty multiplied by the average gap between the poverty line and the income of a poor household, expressed as a percentage of the poverty line. Thus, it takes into account the depth of poverty as well as the percentage of the households that are poor. The last term measures poverty severity:  $p_2$  for  $\alpha = 2$ , is the poverty gap squared, which takes into account the degree of inequality among poor households as well as the depth of poverty and the number of poor households.

While the total consumption and per capita consumption have been frequently used in existing studies, we use the per adult equivalent consumption as our indicator variable because it takes into account differences in household size and composition by gender and age and their impact on household consumption.

## **4.0 Results and Discussions**

### **4.1 Non-Parametric Estimation**

In the present section we estimate the functional form of the demand system by using a non-parametric specification. We investigate the functional form of the budget share for aggregate food consumption. Our general idea is testing whether the shape of food share is linear, or alternatively non-linear. We estimate equation 1 and results are indicated in the Table 2 and figures 1 and 2.

In Table 2 the estimates of the partial linear model indicates that the agricultural occupation and primary education level of the household head tends to increase spending on food. Indeed, less educated farmers are more likely to be poor and hence much of their income is spent on food. Likewise, as the age of the household head increases, food spending increases by 0.06%. On the other hand, households with corrugated iron roofs tend to have smaller food shares than those who do not have iron roofs. In rural areas, the possession of an iron roof is an indicator that determines household wealth and hence it correlates positively with income. Thus, households with iron roofing tend to be richer and it is therefore not surprising that they spend a smaller proportion of their income on food.

Results also indicate that male headed households spend a lower share of their income on food than female headed households, implying that female headed households are poorer than male headed, given that women are generally disadvantaged relative to men in their access to assets, credit, employment and education (Joshi, 2004).

Furthermore, household size has a negative and significant impact on food spending. With per capita expenditure(PCE) held constant, a unit increase in household size will decrease the share of income spent on food by 3%. This empirical observation contradicts the theoretical prediction

because it is expected that the larger the household, the higher per capita food consumption, particularly among poor households whose food consumption is close to subsistence. Again, food in poor households has low own and cross-price elasticity, implying that food among poor households is not easily substitutable. Hence, we should expect the per capita share of income spent on food to increase in proportion to household size and total household resources, but here this is not the case. However, Deaton and Paxson (1998)<sup>4</sup> found similar results indicating that empirical evidence which contradicts the theoretical prediction in both low- and high-income countries. A plausible explanation given our results might be due to the fact that in the agrarian economy of a less developed country, agriculture is labour intensive. Within the social settings of less developed countries particularly in rural areas. Family plays an important role in contributing to labour for agricultural activities including livestock. Large families, possibly with relatives, dependents and children make a net economic contribution to the family. In these circumstances, couples with many relatives and children should eventually be better-off than those with few. The economic contributions of relatives and children, may take the form of labour on the family farm, work activities or the provision of income in cash or kind, derived from wage employment inside or outside agriculture and may eventually translate into an increase in income, their own food production leading to a decline in the share of income spent on food relative to total expenditure.

In figure 1 and 2, we estimate food Engel curves for the whole sample and then fit a quadratic equation to the Engel curves. As Engel predicted, food expenditure shares rise, then fall dramatically as total expenditure rises. Ulimwengu et al. (2012) found similar result for the Democratic Republic of Congo's food Engel curves.

The non-parametric estimation of the food Engel curve in rural Tanzania deviates from the linear fit and instead has very close correlation to a quadratic fit. Moreover, we perform a functional form specification for the different economies of scales (adult members and children less than 5 years old), as indicated in figures 3, 4, 5, 6 and 7. As expected, the share of income spent on food declines with PCE for each household type. The results are still consistent with the food Engel curves and deviate from total linear expenditure and are very close to the quadratic for the expenditure function. For households with one adult member in the household, even though the estimated Engel curve is not linear in expenditure, the non-parametric Engel curves deviate from the parametric quadratic fit. Nevertheless, we have a few observations for one adult

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<sup>4</sup> The section D of Deaton and Paxson (1998) has detailed plausible reasons of such paradox finding. Some of these reasons are direct economies of scale in food consumption, economies of scale in food preparation, food wastage, Collective models, price elasticity of food, measurement error on the larger households, calorie overheads.

and even for five or more adult members in the household. We therefore believe that the shape of the Engel curve is driven by the limited observations available, because the Engel curves are less precisely estimated at the smallest and largest values of the logarithm of per capita expenditure, where fewer households are located. Furthermore, we assess the Engel curve for households with a child of less than 5 years old and superimpose the parametric fit. Similarly, the non-parametric Engel curve deviates from the linear expenditure function and hence can be closely approximated as a quadratic parametric model.

In addition, we use the Härdle and Mammen (1993) test discussed in section 3.1 and test whether linear or quadratic might parametrically approximate the Engel curves. The null hypothesis of this test states that the parametric and non-parametric fits are not different. In this case, our parametric specification is linear and quadratic in the expenditure functional form specification. During testing, we use region as a weighting function of the test, meaning that units which are closer within the region carry a higher weight. As indicated in Table 2, the test is statistically insignificant for the quadratic term, but it is statistically significant at any reasonable significant level for the linear parametric expenditure term, implying that the quadratic term in expenditure can parametrically approximate the food Engel curve in rural Tanzania. Therefore, we include the quadratic term of expenditure in the demand analysis by estimation of the QUAIDS model.

#### **4.2 The Welfare Change**

In this section we present the short- and long-run effects of food prices on household welfare, when households are producers and consumers. However, in rural area it is difficult to distinguish between consumers and producers. Hence, we first examine the net benefit ratio (NBR) of the food items and then estimate the aggregate welfare change due to a price shock. Table 3 presents the NBR of the twelve food items. The first two columns indicate the shares of self-produced and purchased food items. The last three columns indicate the net benefit ratio (NBR) and the percentage number of net sellers and buyers. Results indicate that meat has the largest share with 19% due to purchases, followed by maize with 13.4%. Milk has at least a share of 2% due to purchases. In the case of self-produced items, cassava has the highest share with 27% while sugar, oil and other food item are together the least self-produced food items. Indeed, the smallest share of self-produced items are all zeros, implying that households are heavily reliant on the purchase of such food items for the reason that these food items are either cash crops or industrially produced food items.

The net benefit ratio of rice, meat, sugar, cooking oil and other food categories are negative, implying that these food items are purchased from a market, while the rest of the food

items for consumption are self-produced. Also, the negative sign of the NBR indicates a high proportion of the number of net buyers, a limited number of net sellers in a given food category and vice-versa. Indeed, the short-term effect of the price increase will cause net buyers to lose welfare and net sellers to gain by the amount indicated in the NBR column. In the short-run, a unit increase in price will result in the highest welfare gain of 22% for net sellers of cassava and at least a welfare gain of 1% for bean and seed food sellers. Furthermore, a unit increase in price will result in a welfare loss of 12% for net buyers of meat, 11% for other foods, 9% for sugar, 8% for cooking oil and 3% for rice buyers.

While meat is locally produced, based on the count of rural livestock and comes mostly from indigenous cattle. Cooking oil and sugar are industrially processed items and are mostly imported due to insufficient domestic supply. According to the Tanzania Meat Board (2014), meat production is one of the important components of the livestock sector. The average meat production in 2013/2014 was estimated at 563,086 tones. Over 70% of livestock production in the country is located in the Lake, Northern and Central zones. The actual meat consumption per capita stands at 12 kg. Given the current population of Tanzania of 45 million people, and taking into consideration that FAO recommends 50 kilogram of meat consumption per capita, there is sufficient demand for meat in the country and it is expect to rise as household income increases (Tanzania Meat Board, 2014). Meat price is also increasing in most parts of the country, whereas rural consumers who are residing in areas with low meat production can face a serious loss of welfare due to the price spikes of meat.

In the case of cooking oil, Tanzania mainly focuses on ground nuts (40%), sunflower seeds (36%), sesame (15%), cotton (8%) and palm (1%) for oil production (URT, 2013). In 2010, consumption of edible oil per annum reached approximately 330,000 tons and consumption is growing by 3% annually. About half of the oil consumed is imported, i.e. nearly 170,000 tons (URT, 2013). The price of sunflower oil in the market has increased, due to a shortage of raw material in the oil processing industries, increasing the demand and importation of vegetable oil. As a result, local consumers tend to experience great welfare losses.

As previously discussed, sugar is an industrially produced item and few sugar production factories are available in the country, which causes an insufficient supply of sugar to meet domestic demand. Since independence in 1961, Tanzania has been facing a chronic shortage of sugar for both industrial and domestic use. Recent official government sources reveal that Tanzania's sugar consumption stands at 520,000 tonnes per annum, but the four factories, namely the Tanganyika Plantation Company (IPC), Kilombero, Kagera and Mtibwa Sugar produce only 300,000 tonnes. This translates to a deficit of 220,000 tonnes of sugar, with the excess demand filled by imports, with an approximate annual cost of 132 MM USD (Rabobank,

2013). Nonetheless, sugarcane farmers are taxed highly due to inefficiencies in the sugar milling industry and/or excessive power by the sugar mills caused by poor and/or a lack of regulations. Similarly, consumers are also heavily taxed as tariff exemptions do not necessarily translate into low consumer prices (Nkonya and Barreiro-Hurle, 2012).

In addition, transaction costs are high due to poor transportation infrastructure networks in rural areas, and energy prices further increase the cost. Both costs tend to increase the price of sugar and cooking oil, causing the final price to be relatively high in rural areas as compared to urban areas, because sugar and oil must be transported from cities and town centres. Hence an upward shift of the price of sugar can negatively affect poor rural consumers considerably more than rich rural or urban households.

Likewise, the other food category, which includes tea, coffee and salt, is also mostly comprised of processed industrial goods in the country. Tea is the cheapest consumable food product with high demand, due to a culture of tea drinking in Tanzania. According to the report of GAIN (2015), coffee consumption remains low at 7% of the total national production. However, like in most other East African countries, the coffee culture is slowly gaining traction, though it remains low in rural areas. The Tanzania Coffee Board estimates the annual growth rate of coffee to be an average of between 1.5 and 2% (GAIN, 2015). Consumption growth is constrained by low purchasing power for the majority of the population and the well-established tea drinking culture. Hence, few potential tea and coffee rural consumers can experience a welfare loss when the price of these products increases.

#### **4.3 Expenditure and Price Elasticities of Demand**

In order to examine the NBR as discussed earlier with price information, we need to estimate the elasticities of demand. Thus, in this section we estimate the expenditure and price elasticities of consumers by using the QUAIDS model discussed in section 3.2 and then we compute the change in consumer welfare based on the net benefit ratio approach from the estimated price elasticities. Table 4 presents the estimated elasticities given the average price and household expenditure. However, we use estimated individual price elasticities in the welfare analysis. Based on the estimated expenditure elasticities, the consumption pattern of rural Tanzanians can essentially be grouped into three categories.

**High-income elasticity food groups:** It includes rice, maize, wheat, beans, seeds and meat. On average, the expenditure on these items (across all households) will increase disproportionately more than the increase in total food expenditure.

**Unit-income elasticity food groups:** It includes milk and sugar. On average the expenditure on these items (across all households) will increase at the same rate as the



Increase in total food expenditure.

**Less-than-unity income elasticity food groups:** It includes cassava, vegetables, oil and other food-categories. On average, the expenditure on these items (across all households) will increase relatively less than the increase in total food expenditure.

For all households, most food groups are found to be elastic except for the cassava, oil, vegetable and other food categories, which are found to be inelastic, and thus necessitates that expenditure increases with income. The wheat food group has the highest expenditure elasticity followed by rice, seeds and maize. For wheat and rice, a 10% increase in total food expenditure leads to a 14.8 and 13.7% increase in the consumption of wheat and rice respectively.

Staple foods have high expenditure elasticities, whereas protein products, such as meat and milk, have low expenditure elasticities. We would expect that an increase in income leads to a shift in the consumption pattern from staple foods to meat and milk products including eggs, but the shift is in the opposite direction. There are several possible explanations. Food composition in most parts of the country depends on the availability of food in a particular region. Hence, the shifting of the consumption pattern and the classification of the food item as a necessity or a luxury, are likely to be influenced by the food composition patterns in the region. For example, while 'ugali' cooked from maize is the common meal in the country, between 85 to 90% of Tanzania's population eat maize (Wilson and Lewis, 2015). Rice and wheat are common food items and preferred only in coastal regions. Thus, rice and wheat expenditure elasticities in such regional zones will be highly inelastic, whereas they will be elastic in other regions. In the Lake, Northern and Central regions where meat production is highest in the country, milk and meat products may not remain luxury items as household income rises. In addition, this grouping of commodities depends on the income level of the region. Rice, wheat and maize may be a necessity in a high-income region, such as Dar es salaam, Mwanza and Arusha, but a luxury in a poor low-income region such as in the Lukwa and Kigoma regions.

It is also important to note that, in rural areas where agricultural activities are labour intensive, food composition must be made up of energy dense foods, such as seeds, beans, maize and wheat, suggesting that even if incomes increase, households will continue to spend more on grain products than on protein products such as milk and meat. The proportion of a consumer's income spent on grain products influences the expenditure elasticity. The greater the proportion of income spent on grain products, the higher the elasticity for grains products is.

In addition, the results indicate that all self-produced products have price elasticities that are both compensated ("Hicksian") and uncompensated ("Marshallian"), expectedly negative. This indicates that an increase in the price of a good leads to a decrease in the demand for that good and is thus consistent with demand theory. Based on Marshallian price elasticities, only milk

is found to be unitary price elastic for all samples. This means that a 10% increase in the price of milk leads to a decrease of around 10% in the consumption of milk. However, most food becomes less price elastic when only substitution effects are considered as shown by the inelastic compensated (Hicksian) price elasticities. It is important to compare the expenditure and price elasticities to derive policy implications. For all food groups, estimates reveal that expenditure elasticities surpass price elasticities meaning that income policies for food consumption seem to be more efficient compared to price policies as the expenditure elasticities for all food groups surpass the price elasticities.

#### **4.4 Welfare Analysis: Compensating Variation**

In this section we analyse the short- and long-run effect of food prices on household welfare. Our analysis is based on the net benefit ratio approach proposed by Deaton (1989) combined with the methodology of compensated variation. There are two approaches for deriving compensated variation. The first approach, accounts only for the income effect and uses post budget shares and price information. The second approach, accounts for both the income and substitution effects meaning that a consumer can respond to the price change. The second and the first approach are estimated by equations 14 and 15 respectively. Results are presented in Table 5. The aggregate welfare loss is 39% for the poor, 40% for middle-income consumers and 29% for rich net consumers when no substitution effect is accounted for. The welfare loss declines substantially when households are allowed to substitute with relatively cheap food groups. It falls to 11% for the poor, 11% for middle-income consumers, while rich consumers only saw their welfare decline by 8%. To illustrate this point, we plot the compensating variations against the per capita logarithm of expenditure. Figure 8 indicates that poor households are much more affected by food prices than rich households, because as income rises, both the short- and long-run welfare loss tends to decline and becoming smaller at the higher tail of the income distribution. Similarly, Leyaro et al. (2009) estimated consumer responses in three rounds of the Tanzania Household Budget Survey (1991/92, 2000/01 and 2007). They found that price increases worsened the welfare of most consumers during the 1990s and 2000s and that the poor and in particular the rural poor, bore much more of the burden compared to the non-poor.

Our results of the welfare losses are in line with the previous studies, which have expressed the compensated variation as a proportion of the initial food expenditure as in our case. Akbari et al. (2013) studied the welfare impacts of food price changes on Iranian households between 2009/10 and 2011/12. They estimated a complete food demand system using the QUAIDS model for all food items classified into nine food groups. They found that for

all households, the first order effects as a proportion of 2009/2010 household food expenditure was 51.37 and the second order effect was 49.93 as a proportion of food expenditure. The second order effects dropped to 11.92 when computed as the proportion of the total household expenditure. Likewise, Attanasio et al. (2013) analysed the welfare consequences of food price increases in Mexico. They also estimated a QUAIDS model of demand for food and the welfare loss (second order effect) as a percentage of the food expenditure ranges from 17.1% to 23.2% due to price changes in Mexico between December 2003 and April 2011. The welfare loss was 23% for the poorest consumers in the sample but around 17% for the least poor.

It is important to emphasize that primary motivation behind these studies, and this one, is to show how households have been affected by increases and changes in the relative prices of foods. In fact, these studies have essentially estimated the second stage budgeting by expressing food items as the proportion of the total food consumption and therefore exclude nonfood items in the analysis. Thus, the aggregate welfare changes are taken as percentages of the initial total food consumption. Hence the estimated welfare loss or gain is expected to be much larger than the welfare change when the welfare change is expressed as the percentage of the total expenditure.

As mentioned above and based on the study conducted by Akbari et.al (2013), the estimated welfare effect of food prices are fundamentally low when the compensated variation is expressed as the percentage of total expenditure. Yu (2014) estimated the second order welfare effect of food, beverages and tobacco expressed as the proportion of household expenditure and showed that when global food price grew by 50%, which occurred after Jan. 2009, incomes needed to compensate for the welfare loss in low-, middle- and high-income countries, which were 22%, 14% and 9% respectively.

In some contexts, authors deflate the compensated variation by the household size and express it as a percentage of per capita household expenditure and hence the compensating variation would be scaled down substantially. Many of these studies are in the work of Cranfield and Haq (2010) who investigated the impact of food inflation on consumer welfare for final goods, using data spanning a broad range of countries. Their mean value of per capita compensating variation by scenario, income cohort and as a percent of per capita expenditure on nondurables was found to be in the range of 2.62 to 18.72 % of total expenditure.

Nevertheless, Friedman and Levinsohn (2002) have indicated a very high compensating variation, even when the expression is carried based on initial household expenditure. They estimated the impact of the Indonesian economic crisis on household welfare by using only pre-crisis household information from 1996. With welfare is expressed in percentage terms of the total expenditure, they found the first order compensating variation for all households to have an

average compensating variation between 73% and 85% of the initial household expenditure. Furthermore, they found that Indonesian households in the middle of the distribution, and not the poor, were most adversely impacted by the price changes. However, when the sample was separated into rural and urban cohorts, it was the urban poor, who were the most adversely affected by the crisis, needing an average of 109% of their pre-crisis income in order to reach pre-crisis utility levels. On the other hand, the rural poor require the least amount of compensation, only 70% of their pre-crisis income. These estimates are comparatively huge, even though they drop substantially with the addition of the second order term to provide a better approximation of the CV by including substitution effect. Still our compensating variations are considerable low for both the first and second order effects when accounting for substitution behaviour.

For the case of food producers, the welfare changes are in opposite direction of food consumers. As expected, results in Table 5 indicate that net food producers are in general gaining welfare, due to price changes when only the income effect is considered. In particular, the welfare gain is 52% for poor producers, 44% for middle-income producers and 34% for rich producers. Indeed, the gain is much larger when there is a substitution effect than when no substitution effect is considered. Figure 9 suggests that the effect of food price on welfare is not evenly distributed across the income distribution. The welfare gain due to food prices is larger for the lower-income distribution than on the upper-income distribution, suggesting that food producers at a low-income level are benefiting more from food prices. Most likely, at the upper-income distribution, rural producers tend to be only part-time farmers. Figure 10 attests to such a plausible explanation. It indicates that as household income increases, land size holding of food producers is decreasing, implying that at a high-income level, households sustain their livelihood by income from off-farm activities.

For more insight we compare the weighted median welfare gain of primary and agricultural farm occupants to that of post primary and non-farm occupants for both the short and long-run effects of price changes as shown in figures 11 and 12. Results indicate that both the short- and long-run welfare gains are higher for primary and agricultural famers than post primary and non-farmers. In other words, the prevailing decline of welfare gain for food producers as income rises, is attributed to non-farm and post-secondary food producers, meaning that such household categories do not only depend on agricultural farming for their livelihood, but also on non-agricultural activities. As evidence suggests, small scale farm households in developing countries rarely rely on agriculture alone, but often maintain a portfolio of income activities in which off-farm activities are an important component, although non-farm income accounts for between 35% and 50% of the total income of rural households in

developing countries (Haggblade et al. 2010). For farmers (food producers) in our sample at a high-income level who reported their main economic activities as a non-farm occupation, are most likely to have a large amount of supplementary income from off farming activities. Hence, “non-farm” food producers are exclusively depending on off-farm activities for their livelihood. It is a common path in economic development that society shifts away from agricultural labour dependence when income rises.

At the national level, the impressive average annual GDP growth rate of 7% impacts the structural transformation from agricultural to small industrial and service sectors. Although at a slow pace, the share of agriculture in GDP has fallen from 29% in 2001 to 24% in 2010<sup>5</sup>, and the share of industry has increased from 18% in 2001 to 22.1% in 2012. While, the service sector has remained the largest sector in terms of output. Its share of GDP declined marginally from 45.5% in 2001 to 43.9% in 2012 (ESRF, 2014).

The impact of food price differs by geographical locations, which are characterized by six different regional-zones. As expected, the second order effect of prices on net consumers falls by more than half as compared to the first order. In contrast, the second order for the net producers increases substantially across locations. The most affected net buyers are found in the central zone and the least affected are in the lake zone. The central zone includes regions such as the Dodoma and Singida regions, which are dry sub-humid zones. These zones are heavily infested with tsetse flies and have limited rainfall. Drought is the major determining factor for agricultural production, including livestock, meaning that these regions are food dependent on other regions. On the other hand, the net sellers who have benefited the most are found in the southern highland zone, and the least in the lake zone. The southern highland zone includes regions such as Iringa, Mbeya, Lukwa and Ruvuma. These are known as the big four regions, which feed the country by producing more than 35% of the total annual maize production in the country (Barreiro-Hurle, 2012). The Mbeya region is at the border between Tanzania and Zambia. Although the legal maize trade is complex to some extent, maize exportation flows to Zambia and Malawi and other southern neighbouring countries through Mbeya, primarily from the maize growing zone.

We further disaggregate the welfare loss and gain in terms of maize and non-maize growing regions. As Table 5 suggests, net sellers in the maize growing region have a net aggregate

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<sup>5</sup> Even though, the Tanzanian agricultural sector has grown although at a low rate of 4.3% in average over the last decade and agricultural productivity has been consistently low for many years due to several reasons including small scale agricultural based on familiar labour dependence, low level of technological input use and fall of agricultural export crops (ESRF, 2014).

welfare gain of 11% and 8% in the short- and long-run, more than net sellers in non-maize growing regions. The welfare gain is also higher in the maize growing region than in the non-maize growing region, for both maize and rice products. The gain is possibly attributed to the fact that there is high demand for maize in the country and even from neighbouring countries. Recent estimates of maize exports show a range between 23,000 MT and 156,000 MT. The countries receiving Tanzanian maize are Zambia, Malawi, Rwanda, Burundi, the Democratic Republic of the Congo (DRC) and Kenya. However, though trade with Kenya is vital, where prices are about 20% higher, maize is not usually supplied from the Southern Highland region (Wilson and Lewis, 2015).

Surprisingly, net buyers are strongly affected by food prices, by 8% more in a maize producing region than in non-maize producing regions. As expected, the effect is reduced to 4% when households are allowed to substitute with cheaper food items when the price of food increases. The comparison of the weighted median welfare loss across expenditure quintiles between maize growing and non-growing regions still indicates that in the short-run, the welfare loss is higher in maize growing regions than in non-maize growing regions. The median welfare loss of the 2<sup>nd</sup> quintile is pretty close to both medians of maize producing and non-maize producing regions (figure 13). While the 1<sup>st</sup> quintile median is even closer to the medians of the maize growing region, than the non-maize growing region. The magnitude of the welfare loss in the 3<sup>rd</sup> quintile is relative higher in the maize than in the non-maize region, implying that the overall welfare loss is attributed to the 1<sup>st</sup> and 3<sup>rd</sup> quintile in the maize region. Indeed, poor and rich net maize buyers in the maize region are more negatively affected by food prices than in other regions. However, as figure 14 suggests, in the long-run, the differences in welfare loss between households in the maize and non-maize growing region disappears across all households, implying that the response to the price shock through substitution tends to equalize households utility at the same level of welfare loss for all households.

#### **4.5 Impact of Food Prices on Poverty**

In the present section we examine the impact of food prices on poverty by calculating the poverty measures based on equation 17 on the consumption per equivalent scale. We use the national poverty line per adult equivalent per 28 days of Tanzanian shilling (TZS) 23,933 at the 2010/2011 price index. Table 6 shows the poverty indexes by location and expenditure quintiles before and after price changes. The last two columns are the short- and long-term effects of food price on poverty as measured by  $P_0$ , the head count ratio. Results show that the poverty headcount ratio at the national poverty line in rural Tanzania, stands at 20%, implying that this portion of the population exists or lives below the national poverty line. The poverty head count

ratio varies according to geographical location and the position of the household among the income groups. As expected, 42%, 16% and 2% of the population lives below the national poverty line in the first, second and third expenditure quintiles respectively. Hence, the initial poverty level before the price change is much more pronounced in the low-income groups than in the middle- and high-income groups. The headcount ratio in terms of regional zones, indicates that the lake zone, central zone, southeast and western zones are the poorest regions, with a portion of the population living in poverty above national poverty rates. The western zone is the poorest region, with 29% of the population living below national poverty line. The least-poor regions are the northern, eastern and southern highland regions, with a poverty rate below the national poverty rate. On average, the poverty gap and severity is less noticeable in rural Tanzania, meaning that there is a smaller proportion of poor households whose household consumption is far from the national average poverty line of TZS, 23933 per 28 days. As expected, the poorest regions make up a relatively high proportion of the poverty rates across all measures of poverty.

The short-term effect of price on poverty indicates that the headcount ratio has increased the national poverty headcount by 8%, implying an additional number of households who lose welfare due to changes in food prices. Similarly, food prices have increased the poverty headcount ratios by 3% in the poorest quintile, 10% in the second quintile and 11% in the third quintile of the expenditure distribution. The effect of price is dominated by the second and third quintile of the expenditure distribution. Such categories of households are likely to be net buyers and have a higher food demand relative to their income level. Food price increases reduce real income, thereby reducing their purchasing power and shifting available resources on food consumption. Hence, a price hit can have major and significant effects on their consumption. As a result, many households are becoming trapped in poverty. We observe the same pattern in terms of regions that food price increases increase poverty headcount rates across all regions. The Lake zone in particular, is the most affected with 35% of households living below the national poverty line.

On the other hand, the long-term effect of price on poverty indicates that the headcount ratio has decreased the national poverty headcount by 3%. The headcount in terms of geographical location and expenditure group also drop substantially. Furthermore, the poverty impact is quite varied and drops significantly across regions and expenditure groups. In the long-run, the effects are less negative compared to the initial incidence of poverty because households adapt to the price increases. Households who are net buyers tend to adapt to price increases by substituting to relatively cheaper food items and net producers sell more at the better price.

## 5. Conclusions and Recommendations

In this paper we have estimated food Engel curves using a semi-parametric approach by accounting for several explanatory variables on the parametric side. Estimated food Engel curves reveal that as per capita expenditure increases, food consumption tends to gradually rise until a certain level, where it starts to sharply decline with the rise in per capita expenditure. We test the parametric approximation of the Engel curves and found that quadratic parametric functions approximately fit the non-parametric Engel curves. We argue that using linear expenditure Engel curves in the context of a developing country is too restrictive. We have also shown that the impact of food prices in a rural setting can be examined through the net benefit methodology and compensated variation approaches, which explicitly segregate two different effects. The producer side-effect, usually gains welfare, and the consumer side-effect, which in principle loses welfare. For food producers, the welfare gain is higher in the long-run than in the short-run. Furthermore, the welfare gain is higher at the lower tail of the income distribution than on the higher tail of the income distribution, meaning that the benefit of the increase of food prices is dominated by low- and middle-income producers. We argue that at higher income levels, food producers tend to be dependent on non-agricultural labour and therefore derive a large proportion of their income from non-farming activities. In contrast, net food consumers tends to lose much more of their welfare in short-run than in the long-run. In both cases, poor households tend to lose more welfare than in middle-income and rich households. The effect of food prices on all households varies across regional zones and by household characteristics. We have shown the welfare loss for a specific case in a maize growing region. The welfare loss is higher in the maize growing region than in the non-maize growing region, particularly for the 3<sup>rd</sup> and 1<sup>st</sup> quintiles of the expenditure distribution. Furthermore, we find that the estimated expenditure elasticities outweigh price elasticities, meaning that income policy is more relevant than price policy. Food price has a major impact on poverty, which differs across different household categories and the overall poverty rate. Food price increases tend to increase the rural-poverty headcount and in particular, the poverty effect is much stronger for poor households than for middle-income and rich households. Thus, reformulation of food policy to counterbalance medium- and long-term food price shocks is crucial for reducing poverty and increasing food security particularly for the poor households. Policies such as expanding agricultural production –which is growing at a slow pace– improving domestic agricultural markets, offering subsidies to food producers/consumers, injecting food reserves in domestic markets, lifting tariffs on imported food and limiting exports to protect domestic consumers are instrumental components in the reformulation of food policy.



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## Appendix

Table 1: Definition of the commodity food group

Group	Group name	Goods/items
1	Rice	all types of rice, paddy and grains
2	Wheat	Bread and dried, all types of Pasta, cookies, cakes, wheat ,flour wheat
3	Beans	beans,
4	Seeds	Legumes and Pulses ,Lentils, peas , other legumes, flour made from legumes, soya beans
5	Cassava	sweet potato, cassava, cassava flavour and other tubers
6	Maize	Maize grains and flavour
7	Vegetables and fruit	Onions, tomatoes, carrots, pumpkins, celery, chilli peppers, and other vegetables, Lemon, papaya, orange, tangerine, banana, apple, pineapple, grape, melon, watermelon, mango, other fruits, cooked banana, ripe banana
8	Meat	dairy Beef, pork, chicken, eggs, other poultry, beef and poultry giblets (liver, tripe, etc), meat by-products (hot dog, sausage, ham, bacon, etc), fresh , Fish, sardines, canned fish, seafood, and other types of fish
9	Milk	milk (evaporated, fresh, powdered ,etc), cheese, yogurt, cream
10	Sugar	Sugar, honey, chocolate, jams, sweets
11	Fats and Oils	Fats and oils, lard, butter, margarine, “mawese”, sunflower oil
12	Other food	Salt, tea, coffee, cocoa, foods or meals prepared outside the home, spices , beverages,

Source: Author’s formulation and National Bureau of Statistics classifications

Table 2 : Partial linear model of the Food Engel Curve

Variable	Coef.	Std. Err.	t-statistic	P-value
Agricultural occupation of head	0.06	0.01	5.26	0.00
Male	-0.01	0.01	-1.30	0.20
Log of household size	-0.03	0.01	-2.81	0.01
Log of age of head	0.06	0.02	3.37	0.00
Primary education of head	0.03	0.02	2.08	0.05
Iron sheet roofing	-0.03	0.01	-3.31	0.00
Quarter 2	0.00	0.01	0.18	0.86
Quarter 3	-0.01	0.02	-0.53	0.60
Quarter 4	-0.03	0.01	-2.26	0.03
Standardized Test	Linear		4.00	0.00
	Quadratic		0.62	0.56

Notes: Observation 1531

The standardize test based on H0: Parametric and non-parametric fits are not different

Region dummies are excluded from the table

source: Author's estimation

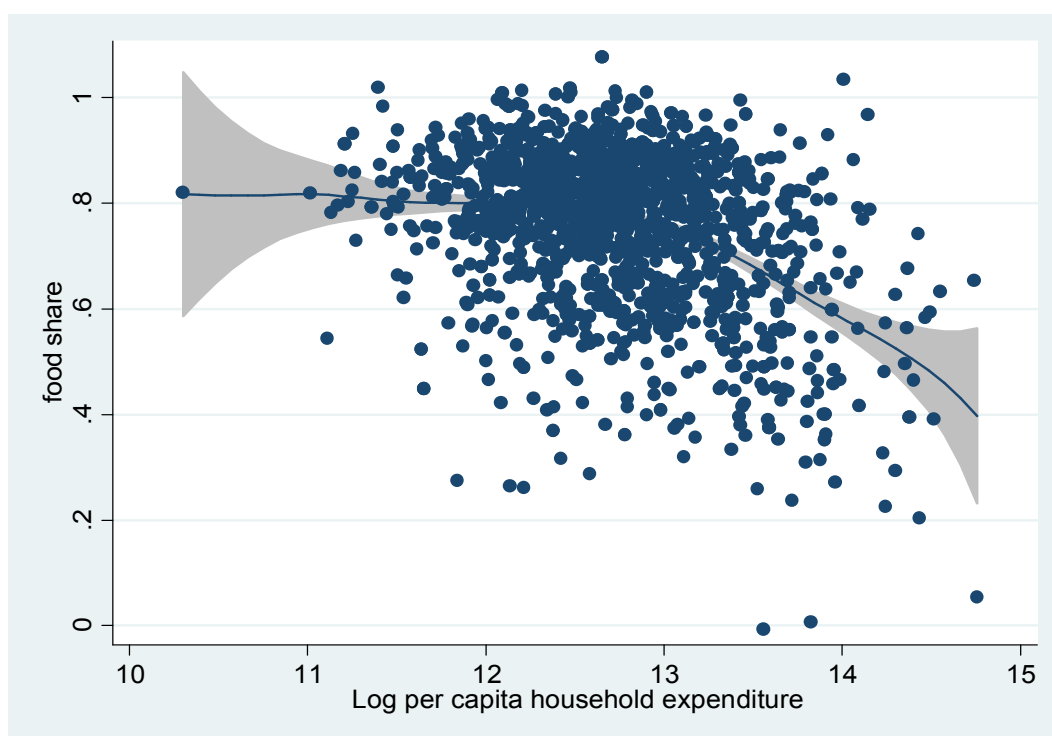


Figure 1: Non parametric estimation of food share

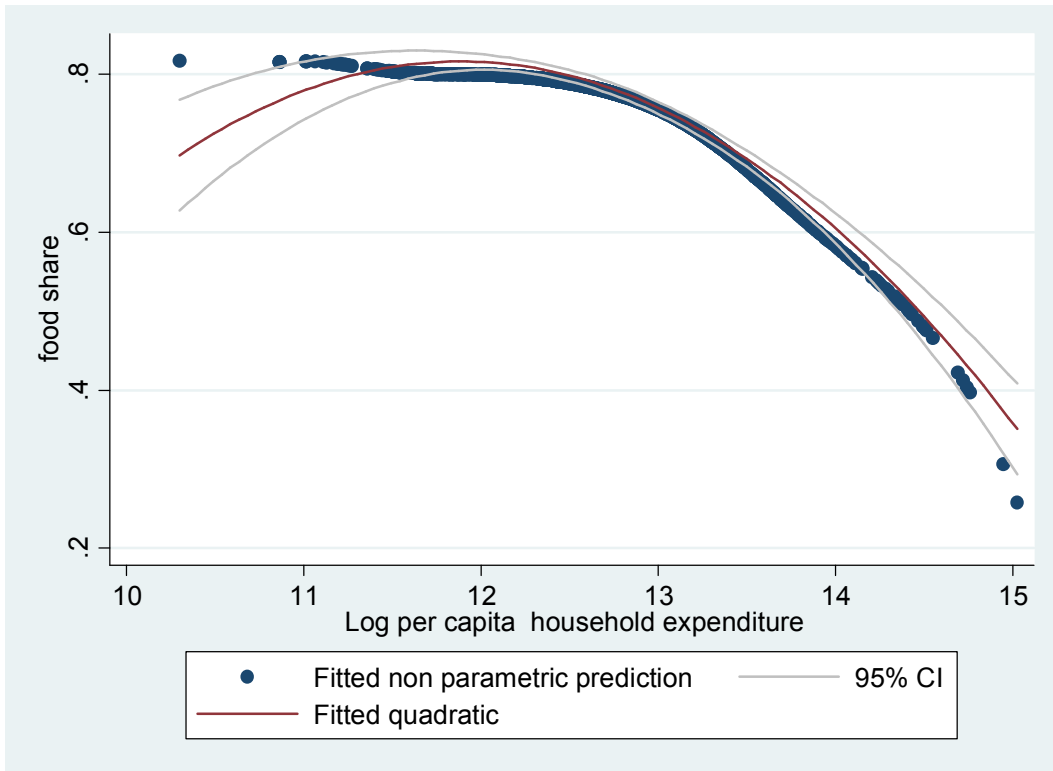


Figure 2: Non parametric versus quadratic fit

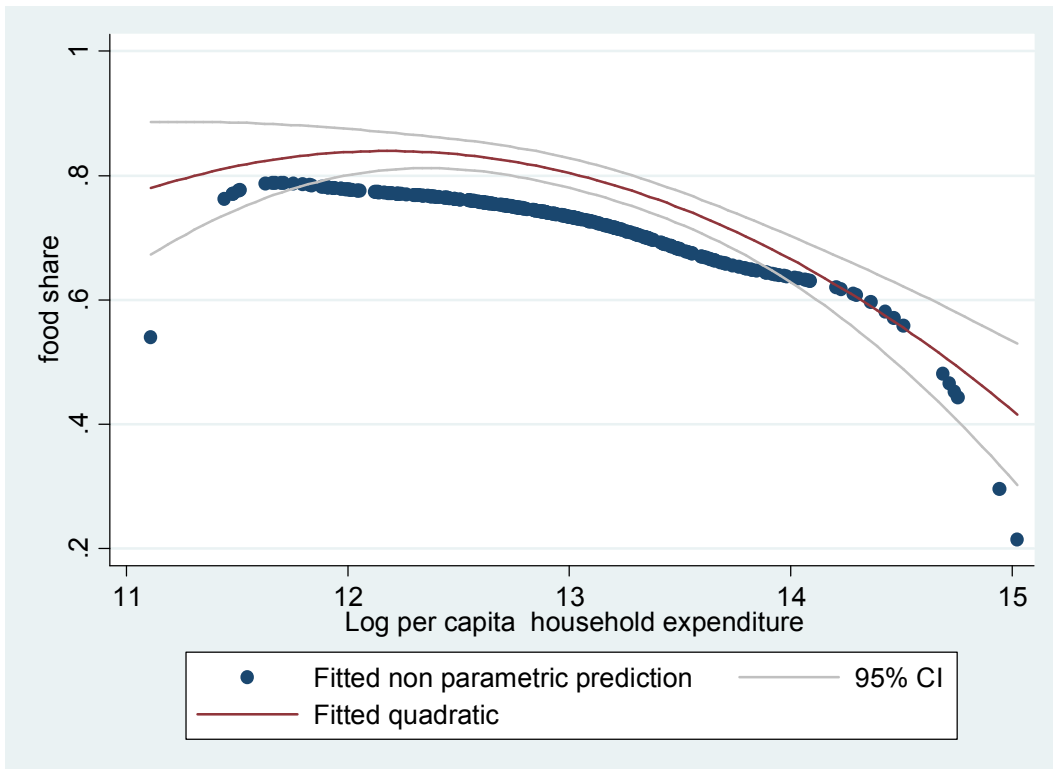


Figure 3: Households with no children (one adult)

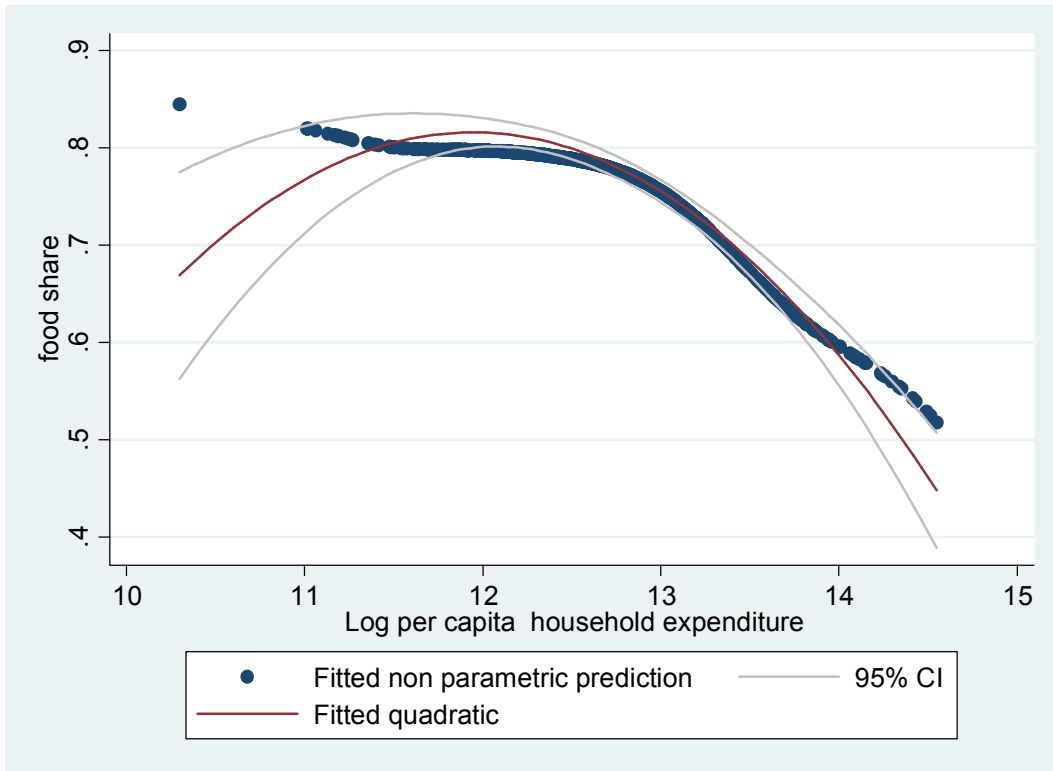


Figure 4: Households with no children (two adults)

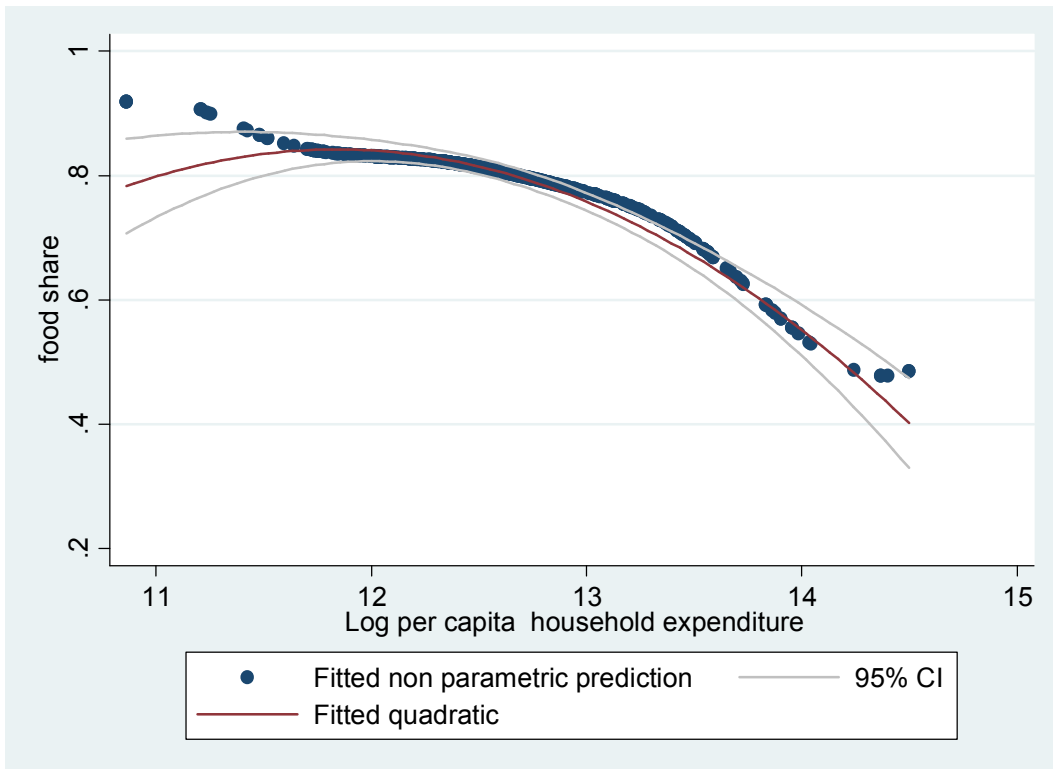


Figure 5: Households with no children (three adults)



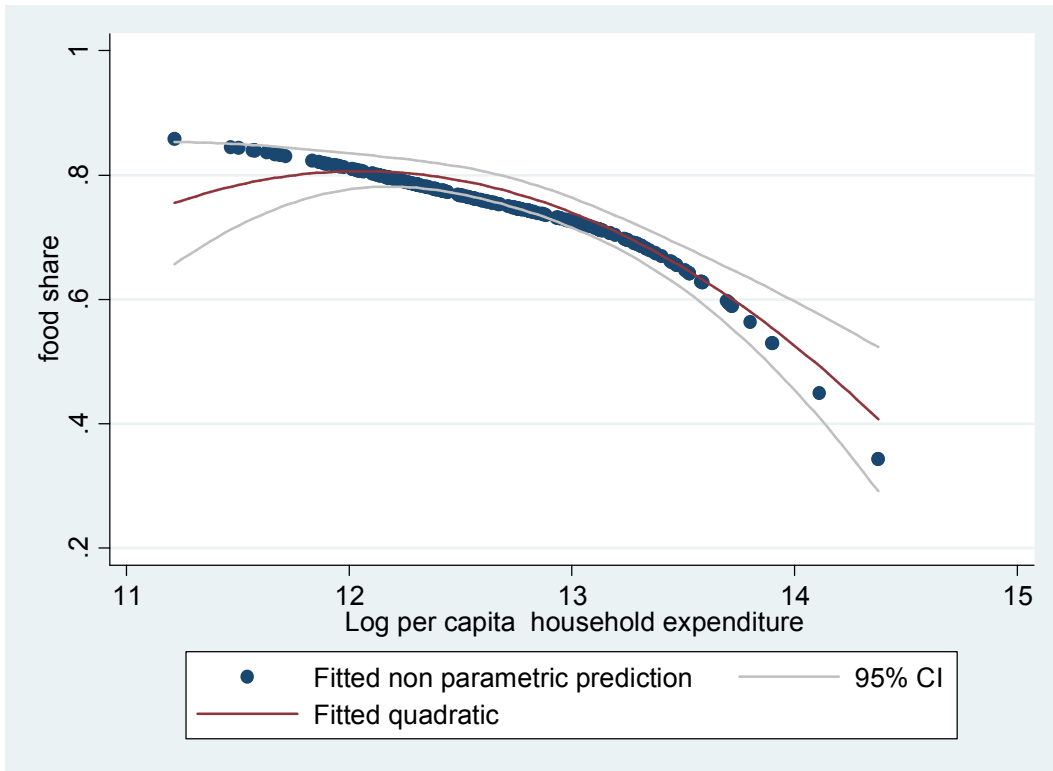


Figure 6: Households with no children (four adults)

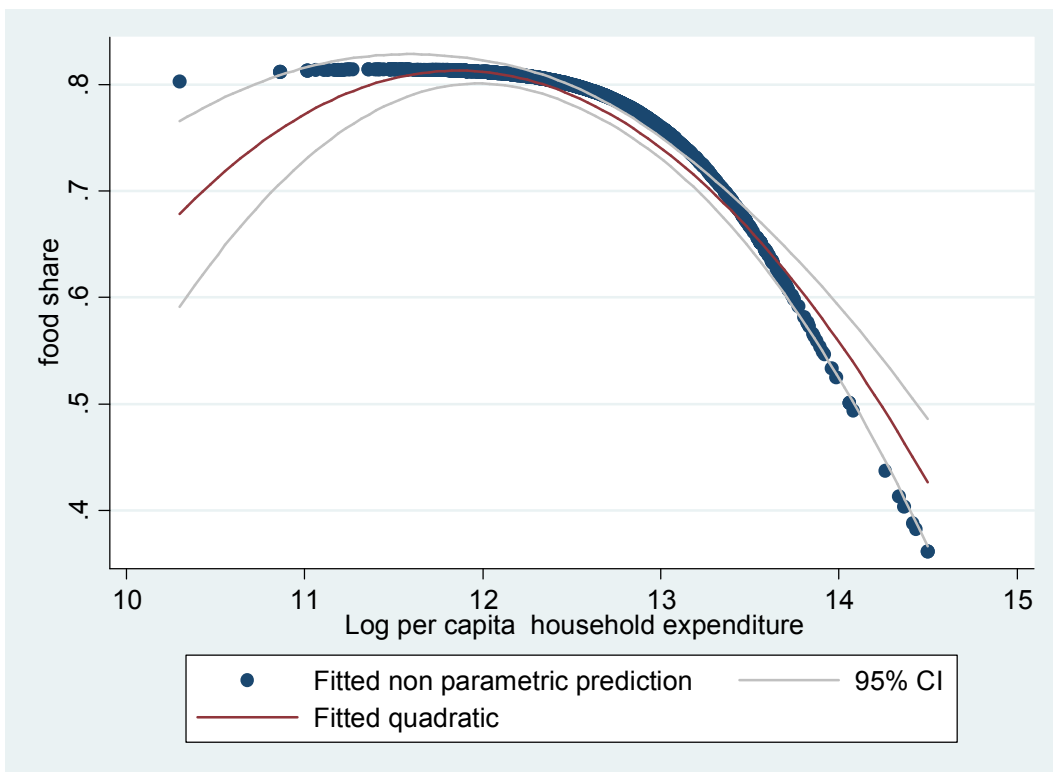


Figure 7: Households with children

Table 3: Food consumption (TZS) in Tanzania, 2008/2009

Variable	Produce		Purchase		NBR=PR-CR		% Net seller	% Net buyer
	Mean	Std. Dev	Mean	Std. Dev.	Mean	Std. Dev.		
Rice	0.05	0.16	0.08	0.15	-0.03	0.23	42.4	57.6
Maize	0.24	0.32	0.13	0.22	0.13	0.43	65.62	34.38
Wheat	0.04	0.16	0.04	0.10	0.00	0.19	37.89	62.11
Cassava	0.27	0.33	0.05	0.13	0.22	0.37	77.64	22.36
Sugar	0.00	0.03	0.08	0.12	-0.09	0.12	15.00	85.00
Beans	0.06	0.15	0.05	0.11	0.01	0.20	56.19	43.81
Seeds	0.05	0.13	0.04	0.09	0.01	0.17	58.29	41.71
Vegetable	0.15	0.24	0.12	0.15	0.02	0.30	50.17	49.83
Meat	0.08	0.21	0.19	0.22	-0.12	0.33	30.88	69.12
Milk	0.05	0.16	0.02	0.06	0.03	0.17	69.32	30.68
Oil	0.00	0.04	0.08	0.13	-0.08	0.14	18.25	81.75
Other	0.00	0.03	0.10	0.19	-0.11	0.20	10.51	89.49

Notes: Conversion; Tanzania , 1 egg=64grams , goat meat= 12 kilos per piece, chicken= 2kilos per piece India , 1 piece of coconut=1kg , 1 orange=150grams Kenya, 1 Mango = 511grams

Source: Author's computation

Table 4: Food demand elasticities in Tanzania for 2008/2009

Variable	Compensated		Uncompensated		Expenditure	
	Elasticities	Std. error	Elasticities	Std. error.	Elasticities	Std error
Rice	-0.49	0.03	-0.61	0.03	1.37	0.03
Maize	-0.61	0.02	-0.77	0.02	1.21	0.03
Wheat	-0.54	0.04	-0.60	0.04	1.48	0.04
Cassava	-0.79	0.03	-0.84	0.03	0.94	0.05
Sugar	-0.60	0.03	-0.69	0.03	1.03	0.03
Beans	-0.42	0.05	-0.48	0.05	1.15	0.04
Seeds	-0.61	0.03	-0.66	0.03	1.27	0.04
Vegetable	-0.64	0.02	-0.75	0.02	0.89	0.02
Meat	-0.59	0.01	-0.79	0.01	1.06	0.02
Milk	-0.98	0.05	-0.99	0.05	1.04	0.07
Oil	-0.49	0.03	-0.56	0.03	0.89	0.03
Other	-0.69	0.01	-0.71	0.01	0.17	0.02

Notes: Source: Author's computation

Table 5: Welfare changes in Tanzania, 2008/2009 to 2010/2011

Category	Net consumers				Net producers			
	First order		Second order		First order		Second order	
	Mean	std	Mean	Std	Mean	std	Mean	std
Poor	-0.39	1.45	-0.11	0.51	0.52	0.84	0.89	1.16
Middle	-0.40	1.28	-0.11	0.59	0.44	0.78	0.91	1.20
Rich	-0.29	1.13	-0.08	0.46	0.34	0.73	0.75	1.15
Central	-0.72	1.37	-0.08	0.41	0.52	0.70	0.94	0.91
Northern	-0.33	0.82	-0.11	0.42	0.33	0.49	0.58	0.66
Eastern	-0.44	0.90	-0.08	0.47	0.48	0.80	0.84	1.18
Southern East	-0.52	1.09	-0.21	0.53	0.66	0.99	1.34	1.65
South highland	-0.49	1.64	-0.16	0.61	0.70	0.89	1.22	1.42
Western	-0.42	1.53	-0.09	0.52	0.37	0.74	0.77	0.98
Lake	-0.25	1.45	-0.09	0.37	0.33	0.89	0.78	1.18
Maize region	-0.43	1.45	-0.13	0.51	0.52	0.77	0.93	1.21
Non maize region	-0.35	1.23	-0.09	0.54	0.41	0.81	0.85	1.21

Source: Author's computation

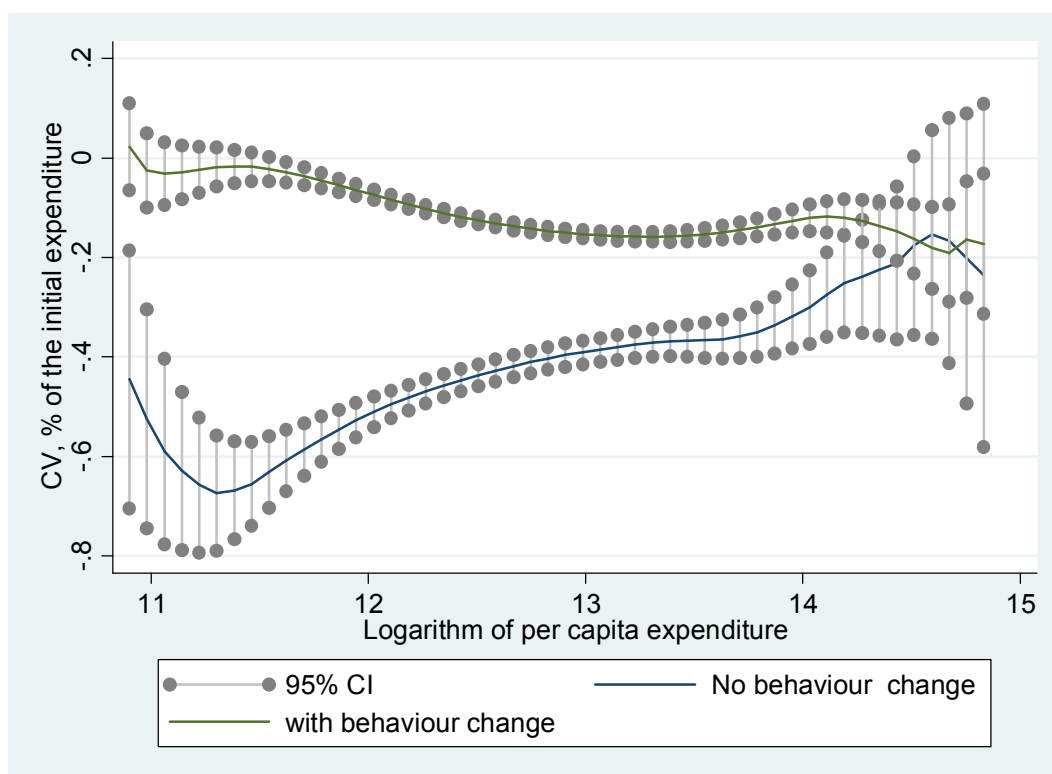


Figure 8: Net consumer welfare change

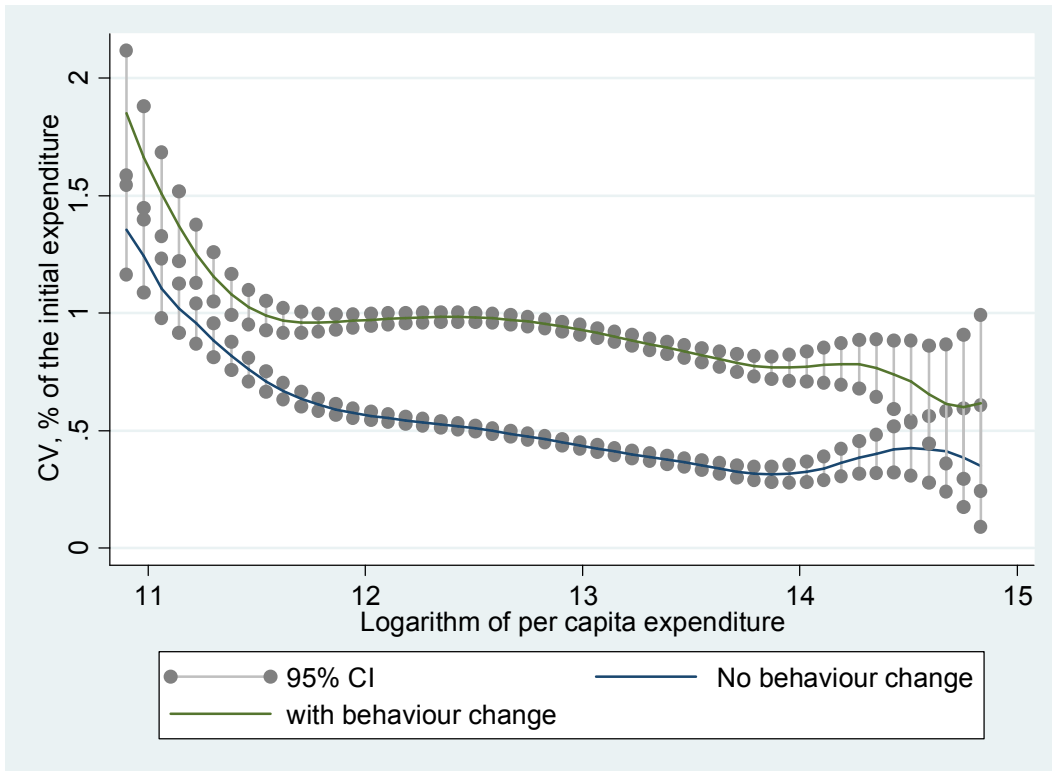


Figure 9: Net producer welfare change

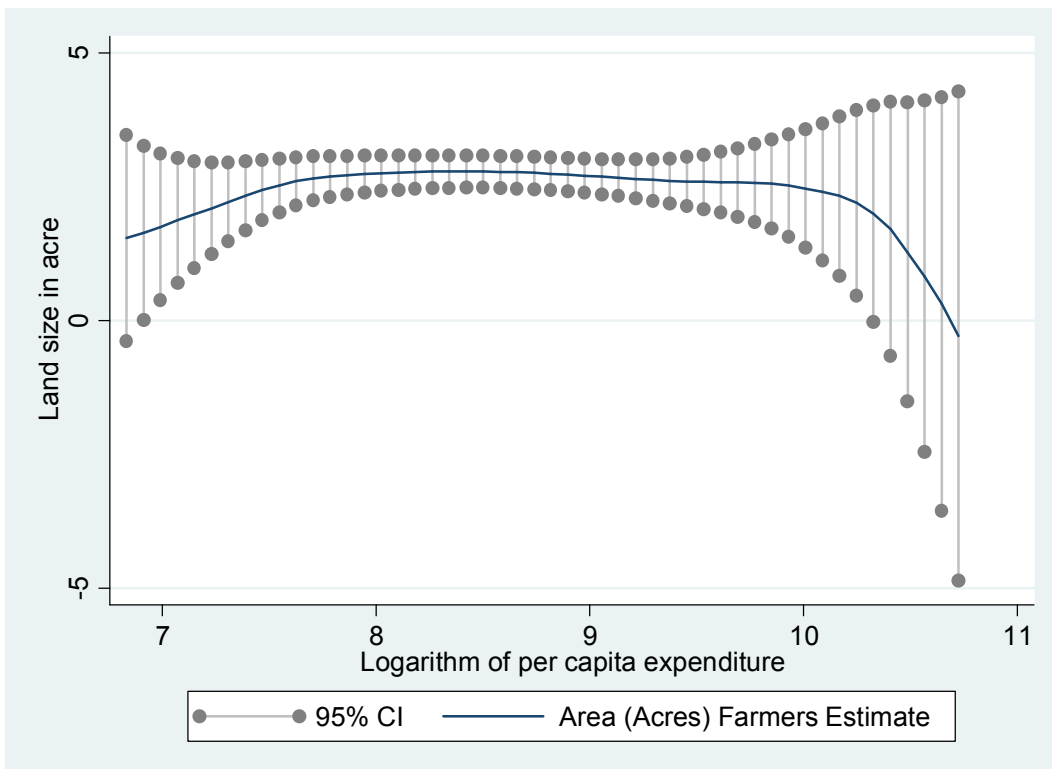


Figure 10: Farm holding land size (Acres)

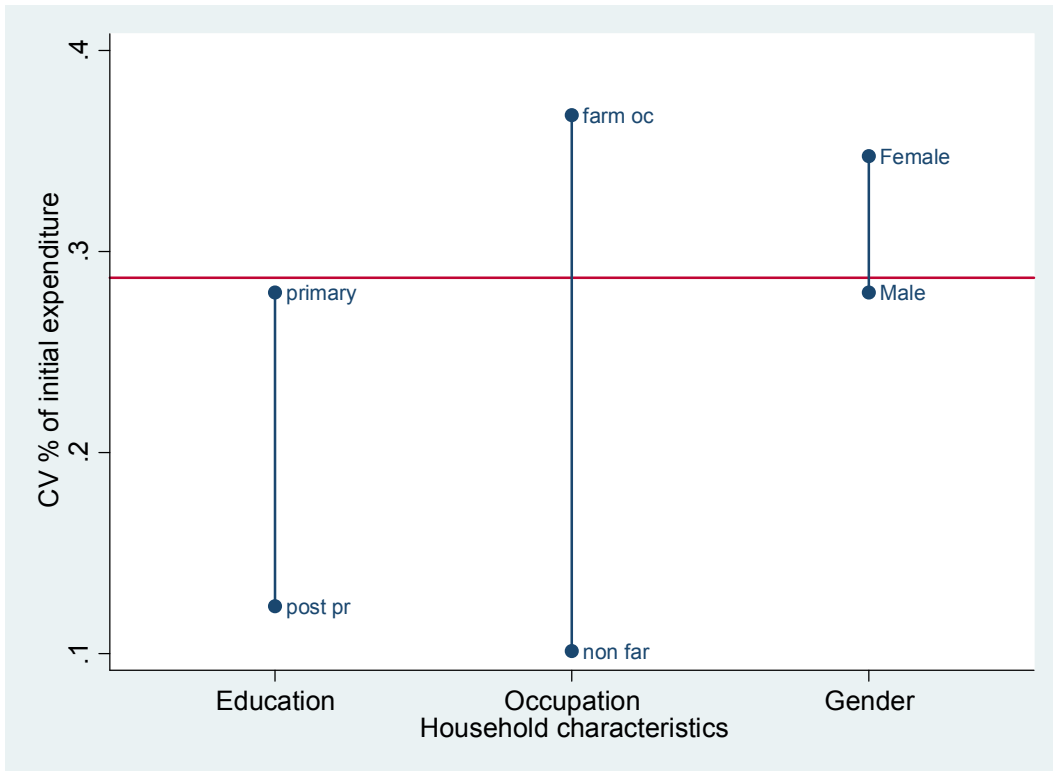


Figure 11: Weighted medians-NBR Producers (No behaviour change)

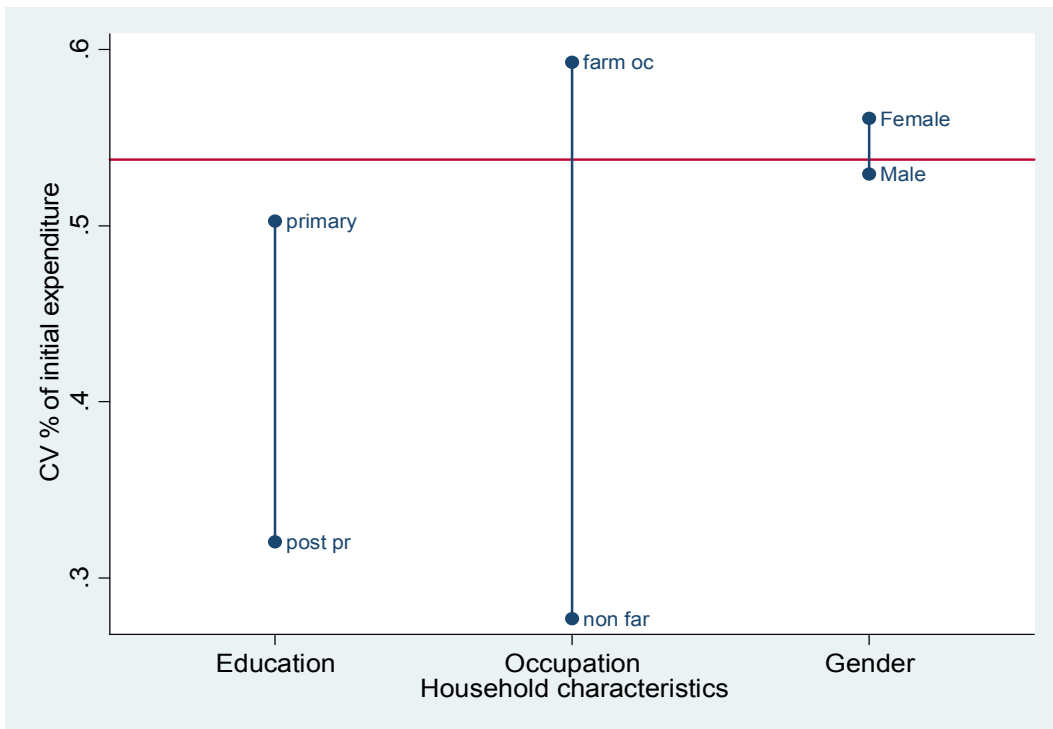


Figure 12: Weighted medians-NBR of producers (with behaviour change)

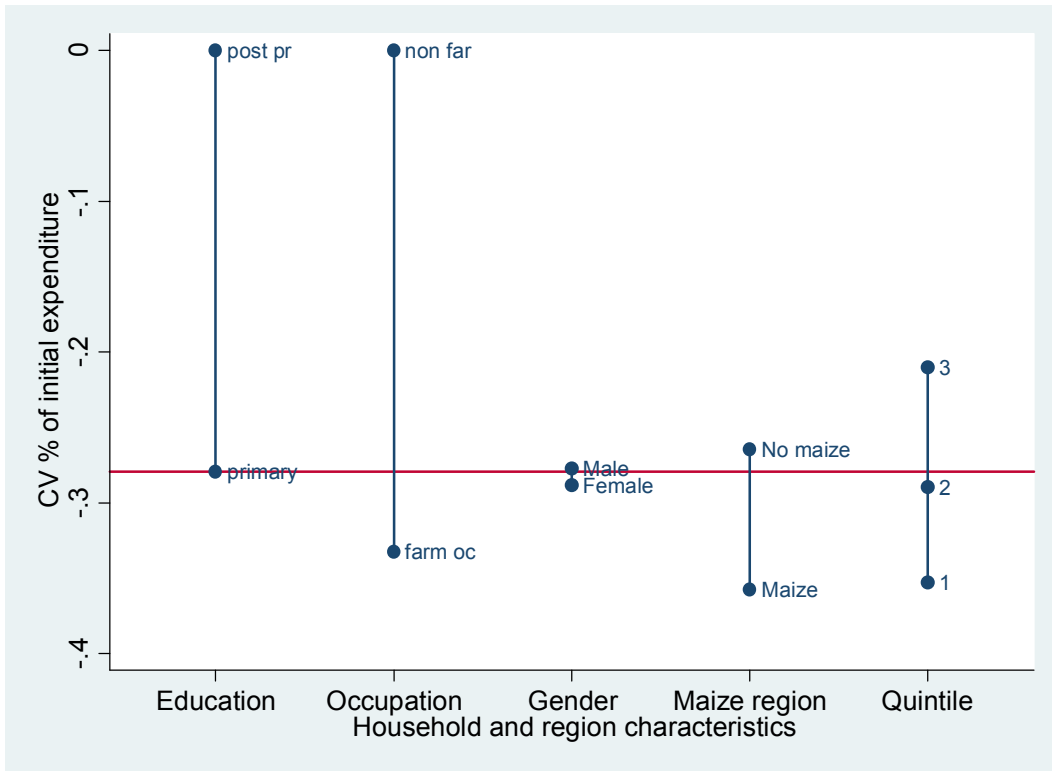


Figure 13: Weighted medians-NBR of consumers (without behaviour change)

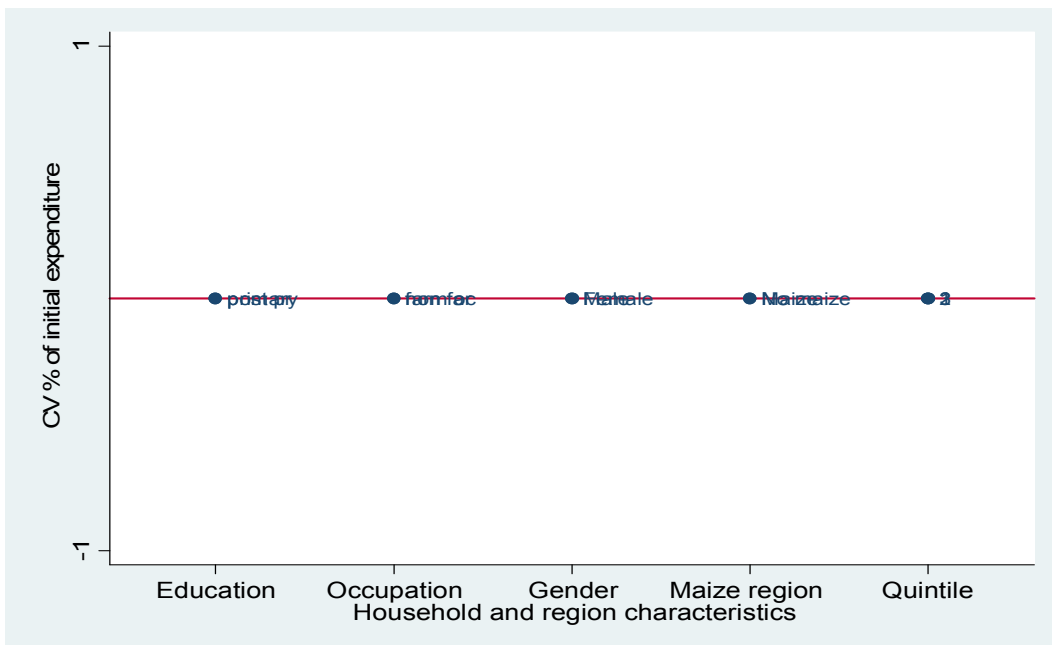


Figure 14: Weighted medians-NBR of consumers (with behaviour change)

Table 6: Poverty Profile by region and expenditure category

Region/category	Pop.	Poverty indexes			Relative contribution			Head count (P0)	
	%	P0	P1	P2	P0	P1	P2	Short run	Long run
Central	0.06	0.26	0.06	0.02	0.07	0.07	0.06	0.31	0.23
	0.01	0.04	0.01	0.01	0.01	0.02	0.02	0.05	0.04
Northern	0.17	0.12	0.02	0.01	0.09	0.08	0.07	0.18	0.12
	0.01	0.02	0.00	0.00	0.02	0.02	0.02	0.02	0.02
Eastern	0.07	0.14	0.04	0.01	0.05	0.05	0.06	0.17	0.12
	0.01	0.03	0.01	0.01	0.01	0.02	0.02	0.03	0.03
South east	0.14	0.21	0.05	0.02	0.15	0.15	0.15	0.26	0.19
	0.01	0.03	0.01	0.00	0.02	0.02	0.03	0.03	0.02
South highland	0.21	0.20	0.05	0.02	0.21	0.21	0.20	0.34	0.15
	0.01	0.02	0.01	0.00	0.02	0.03	0.03	0.02	0.02
Western	0.16	0.29	0.07	0.03	0.24	0.25	0.24	0.36	0.25
	0.01	0.03	0.01	0.00	0.02	0.03	0.04	0.03	0.03
Lake	0.13	0.21	0.06	0.02	0.14	0.15	0.17	0.35	0.18
	0.01	0.03	0.01	0.00	0.02	0.02	0.03	0.03	0.03
Quintile 1	0.33	0.42	0.12	0.05	0.70	0.80	0.86	0.45	0.35
	0.01	0.02	0.01	0.00	0.02	0.02	0.02	0.02	0.02
Quintile 2	0.33	0.16	0.03	0.01	0.26	0.18	0.12	0.26	0.14
	0.01	0.02	0.00	0.00	0.02	0.02	0.02	0.02	0.01
Quintile 3	0.33	0.03	0.00	0.00	0.04	0.02	0.01	0.14	0.02
	0.01	0.01	0.00	0.00	0.01	0.01	0.01	0.01	0.01
Population	1.00	0.20	0.05	0.02	1.00	1.00	1.00	0.28	0.17
	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.01

Notes: Poverty line; TZS. 23933 per 28 days calendar