Welfare Impacts of Rising Food Prices in Rural Ethiopia: a Quadratic Almost Ideal Demand System Approach

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This revised version: 29 June 2012

Selected Paper prepared for presentation at the International Association of Agricultural Economists (IAAE) Triennial Conference, Foz do Iguaçu, Brazil, 18-24 August, 2012.

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Abstract

Ethiopia has experienced high food prices since early 2004. This paper examines the welfare impacts of rising food prices in rural Ethiopia using Quadratic Almost Ideal Demand System (QUAIDS) approach controlled for expenditure endogeniety and zero consumption expenditure. The elasticity coefficients from QUAIDS are used to estimate Compensated Variations (CV), which explicitly accounts for profit function and substitution effects. The study uses Ethiopia Rural Household Survey (ERHS) panel data in four waves encompassing both low and high price periods. The results have shown high food prices in recent years (between 2004 and 2009) increased welfare gain of rural households by about 10.5 percent on aggregate, as compared to less than 1 percent for the reference period (between 1994 and 2004). The welfare gains further improved to 18 percent (high price periods) with substitution effects, compared to 7.2 percent (low price periods). The welfare gains at aggregate level may not be equally distributed among rural households as about 37-46 percent of the sample households were net-cereal buyers (major staple crops) over the survey periods. However, the analysis has revealed high food price benefits not only net-cereal sellers but also autarkic and net-cereal buyers. The autarkic and net-cereal buyers could diversify income sources and benefits from high prices of other commodities such as such as pluses, fruits & vegetables, animal and animal products. They could also diversify to off-farm activities as average income from wage and transfer has indeed increased in 2009. Only poor families with limited farm and non-farm income need to be supported with safety net programs (both input and consumption support). It should be noted that, in the long-run, high prices could encourage net-sellers to invest and increase production which will eventually lead to lower food prices, which in turn benefit net-buyers. Meanwhile, many current net buyers could become net-sellers if grain prices are stable and favourable and if productive inputs are made available and affordable.

Keywords: welfare, rising food prices, panel data, rural Ethiopia

1 Introduction

The prices of many staple foods have been unprecedentedly increased in recent years. Between 2005 and 2007, for instance, the price of maize increased by 80 percent; milk powder by 90 percent; wheat by 70 percent and rice by 25 percent (Ivanic and Martin, 2008). In 2008, further increase in the food prices had reached an alarming proportions; international price of wheat and maize were three times higher than in early 2003, and the price of rice was five times higher (von Braun, 2008). The food prices had plummeted after peaking in the second quarter of 2008, but have risen dramatically, except for meat and dairy products and partly for rice, since July/August 2010. In the latter period, the price of maize increased by 74 percent; wheat by 84 percent; sugar by 77 percent and oils & fats by 57 percent. By early of March 2011, the food prices passed the level that reached in the second quarter of 2008 (FAO, 2011).

The rapid increase in staple food prices have pushed million of people into hunger and poverty, created global crisis, caused political and economical instability and social unrest. For instance, some countries like Tunisia, Egypt and Algeria have been experiencing riots, in part caused by increasing costs of food in recent years.

Ethiopia is one of the countries that have experienced higher prices since early 2004. The overall inflation, mainly driven by food price inflation, had sharply increased from 15.1 percent in June 2007 to historical peak of 55.3 percent in June 2008. During the same period, food prices inflation rose from 18.2 percent to 91.7 percent (CSA, 2009). Inflation was slightly decreased from July to October 2009 but increased by 14.5 percent in 2010, as compared to 2009 (CSA, 2010), and further climbed to 38.1 percent in June 2011, as compared to the same period in 2010[1].

While higher food prices are a threat for many poor people in developing countries who spend nearly 60-80 percent of total budget on food (see Wood *et al.*, 2010; Mitchell, 2008; Ivanic and Martin, 2008; von Braun, 2008), it could also represent an opportunity for those who are making a living from agriculture. Most of the poor households in

[1] http://www.bloomberg.com/news/2011-07-12/ethiopia-inflation-rate-climbs-to-38-1-in-june-from-year-ago-agency-says.html cited on 14 July 2011.

developing countries live in rural areas and are both producers and consumers of food commodities and hence there are gainers among them (de Janvry and Sadoulet, 2009). Furthermore, studies in different developing countries have shown that rising food prices have a positive impact on aggregate welfare of rural households albeit the benefit and cost are not spread evenly across the population (see, for instance, Vu and Glewwe, 2010; Crafield and Haq, 2010).

Only few studies have examined welfare impacts of soaring food prices in rural Ethiopia. Loenining and Oseni (2007), using data from the 2000 Welfare Monitoring and the Household Income and Consumption Expenditure Survey (WMS/HICES) and based on Net Benefit Ration (NBR) analysis, have estimated a hypothetical 10 percent increase in food prices, between 2000 and 2007, could increase rural income level by 1-2 percent. The benefits; however, were biased towards better-off households. Similarly, Tefera *et al.* (2010), based on the 2008 Ethiopia Agricultural Marketing Household Survey (EAMHS) and using nonparametric NBR analysis, have shown that higher cereal prices have positive impact on aggregate welfare of rural household but majority (about 56%) of them are net cereal buyers.

The NBR analysis, which measures the elasticitity of cost of living with respect to changes in prices (Deaton, 1989), however, does not take into account the substitution effects or changes in demand patterns of household's responsiveness to change in relative price and income. Households more often substitute one commodity for the other when relative price change. Moreover, Kulgman and Leoning (2007) pointed out that given the simultaneous production and consumption decisions of rural households, measuring welfare impacts of high food prices are challenging and needs further investigation in Ethiopia.

This paper analysis welfare impacts of rising food prices in rural Ethiopia using Quadratic Almost Ideal demand Systems (QUAIDS) approach controlled for expenditure endogeneity as well as censoring for selection bias due to observed zero consumption. The elasticity coefficients from QUAIDS are used to estimate Compensated Variations (CV), which explicitly accounts for profit function and substitution effects. The study uses the Ethiopia Rural Household Survey (ERHS) panel data in four waves surveyed in

1994, 1999, 2004 and 2009. The ERHS data is appropriate for this analysis as it has information for low and high price periods. The results have shown that the QUAIDS estimate controlled for expenditure endogeneity and zero consumption observations improve the significance of the expenditure parameters. Most of the previous demand studies in Ethiopia, with the exception of Tafere et al. (2010) and Alem (2011)[2], used the Almost Ideal Demand System (AIDS) model. The shortcoming of the AIDS model is that it assumes linear Engel curves and constant expenditure elasticity. Such assumptions have been shown to be restrictive, even in developing countries (examples include Meekashi and Ray, 1999; and Abdulai, 2004 cited in Bopape, 2006).

The study also has shown income and price elasticities, in particular income elasticities, have increased (in absolute terms) in the period of high food price, as compared to low food prices. The CV results have also shown high food prices (between 2004 and 2009) increased the welfare gains of rural households by about 10.5 percent at aggregate, compared to less than 1 per cent during the low food price (1994-2004). The welfare gains further improved to 18.0 percent (high price period) with substitution effect, compared to 7.2 percent (low price period).

The remainder of the paper is structured as follows. Section 2 discusses the methodology, while section 3 presents the data and descriptive statistics. The results are presented in section 4and section 5 concludes.

2 Methodology

2.1 Demand system

Estimating welfare impact of rising food prices requires reliable price and income elasticities that could be commonly derived from utility-based demand models. The Stone (1954) Linear Expenditure System (LES) and Theil (1965) Rotterdam model are among the first attempts to derive utility-based demand models. They, however, imposed theoretical restrictions that are not flexible. In the 1970's researchers

[2]Alem's food demand system, however, doesn't control for expenditure endogeneity and zero consumption and Tafere et al. (2010) demand system is based on cross-sectional but nationally representative 2004/05 HICS data.

thoroughly focused on developing a flexible functional forms. The transcendental logarithmic (translog) system of Christensen *et al.* (1975); its modified version of Jorgenson *et al.* (1982) and the Almost Ideal Demand System (AIDS) of Deaton and Muellbauer (1980a) are among the two models developed for estimating flexible demand systems. The models necessitate approximating direct and indirect utility functions or the cost function with some specific functional form that has enough parameters to be regarded as a reasonable approximation to whatever the true unknown function might be (c.f Bopape, 2006). They are members of the Price Independent Generalized Logarithmic (PIGLOG) class of demand models (Muellbauer, 1976), which have budget shares that are linear functions of log total expenditure.

The AIDS model has been the most commonly used specification in applied demand analysis for more than two decades as it satisfies a number of desirable demand properties.[3] Moreover, it allows a linear approximation at estimation stage and has budget shares as dependent variables and logarithm of prices and real expenditure/income as regressors. Banks *et al.* (1997), however, observed the existence of nonlinearity in the budget shares for some, if not all, commodities and subsequently introduced an extension to permit non-linear Engle Curves. They proposed a generalized Quadratic Almost Ideal Demand System (QUAIDS) model which has budget shares that are quadratic in log total expenditure. Moreover, the QUAIDS retains the desirable properties of the popular AIDS model nested within it and allows for flexibility of a rank three specification in the Engel curves. The intuitive explanation of the quadratic term is that, goods can be luxurious at low levels of total expenditure and necessities at higher levels (Ecker and Qaim, 2008). Since the introduction of QUAIDS model, researchers have applied to estimate demand systems using data from a wide ranges of countries.

The AIDS as well as QUAIDS models are derived from indirect utility function (V) of the consumer given by:

$$\ln V = \left\{ \left[\frac{\ln x - \ln a(p)}{b(p)} \right]^{-1} + \lambda(p) \right\}^{-1} \tag{1}$$

[3]AIDS model satisfies axioms of choice exactly and allows exact aggregation over consumer. It is simple to estimate and can be used to test the restriction of homogeneity and symmetry through linear restriction on fixed parameters (see Deaton and Muellbauer, 1980b and Moschini, 1995)

where x is total food expenditure, p is a vector of prices, $a(p)$ is a function that is homogenous of degree one in prices, and $b(p)$ and $\lambda(p)$ are functions that are homogenous of degree zero in prices; $\ln a(p)$ and $\ln b(p)$ are specified as translog and cob-Douglass equations as originally specified in Deaton and Muellbauer's AIDS model. Note also that $\lambda(p)$ is set to zero in Deaton and Muellbauer's AIDS model.

$$\ln a(p) = \alpha_0 + \sum_{i=1}^{n} \alpha_i \ln p_i + \frac{1}{2} \sum_{i=1}^{n} \sum_{j=1}^{n} \gamma_{ij} \ln p_i \ln p_j \qquad (2)$$

$$b(p) = \prod_{i=1}^{n} p_i^{\beta_i} \qquad (3)$$

$$\lambda(p) = \sum_{i=1}^{n} \lambda_i \ln p_i \qquad (4)$$

wherei= 1, ... , n represent commodities

After application of the Roy's identity to equation [1], the QUAIDS expressed in budget shares form is given by:

$$w_i = \alpha_i + \sum_{i=1}^{n} \gamma_{ij} \ln p_j + \beta_i \ln\left(\frac{x}{a(p)}\right) + \frac{\lambda_i}{b(p)} \left[\ln\left(\frac{x}{a(p)}\right)\right]^2 + \varepsilon_i, \qquad i = 1, \ldots, n \quad (5)$$

where w_i is budget share for good i, α_i, γ_{ij} and β_i are the parameters to be estimated, ε_i is error term.

The demand theory requires that the above system to be estimated under restrictions of adding up, homogeneity and symmetry. The adding up is satisfied if $\sum_{i}^{n} w_i = 1$ for all x and p which requires.

$$\sum_{i=1}^{n} \alpha_i = 1, \sum_{i=1}^{n} \beta_i = 0, \sum_{i=1}^{n} \gamma_{ij} = 0, \sum_{i=1}^{n} \lambda_i = 0 \qquad \text{(adding-up)} \qquad (6)$$

$$\sum_{i=1}^{n} \gamma_{ji} = 0 \qquad \text{(Homogeneity)} \qquad (7)$$

$$\gamma_{ij} = \gamma_{ji} \qquad \text{(Slutsky symmetry)} \qquad (8)$$

These conditions are satisfied by dropping one of the *n* demand equations from the system and recovering parameters of the omitted equations from the estimated equations.

Household demand for food consumption depends not only on their income and product prices but also on household preferences as well as socio-demographic characteristics (Dhar *et al.*, 2003; Mazzocchi, 2003; Akbay *et al.*, 2007). Household demographic factors can be incorporated (in the demand model) using demographic transition method[4] (Pollak and Wales, 1981; Heien and Wessells, 1990). The QUAIDS can then be modelled after specifying the constant terms, α_i, as follows:

$$\alpha_i = \delta_i + \sum_{j=1}^{s} \delta_{ij} D_j , \ \ \& \ \sum_{j=1}^{s} \delta_{ij} = 0 \quad \text{i= 1,..., n} \tag{9}$$

where δ_i and δ_{ij}'s are parameters to be estimated and D_j are demographic attributes including household size, age of head and head highest grade completed, among others.

Furthermore, cross-sectional/panel data often contains significant proportions of zero observations for food (aggregates) that are not consumed during survey period. This causes censored dependent variables and leads to bias results. Heien and Wessells (1990) introduced a two-step estimation procedure based on Heckman's (1979) work. However, Shonkwiler and Yen (1999) pointed out inconsistency in Heien and Wessells (1990) estimator as it performs poorly in Monte Carlo simulations, and suggest an alternative two-step estimation procedure. In the latter approaches, zero consumption is modelled in the following system of demand equations with limited dependent variables

$$w_i^* = f(x_i, \mu_i) + u_i , \qquad \mathrm{d}_i^* = z_i^{'} \partial_i + v_i , \tag{10}$$

$$d_i = \begin{cases} 1 & \text{if} \ \ \mathrm{d}_i^* > 0 \\ 0 & \text{if} \ \ \mathrm{d}_i^* \le 0 \end{cases} \qquad w_i = d_i w_i^*$$

where w_i is budget share of good *i* (as specified above) and d_i is a binary outcomes that take one if household consumes food item of the considered aggregate, and zero

[4]The other widely used technique is demographic scaling but has highly nonlinear specification (Heien and Wessells, 1990)

otherwise; and w_i^* and d_i^* are the corresponding unobserved (latent) variables, x_i are households expenditure (income) and prices and z_i are households demographic and related variables; μ_i and ∂_i are vectors of parameters to be estimated u_i and v_i are the random errors.

Assuming error terms (u_i and v_i) have a bivariate normal distribution with $\text{cov}(u_i, v_i) = \phi$, for each commodity, Shonkwiler and Yen (1999) correct for inconsistency in the demand system by defining the second-stage regression as;

$$w_i^* = \Phi(z_i^{'}\partial_i) f(x_i, \mu_i) + \delta_i \phi(z_i^{'}\partial_i) + e_i \tag{11}$$

where $\phi(z_i^{'}\partial_i)$ and $\Phi(z_i^{'}\partial_i)$ are the probability density function (PDF) and the cumulative distribution function, respectively, which are obtained, in theory, from a probit model using equation (10) in the first step for each of food commodity.

The QUAIDS model for each food commodity with household demographic in the second-step is then modified as:

$$\begin{aligned} w_i^* = {} & \alpha_i \Phi(z_i^{'}\partial_i) + \sum_{i=1}^{n} \gamma_{ij} \ln p_j \Phi(z_i^{'}\partial_i) + \beta_i \Phi(z_i^{'}\partial_i) \ln\left(\frac{x}{a(p)}\right) + \\ & \frac{\lambda_i}{b(p)} \Phi(z_i^{'}\partial_i) \left[\ln\left(\frac{x}{a(p)}\right)\right]^2 + \sum_{j=1}^{s} \delta_{ij} D_j \Phi(z_i^{'}\partial_i) + \delta_i \phi(z_i^{'}\partial_i) + \varepsilon_i, \qquad i = 1, \ldots, n \end{aligned} \tag{12}$$

Yen et al. (2003) and Ecker and Qaim (2008), however, noted that since the right-hand side of the system doesn't add up to one in the second step (equation 12), the adding-up conditions specified in equation (5) cannot be imposed and therefore the system must be estimated based on the full n-vector.

In order to derive conditional expenditure on food prices elasticities, equation (12) is differentiated with respect to ln$m$ and lnp_j, such that

$$\psi_i = \frac{\partial w_i^*}{\partial \ln x} = \Phi(z_i^{'}\partial_i)\left(\beta_i + \frac{2\lambda_i}{b(p)}\left\{\ln\left[\frac{x}{a(p)}\right]\right\}\right) \text{and} \tag{13}$$

$$\psi_{ij} = \frac{\partial w_i^*}{\partial \ln p_j} = \Phi(z_i^{'}\partial_i)\left(\gamma_{ij} - \psi_i\left(\alpha_j + \sum_{k=1}^{n}\gamma_{jk}\ln p_k\right) - \frac{2\lambda_i\beta_j}{b(p)}\left\{\ln\left[\frac{x}{a(p)}\right]\right\}^2\right) \quad (14)$$

where p_k is a price index calculated as the arithmetic mean of prices for all *k* food groups in the system. The conditional expenditure elasticities are then obtained by $e_i = (\psi_i / w_i^*) + 1$. These are greater than unity at low expenditure levels and eventually become less than unity when total expenditure increase, while the term λ_i becomes more important (Ecker and Qaim, 2008). The conditional, Marshallian (uncompensated) price elasticities are derived as $e_{ij}^u = (\psi_{ij} / w_i^*) - \vartheta_{ij}$, where ϑ_{ij} is the Kronecker delta equating one when *i=j*, and zero otherwise. Using the Slutsky equation, the conditional, Hicksian (compensated) price elasticities are given by $e_{ij}^c = (\psi_{ij} / w_i^*) + e_i w_j$. All elasticities are computed at the sample median.

The system is estimated using Brain P Poi (2008) "demand-system estimation: update, Non-Linear Seemingly Unrelated regression (lnsur) model", written in STATA. We based on Poi's nlsur and developed a program that has taken into account the two-stage probit model for zero consumption expenditure and household demographics.

2.2 Compensated Variation

In order to estimate the welfare impact of rising food prices, we compute compensating variation(see also Friedman and Levinsohn, 2002; Vu and Glewwe, 2010; Alem, 2011) which make use of household budget shares observed after prices change and the estimated price elasticities as derived from QUAIDS. Compensated variation is the amount of money/income required to compensate household after price changes and to restore that households to pre-changed utility level. The compensating variation can be implicitly defined through the indirect utility function V:

$$V(x^0 + CV, p_c^1) = V(x^0, p_c^0) \quad (15)$$

where χ represents household expenditure, CV is compensating variation and p_c is a vector of prices for consumer goods (Deaton and Muellbauer, 1980b). The subscripts (0) and (1) refer to initial period and period after price change, respectively. The expression for CV in equation (15) can be re-expressed using the expenditure (or cost) function e (p, u) where u is utility, as follows:

$$CV = e(p_c^1, u^0) - e(p_c^0, u^0) \quad (16)$$

CV will be positive if welfare after price change is lower than the initial level, and negative in the opposite case. Moreover, since rural households are both producers and consumers of food commodities, the money required to maintain pervious level of utility is the difference between changes in the cost of maintaining current consumption and changes in income from current production (Vu and Glewwe, 2010):

$$CV = [e(p_c^1, u^0) - e(p_c^0, u^0)] - y(p_p^1, u^0) \quad (17)$$

where the second term in the right hand side is defined as a profit function after changes in the price of produced good and p_p is a vector of prices for produced goods. Equation (17) yields the total amount of money need to maintain the previous utility after change in prices of goods. The compensated variation for the first order effect of price changes which doesn't take into account household's behavioural response (substitution between commodities) can be approximated using first-order Taylor expansion of the minimum expenditure function as follows (Friedman and Levinsohn, 2002; Vu and Glewwe, 2010):

$$\Delta \ln e \approx \sum_{i=1}^{n} [w_i \Delta \ln(p_{ci}) - (p_{pi} y_i / x) \Delta \ln(p_{pi})] \quad (18)$$

where w_i is budget share of good i in the initial period, $\Delta \ln(p_{ci})$ and $\Delta \ln(p_{pi})$ represent the proportionate consumer and producer price changes of commodity i, respectively, x is household total expenditure, and ($p_{pi} y_i / x$) is sales of i^{th} product as a fraction of household consumption expenditure. Following Vu and Glewwe (2010), we specify w_i as household budget share of good i, excluding self-supplied consumption. Welfare effects can be computed from observation of the values of purchases and sales of goods whose price are affected (de Janvry and Sadoulet, 2009). The specification in equation (18), however, helps us to measure only the immediate first order effects of price changes i.e., assuming not substitution effects between commodities. The income needed to maintain household's level of utility after soaring food price is lower if households can substitute away from goods whose prices have increased the most. Thus, one has to consider a second-order Taylor's expansion of expenditure function that allows for substitution behaviour (Friedman and Levinsonh, 2002; Vu and Glewwe, 2010) that can be given as:

$$\Delta \ln e \approx \sum_{i=1}^{n} w_i \Delta \ln(p_{ci}) - (p_{pi} y_i / X) \Delta \ln(p_{pi}) + \frac{1}{2} \sum_{i=1}^{n} \sum_{j=1}^{n} w_i \varepsilon_{ij} \Delta \ln(p_{ci}) \Delta \ln(p_{cj}) \quad (19)$$

where ε_{ij} is compensated price elasticity and other variables are as specified in equation (18).

This method was used for analysis of welfare impacts of rising food prices by Friedman and Levinsohn (2002) and Minot and Goletti (2000) for households in Vietnam, Vu and Glewwe (2010)for households in Mexico and Alem (2011) for urban households in Ethiopia. Notwithstanding that facts that this method also ignores substitution effects between goods in production in response to price changes and lead to under estimation of income gain in production that could be obtained by switching into production of the higher priced crops (de Janvry and Sadoulet, 2009). Further agro-climatic specific production studies could give more insights on the substitution effects of production.

3 Data Sources and Descriptive Statistics

The study uses the Ethiopia Rural Household Survey (ERHS) panel waves[5] conducted by the Economics Department of Addis Ababa University (AAU) in collaboration with the Centre for the Study of African Economies (CSAE) at Oxford University, the International Food Policy Research Institute (IFPRI) and the Ethiopia Development Research Institute (EDRI). The survey was started in 1989 when IFPRI team visited 450 households in seven farming villages in Central and Southern Ethiopia (see Dercon and Hoddinot, 2004; von Braun and Yohannes, 1992). In 1994, the survey was expended to 15 villages so as to cover the main agro-climatic zones and main farming systems in the

[5]The data, 1989-2004, have been made available by the Economics Department, Addis Ababa University, the Centre for the Study of African Economies, University of Oxford and the International Food Policy Research Institute. Funding for data collection was provided by the Economic and Social Research Council (ESRC), the Swedish International Development Agency (SIDA) and the United States Agency for International Development (USAID); the preparation of the public release version of these data was supported, in part, by the World Bank. AAU, CSAE, IFPRI, ESRC, SIDA, USAID and the World Bank are not responsible for any errors in these data or for their use of interpretation.

country. The sample households were randomly selected from each village or Peasant Association (PA) through stratification techniques in order to have a sufficient coverage of the farming systems (Dercon and Hoddinot, 2004). In total about 1,477 households were included in the 1994 survey. These households have been re-interviewed in the late 1994 as well as in 1995, 1997, 1999, 2004 and 2009. Since 1999, three additional villages have been included and the sample sizes are expanded to 1685 households. This study uses the 1994, 1999, 2004 and 2009 data (excluding three additional villages included since 1999). The sample attrition is low[6], with only 12.4 percent between 1994 and 2004 (or 1.3 per cent per year) (Dercon and Hoddinot, 2004). Limited access to land for cultivation in other areas could be one of the plausible reasons for low attrition rate. We have a balanced panel data for 1,200 households.

The dataset provides detailed information on household demographics, production, consumption (food and non-food), purchases and sales, landholdings and livestock ownership, among others. Moreover, information on prices, access to health and education as well as infrastructure was also collected using a separate questionnaire at the community level.

The surveys were conducted immediately after harvest season and information on food and non-food expenditure were collected for the "the last week" and "the last four months" prior to the survey time, respectively. Household food consumption was reported in terms of quantity either from own harvest, purchase or gift (from relatives, government and non-governmental organization). Household consumption expenditure of purchased food items was also reported. The quantity of consumption is converted into expenditure (imputed value) using prices collected at community level. Since we used pooled data, all nominal prices are converted into real prices by deflating each price variable with a weighted price index using one surveyed village (Harassew) and the 1994 survey period as a reference.

Food budget accounts for the largest share of household expenditure (about 78per cent) in each period (Table 1).Food budget share of households in low income group[7] is greater than high income group by about two percentage points. Food consumption

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[6]Using probit regression we estimated the probability of being attirtors (see appendix)

[7]Households are classified into low, middle and high income groups based on average real per capita annual income across the survey rounds.

shares increased by 1.07 percentage points between 1994 and 2004 (on average, about 0.107 percentage points per year) and about 1.04 percentage points between 2004 and 2009 (about 0.208 percentage point per year); implying the importance of food in the budget of the sample households. Clothing is the second most important in the household budgets that accounts, on average, for about 7 percent. Housing & utensils, health, education & transport as well as household consumables are somewhat fluctuating but account for 2-4 percent of household budgets in the survey panel. Over the survey rounds, clothing shares declined by about 0.6 and 1.8 percentage points, housing & utensils by 0.4 and 0.7 percent, respectively.

Table 1: Average budget shares of commodities by survey rounds and income groups (in %)

	Survey rounds				Income groups			%changes	
	1994	1999	2004	2009	low	Middle	high	(1994/04)	(2004/09)
Food	76.63	77.67	77.70	78.75	78.71	78.12	76.22	1.07	1.04
Clothing	7.60	10.86	6.95	5.17	7.68	7.19	8.07	-0.66	-1.78
Housing & utensils	2.79	2.02	2.43	1.77	2.04	2.18	2.54	-0.36	-0.66
Heath, education & transport	3.59	1.57	3.89	3.47	2.85	2.96	3.59	0.29	-0.41
Household consumables	0.24	1.15	0.54	0.67	0.70	0.65	0.60	0.29	0.13
Others non-food[8]	8.58	6.74	8.50	7.05	7.01	8.13	8.02	-0.08	-1.44

Source: Author's computation from ERHS panel data

Data on food consumption was collected for more than 75 food items in the survey panel. In order to maintain reasonable parameters, the food items were reclassified into ten food groups: *teff*, barley, wheat, maize, sorghum, root crops, pulses, fruits & vegetables, animal products and "other foods". Table A1 lists the groupings and food items in each group. We form food groupings based on a typical consumption behavior of households in Ethiopia. Moreover, there is no theoretical basis on how to construct commodity groupings; the decision is mostly made by the researchers on an ad-hoc basis. One of the major challenges for commodity groupings is on how to compute prices for aggregated food bundles. For our analysis, prices for such commodities were calculated using expenditure share of food items in each group as a weight.

[8] These includes ceremonial expenses, contribution to iddir, donation to the church, taxes and levies, compensation and penalty, and voluntary contributions, among others

Table 2 presents budget shares for food categories by survey rounds as well as income groups (low, middle and high). Cereals (*teff*, barley, wheat, maize and sorghum) are the major staples in the Ethiopian dish and account for the lion's share of household food budget (on average, about 45-50 percent). Across income groups, cereal consumption for households in the high income group is more than the low income group by about two percentage points. Among cereals, maize consumption dominates in most of the survey rounds (13.08 percent), followed by wheat and *teff*[9]. More importantly, *teff* consumption is important for households in high income group as maize and root-crops do for households in the low income group (Table 2). The share of wheat consumption declines moderately with increase in the income level of the households.

Pluses and animal products as well as fruits & vegetables mainly use for making sauces so as to complement the main dish. Pulses account for about 8 percent of food expenditure while animal products shares nearly 9 percent. Fruits & vegetables is limited to 2-4 percent of expenditure. While share of pulses and animal products slightly increased across income groups, fruits & vegetables shares declined (Table 2). "Other foods" such as cooking oils, pepper, coffee and tea, among others, have also a significant share of food consumption expenditure (about a quarter of household budget) (Table 2).

[9] In 2009, however, wheat becomes more important, followed by maize and teff (Table 2). It could be results from the trickle-down effect of wheat distributions in urban areas at subsidized price.

Table 2: Household food budget shares (in %) and household demographics

	Survey rounds				Income groups		
	1994	1999	2004	2009	Low	middle	High
Teff	6.6	12.6	9.2	10.8	4.5	11.1	13.8
Barley	8.2	7.4	7.8	5.9	5.5	6.6	10.0
Wheat	8.9	10.3	9.2	11.8	13.4	9.7	10.4
Maize	13.3	13.3	11.5	10.9	14.9	11.1	7.5
Sorghum	7.6	7.0	7.0	9.1	7.1	10.0	6.0
Root crops	4.6	6.9	10.7	5.5	10.5	5.9	4.5
Pulses	10.1	8.0	7.8	8.0	7.1	9.0	9.3
Fruits &vegetables	7.6	2.0	2.2	3.5	5.4	3.1	2.8
Animals products	5.5	9.5	9.3	8.4	7.6	7.9	8.9
Other foods	27.5	23.0	25.3	26.1	24.0	25.7	26.7
Family size (in number)	6.2	6.0	5.7	5.7	6.4	5.7	5.5
Head education (in year)	1.0	0.5	0.5	1.5	0.6	0.9	1.1
Sex of head; 1 = male)	0.8	0.7	0.7	0.7	0.7	0.8	0.8
Monthly real per capita food expenditure (in Birr)	45.8	72.4	70.4	51.1	41.5	58.85	79.2
Annual real per capita income (in Birr)	403.4	413.2	459.3	595.6	183.7	384.7	835.2

Source: Authors' computation from ERHS panel data

Table 2 also presents, real per capita annual income and monthly expenditure as well as household demographics. While household income eventually increased from Birr 400 in 1994 to about 460 in 2004 and further to about 560 in 2009, household average per capita consumption expenditure moderately increased from Birr 46 in 1994 to about Birr 70 in 1999 and 2004 but significantly decreased to Birr 51 in 2009. In 2009, the larger proportions of households income could then be used to cover input cost (mainly fertilizer) as fertilizer prices also soared by more than 250 percent between 2004 and 2009[10]. Across income groups, average income for households in the high income group is about 4 times greater than average income in the low income group whereas, average consumption of household in high income group is only about 1.5 times greater than the average consumption in the low income group. It implies that households are more likely smoothing their consumption than income.

The sample households are characterized by male headed household (about 80 per cent) and large family size (about 6 persons per head). Most of households head are illiterate (with less than one year of schooling). Households in high income group have

[10]The price of DAP was about 28USD/100kg in 2004 and 100USD/100kg in 2009

lower family size and relatively better level of head education (1.1 year) than households in the lower income group (0.6 year) (Table 2).

Nominal and real prices of food commodities/groupings are presented in Table 3. The nominal and real price of *teff* is the highest among cereals in all survey panel, followed by wheat and barley prices, respectively. Aggregated food items, in particular animal products costs, on average, Birr 8-15 per kg. The nominal prices of most food items were increased moderately between 1994 and 2004 but have soared since 2007/08. Accordingly, between 2004 and 2009, the nominal prices of teff increased by 245 percent barley, wheat and maize by about 200 percent and animal products by about 147 per cent. The real prices, however, increased by about 30 percent for *teff*, 25 percent for sorghum, root-crops and fruits & vegetables and about 10-16 percent for other crops (Table 3).

Table 3: Average nominal and real (per kg) prices by survey rounds

	Nominal prices				Real prices			
	1994	1999	2004	2009	1994	1999	2004	2009
Teff	2.20	2.23	2.53	8.67	1.90	1.86	2.07	2.70
Barley	1.49	1.76	1.50	4.48	1.29	1.47	1.23	1.39
Wheat	1.53	2.01	1.67	5.06	1.32	1.69	1.36	1.58
Maize	1.35	1.51	1.27	3.68	1.16	1.26	1.04	1.14
Sorghum	1.32	1.64	1.31	4.32	1.13	1.37	1.06	1.34
Root crops	1.37	1.09	1.45	2.93	1.16	0.92	0.95	1.19
Pulses	1.89	2.34	2.57	5.73	1.64	1.95	1.79	2.10
Fruits &vegetables	1.65	1.73	2.11	4.25	1.35	1.39	1.34	1.67
Animals products	7.85	10.15	15.18	37.53	6.85	8.65	11.59	15.54
Other foods	6.70	6.80	6.28	16.41	5.87	5.66	5.14	5.12

Source: Authors' computation from ERHS panel data

Table 4 presents the proportions of "zero consumption" in the panel samples. The problem of "zero consumption" is sever for all food commodities, with exception of "other foods", in particular for *teff* (0.86), barely (0.76) and sorghum(0.77) for households in the low income group. This could be plausible as households may not necessary consume all items during the survey periods. The estimations are, therefore, adjusted to account for the large fractions of observed zero consumption using a two-step procedure as described above. In the first stage, the probit regression is estimated for each food group using household demographics, including age-sex compositions of the households as well as vectors of price as regressors. Moreover, the endogeneity of expenditure in the demand model is explicitly tested and corrected using augmented regression technique; the OLS regression is estimated for budget share of each food group using vector of price, real income and its squared as regressors, followed by predicting the residuals that to be included into the systems of equations of QUAIDS.

Table 4: The proportion of zero consumption expenditure by rounds and income groups

	Survey rounds				Income groups		
	1994	1999	2004	2009	Low	Middle	High
Teff	0.81	0.62	0.70	0.70	0.86	0.67	0.60
Barley	0.71	0.68	0.65	0.75	0.79	0.73	0.58
Wheat	0.49	0.56	0.55	0.46	0.59	0.54	0.41
Maize	0.65	0.48	0.54	0.58	0.52	0.55	0.62
Sorghum	0.69	0.71	0.73	0.62	0.77	0.61	0.68
Root crops	0.65	0.57	0.63	0.60	0.56	0.65	0.63
Pulses	0.32	0.35	0.37	0.23	0.44	0.29	0.23
Fruits & vegetables	0.42	0.55	0.55	0.36	0.55	0.46	0.40
Animal products	0.65	0.54	0.53	0.55	0.64	0.56	0.51
Other foods	0.01	0.01	0.01	0.00	0.01	0.00	0.00

Source: Authors' computation from ERHS panel data

4 Empirical Results

The QUAIDS are estimated for pooled, the low price period (the 1994-2004) and the high price period (the 2009) sample households in the panel (Table A2). We also included analysis for households in three income groups (low, middle and high) as aggregated information may obscure impacts of income inequality among households. The systems of equations in AUAIDS are estimated through imposing theoretical restrictions and applying Non-Linear Seemingly Unrelated regression (nlsur).The estimates are also controlled for selection bias due to observed zero consumption, endogeneity in expenditure and household demographics. For the pooled as well as low price period, the estimations are also controlled for survey rounds, so as to take into account any structural changes. In all estimation the standard errors reported are robust to heteroskedasticity.

Almost all own and cross-price elasticity parameters are statistically significant at 1% level of significance for all households as well as income groups (Table A2).

Furthermore, at least nine of the ten expenditure parameters (β) for pooled, low and high price periods as well as for all income groups are significant at 1% level of significance with the expected positive sign. The squared expenditure terms (λ) in at least eight of ten systems of equations are significant at 1% level of significance with expected negative sign. The positive and negative sign in the expenditure and its squared, respectively revealed the property of Engle's curve. Moreover, the significance of the squared expenditure terms provide the evidence in favor of using rank three QUAIDS over AIDS, which is of rank two demand system.

Furthermore, exogeneity of the expenditure are rejected in all systems of equations for low price period (1994-2004), low and high income groups as well as in nine and six of ten systems of equations in pooled data and high price period (the 2009), respectively. Accordingly, controlling for endogeneity problem significantly improve the estimate of expenditure parameters(Table A2).The coefficients of household size (δ),introduced to capture taste differences across households, are negative and significant for teff consumption (in most cases), mixed for barley and wheat whereas positive and significant for maize and sorghum. It is also mixed for root-crops, pulses as well as fruits & vegetables. The intuitive explanation is that as family size increases, for a given level of budget and prices, households tend to adjust their consumption pattern towards relatively cheaper food items as such as maize and root crops and away from expensive items such as teff and wheat. In another words, as rural households are both producers and consumers, they may decide to sell out expensive food items and instead buy cheaper food so as to mitigate their consumption shortfall. The decision, however, may lead them to buy and consume less nutritious food items.

The coefficients of household size for animal products are positive and significant for pooled sample as well as low, middle and high income groups of the 1994-2004 panel data. This could be plausible as rural households in Ethiopia mainly depend on their own production for animal products consumption, although some of the products such as beef and mutton are relatively more expensive in the markets. In 2009, however, the coefficients become negative albeit found to be statistically insignificant. The latter development could be because of increasing the living costs in recent years, households with larger family size may reduce their consumption need for animal products, although they are the producers, and have started selling out as sources of income and instead buy basic necessities such as maize, sorghum as well as root crops, at relatively lower cost.

A full set of elasticity estimate are calculated at median values of the predicted expenditure share, after controlling for "zero consumption expenditure". The estimates are bootstrapped 250 times in order to obtain reliable standard errors. Table 5 and 6 present expenditure and income elasticities, respectively. The elasticity estimates are found to be either close to or greater than unity for all households and income groups. This could be a reflection that most of rural households are not yet consuming the desired quantities and hence suggest that as their income increases they will spend proportionately more on consumption of those food items/groups under consideration. Moreover, Ecker and Qaim (2008) have shown that at lower level of consumption, when the impacts of squared log total expenditure is less important than log total expenditure, income elasticity is greater than unity. This is particularly true in Ethiopia as many of the households consume inadequate quantities of calories, protein and other nutrients (see for instance, Tafere *et al.,* 2010). In 2009, after soaring food prices, both expenditure and income elasticities, in particular income elsticities are improved (in absolute terms) for most of food commodities/groupings, as compared to the low price period (Table 5 and Table 6).

Table5: Expenditure elasticity for sample households and by income groups

	All HH 1994-2009	All HH 1994-2004	All HH 2009	Income groups (1994-2009)		
				Low	Middle	High
Teff	1.014	1.003	1.015	1.044	1.013	1.006
	(0.000)**	(0.000)**	(0.000)**	(0.001)**	(0.000)**	(0.000)**
Barely	1.004	1.003	1.01	0.993	1.014	1.013
	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**
Wheat	1.006	1.004	1.013	1.000	1.008	1.018
	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**
Maize	1.006	1.001	1.01	1.023	1.009	1.002
	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**
Sorghum	1.018	1.000	1.017	1.066	1.021	1.005
	(0.000)**	(0.000)**	(0.000)**	(0.002)**	(0.000)**	(0.000)**
Root crops	0.989	1.010	1.004	1.003	0.978	0.982
	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**
Pulses	1.019	0.987	1.027	0.975	1.005	1.033
	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**
Fruits& vegetables	1.064	1.023	1.032	1.149	1.017	0.976
	(0.000)**	(0.000)**	(0.000)**	(0.001)**	(0.000)**	(0.000)**
Animal products	1.124	1.163	1.119	1.231	1.043	1.034
	(0.001)**	(0.002)**	(0.001)**	(0.004)**	(0.001)**	(0.000)**
Other foods	0.758	0.948	0.759	0.551	0.893	0.924
	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.002)**
N	4,792.0	3,597.0	1,350.0	1,200.0	853.0	1,593.0

+ $p<0.1$; * $p<0.05$; ** $p<0.01$; Note: Robust standard errors in brackets

Table6: Income elasticity for sample household and by income groups

	All HH 1994-2009	All HH 1994-2004	All HH 2009	Income groups (1994-2009)		
				Low	Middle	High
Teff	0.930	0.894	0.931	0.957	0.929	0.923
	(0.000)**	(0.000)**	(0.000)**	(0.001)**	(0.000)**	(0.000)**
Barely	0.921	0.895	0.926	0.911	0.930	0.929
	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**
Wheat	0.923	0.895	0.929	0.917	0.924	0.934
	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**
Maize	0.923	0.893	0.926	0.938	0.926	0.919
	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**
Sorghum	0.933	0.892	0.933	0.978	0.936	0.922
	(0.000)**	(0.000)**	(0.000)**	(0.001)**	(0.000)**	(0.000)**
Root crops	0.907	0.901	0.921	0.920	0.897	0.901
	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**
Pulses	0.935	0.881	0.942	0.895	0.922	0.947
	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**
Fruits& vegetables	0.976	0.912	0.947	1.054	0.933	0.895
	(0.000)**	(0.000)**	(0.000)**	(0.001)**	(0.000)**	(0.000)**
Animal products	1.031	1.037	1.027	1.129	0.956	0.948
	(0.001)**	(0.002)**	(0.001)**	(0.004)**	(0.001)**	(0.000)**
Other foods	0.695	0.845	0.696	0.957	0.929	0.923
	(0.000)**	(0.000)**	(0.000)**	(0.001)**	(0.000)**	(0.000)**
N	4,792.0	3,597.0	1,350.0	0.911	0.930	0.929

+ $p<0.1$; * $p<0.05$; ** $p<0.01$; Note: Robust standard errors in brackets

Table 7 presents uncompensated own-price elasticities while Table A3and A5report the complete estimates for 1994-2004 and 2009, respectively. The negativity property is satisfied for all food items/groups. All own-price elasticity estimates are statistically significant at 1% level of significance. Similar to income and expenditure elasticities, own price elasticities for most of food items/groups are either close to or greater than unity. The results are consistent with elasticity estimates for rural households in Ethiopia using the 2004/05 nationally representative Household Income and Consumption Expenditure Survey (HICS) data (see Tafere *et al.,* 2010). The higher own-price elasticity (greater or equal to unity) indicates that a uniform percentage reduction in prices of commodities could result in a greater demand for consumption of almost all food commodities. The reduction in the prices, however, could be at a cost of decreasing in the net revenues that could be obtained by selling out the products, as rural households are both producers and consumers of food items we considered.

A comparison of price elasticities between low price period (1994-2004) and high price period (2004-2009) have shown that elasticities (in absolute terms) declined for *teff*, fruits & vegetables as well as animal products while relatively increased for barely, wheat, maize and sorghum. Moreover, the absolute reduction in price elasticity for *teff* consumption is higher, reflecting the demand for *teff* is more sensitive to price change; the real price of *teff* was soared by about 30 per cent between 2004 and 2009. Moreover, *teff* is perceived as luxury food item for most rural households in Ethiopia.

Table 7 also presents own-price elasticities for low, middle and high income groups. In a relative terms, the demand for most of food items/groupings are more elastic for households in the low and high income groups while inelastic for households in the high income group.

Table 7: Uncompensated (Marshallian) price elasticity

	All HH 1994-2009	All HH 1994-2004	All HH 2009	Income groups (1994-2009) Low	Middle	High
Teff	-0.979	-0.945	-0.654	-0.973	-0.996	-0.965
	(0.000)**	(0.001)**	(0.009)**	(0.001)**	(0.000)**	(0.000)**
Barely	-1.030	-1.018	-1.164	-1.043	-1.036	-1.021
	(0.000)**	(0.000)**	(0.006)**	(0.001)**	(0.001)**	(0.000)**
Wheat	-1.021	-1.023	-1.119	-1.028	-1.014	-1.012
	(0.000)**	(0.000)**	(0.001)**	(0.000)**	(0.000)**	(0.000)**
Maize	-1.027	-1.028	-1.116	-1.025	-1.040	-1.010
	(0.000)**	(0.000)**	(0.005)**	(0.000)**	(0.000)**	(0.000)**
Sorghum	-1.003	-0.998	-0.974	-0.993	-1.039	-0.979
	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**
Root crops	-1.034	-1.028	-1.076	-1.026	-1.050	-1.033
	(0.000)**	(0.000)**	(0.001)**	(0.000)**	(0.001)**	(0.000)**
Pulses	-1.001	-0.999	-1.043	-1.042	-1.008	-0.977
	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**
Fruits& vegetables	-0.963	-0.996	-0.883	-0.986	-0.969	-0.976
	(0.000)**	(0.000)**	(0.001)**	(0.000)**	(0.000)**	(0.000)**
Animal products	-0.982	-0.972	-0.916	-1.013	-0.998	-0.961
	(0.000)**	(0.000)**	(0.002)**	(0.000)**	(0.000)**	(0.000)**
Other foods	-0.734	-0.643	-0.816	-0.514	-0.879	-0.984
	(0.000)**	(0.000)**	(0.001)**	(0.001)**	(0.000)**	(0.001)**
N	4,792.0	3,597.0	1,350.0	1,200.0	853.0	1,593.0

+ $p<0.1$; * $p<0.05$; ** $p<0.01$

Note: Robust standard errors in brackets

Cross-price elasticity effects are also presented in Table A3 and A5. There appears to be strong substitutability/complementarily effects between pairs of food commodities or groups. Among five major cereals, for instance, while there are substitution effects between *teff* and barley, barley and sorghum, wheat and maize, there are complementary effect between *teff* and wheat, teff and maize and teff and sorghum. The same holds between barley and maize, barley and wheat as well as barley and sorghum. The results are almost consistent with Alem (2011) findings for urban households in Ethiopia. Tafere *et al.* (2010), however, found absence of strong substitutability/complementarily effect between pairs of most of food commodities both for urban and rural households. The difference could arise because of difference in the price dataset used for estimation. While this study as well as Alem's finding is based on the market price information collected at the community level during the survey periods, Tafere *et al.*'s findings are based on unit values derived from a ratio of expenditure and quantities of commodities consumed as collected by HICE survey at household level. The limitation of using unit values as prices has thoroughly examined in Deaton (1988, 1990, and 1997) and more recently in Crawford *et al.* (2003) and Kider (2005).

Table 8: Compensated (Hicksian) price elasticity

	All HH 1994-2009	All HH 1994-2004	All HH 2009	Income groups (1994-2009)		
				Low	Middle	High
Teff	-0.682	-0.652	-0.354	-0.822	-0.671	-0.563
	(0.003)**	(0.004)**	(0.012)**	(0.005)**	(0.008)**	(0.006)**
Barely	-0.730	-0.698	-0.917	-0.791	-0.770	-0.596
	(0.002)**	(0.003)**	(0.010)**	(0.005)**	(0.005)**	(0.004)**
Wheat	-0.534	-0.553	-0.568	-0.633	-0.560	-0.416
	(0.003)**	(0.003)**	(0.004)**	(0.005)**	(0.007)**	(0.005)**
Maize	-0.587	-0.578	-0.696	-0.532	-0.623	-0.627
	(0.002)**	(0.003)**	(0.008)**	(0.005)**	(0.005)**	(0.004)**
Sorghum	-0.685	-0.704	-0.605	-0.801	-0.631	-0.656
	(0.002)**	(0.003)**	(0.007)**	(0.004)**	(0.005)**	(0.003)**
Root crops	-0.652	-0.643	-0.663	-0.570	-0.735	-0.673
	(0.003)**	(0.003)**	(0.005)**	(0.004)**	(0.006)**	(0.004)**
Pulses	-0.305	-0.329	-0.283	-0.532	-0.292	-0.179
	(0.002)**	(0.003)**	(0.003)**	(0.005)**	(0.005)**	(0.005)**
Fruits& vegetables	-0.399	-0.484	-0.242	-0.481	-0.409	-0.390
	(0.003)**	(0.003)**	(0.006)**	(0.007)**	(0.006)**	(0.004)**
Animal products	-0.491	-0.488	-0.384	-0.541	-0.576	-0.449
	(0.004)**	(0.004)**	(0.009)**	(0.008)**	(0.007)**	(0.006)**
Other foods	0.020	0.111	-0.570	0.030	0.010	-0.745
	(0.000)**	(0.000)**	(0.004)**	(0.001)**	(0.000)**	(0.004)**
N	4,792.0	3,597.0	1,350.0	1,200.0	853.0	1,593.0

+ $p<0.1$; * $p<0.05$; ** $p<0.01$
Note: Robust standard errors in brackets

Compensated (Hicksian) own-price elasticities are presented in Table9 as well as in TableA4 and A6.Similar to uncompensated price elasticities, the negativity property of own-price elasticities hold for all commodities except for "*other food*" group which is unexpectedly positive in the 1994-2004 panel data. In contrast to uncompensated down-price elasticities, almost all coefficients of compensated own-price elasticities are less than unity. It implies that if we consider compensated own-price elasticities, an increase in prices will not strongly lead to decrease in the demand for food items. Moreover, *teff* and animal products are more likely to be price elastic for households in the low income group than households in the middle and high income groups. Although comparisons of compensated own-price elasticities before and after soaring food prices have revealed mixed results, substitutability and complementarily effects holds in the same patterns as with uncompensated own-price elasticity.

Estimating price elasticities are followed by examining welfare impacts of rising food prices using compensating variation, based on changes in real prices between 1994 and 2004 (the low price period) and between 2004 and 2009 (the high price period).As we discussed in the descriptive statistics, the real prices increased by about 1-5 per cent between 1994 and 2004 and about 17 per cent between 2004 and 2009. Table 9 presents the results for the pooled data, for the periods 1994-2004 and 2004-2009 as well as by income groups. In the periods of 1994-2004, the first order welfare effect of rising food prices was about -0.009. This could be interpreted as rising food prices could increase rural household welfare gain that accounts for 0.9 percent. However, there are disparities among income groups; 0.6, 0.8 and 1.3 percent for households in the low, middle and high income groups, respectively. The first order effects, though informative, might be biased since they don't take in to account households' option of substituting one commodity for the other when relative prices change. Consequently, Table 9 also reports the full effects of compensating variations that take into accounts substitution as well as profit effects. With substitution, welfare gains of rural households increased by about 7.2 percent; 3.1 percent for low and middle income groups and 10.9per cent for high income group. This might indicate household ability to substitute away from more expensive food items by less expensive one. For equivalent levels of quantity demanded, households may sell out the expensive one at better-off prices (better revenue or income) and instead buy the cheaper one at lower price (at low cost) provided that they are indifferent between consumption of either of the products.

Table 9: First and second order welfare impacts of rising in real prices

	All	Income groups		
		Low	Middle	High
		… between 1994 and 2004		
1st order	-0.009	-0.006	-0.008	-0.013
	(0.001)**	(0.003)*	(0.001)**	(0.001)**
2nd order	-0.072	-0.031	-0.031	-0.109
	(0.005)**	(0.007)**	(0.007)**	(0.008)**
		… between 2004 and 2009		
1st order	-0.105	-0.072	-0.095	-0.153
	(0.007)**	(0.012)**	(0.010)**	(0.014)**
2nd order	-0.180	-0.097	-0.239	-0.207
	(0.029)**	(0.044)**	(0.056)**	(0.056)**

+ $p<0.1$; * $p<0.05$; ** $p<0.01$
Note: Robust standard errors in brackets
Source: Authors' computation from ERHS panel data

Between 2004 and 2009, welfare gains of rural households increased by about 10.5 per cent; about 18.0 percent with substitution effects. The gain in welfare for households in low, middle and high income groups are about 7.2, 9.5 and 15.3 percent, respectively.

Welfare gain further improved, with substitution effects, to about 9.7 per cent for low income, 23.9 percent for middle income and about 21.0 percent of high income group.

Welfare impacts of high food prices are also computed by gender of household head. At the aggregate level, the benefits of male headed households are greater than their counterparts (Table 10). Between 1994 and 2009, welfare gains of male headed households increased by 4.1 percent as compared to 3.7 percent for female headed households. The welfare gains, with substitution effect, further increased to 23.7 percent for male headed households and 20.7 percent for female headed households. The analysis by income groups, under first order condition (i.e. without substitution effect), however, has revealed welfare gains for female headed households in the low income group are slightly greater than male headed households of the same income groups. With substitution effect, the gains of male headed households are greater than female headed in all income groups. Households could substitute more expensive food items with cheaper one with increase in prices. In doing so, household could possible switch from more to less nutritious food items. The fact that first order welfare gains for female headed households are greater than their counterparts of the low income group could possibly reflect that female headed household may prefer to continue consuming the same staples (even when their prices are high) because of their concern about the diet of their family. May be mother (at low level of income) who have the decision power do not want to compromise on food.

Table 10: First and second order welfare effects by sex of household head (1994-2009)

		All HH	Low	Middle	High
1st order	Female	-0.037	-0.038	-0.043	-0.049
		(0.006)**	(0.009)**	(0.007)**	(0.006)**
	Male	-0.041	-0.032	-0.040	-0.053
		(0.002)**	(0.005)**	(0.004)**	(0.003)**
2nd order	Female	-0.207	-0.100	-0.094	-0.294
		(0.015)**	(0.019)**	(0.019)**	(0.030)**
	Male	-0.237	-0.115	-0.093	-0.294
		(0.008)**	(0.010)**	(0.009)**	(0.015)**

+ $p<0.1$; * $p<0.05$; ** $p<0.01$
Note: Robust standard errors in brackets

Although rising in food prices results in welfare gains for rural households at aggregate level, the benefits may not equally distributed among rural households. For instance, over the survey periods, about 41-46 per cent of sample households are net cereal buyers (*teff*, barley, wheat, maize and sorghum) (Table 11) and could be adversely affected by high food prices as cereals account for nearly 50 per cent of total food expenditure. Analyses by net-cereal marketing positions of the households, however, have revealed that high food prices benefit not only net-cereal sellers but also autarkic and net-cereal buyers (Table 12). These could be plausible as the livelihoods of rural households depends on diversifying income sources and hence net-cereal buyers could benefit from high prices of other activities such as animal and animal products, pulses, fruits & vegetables, among others.

These households could also be compensated through diversifying income sources to off-farm activities. Thus, we explored income that could be derived from off-farm activities such as wage and self-employment as well as household transfers. Between 2004 and 2009, household annual real income from wage and transfer increased by about 135 per cent and 25 per cent, respectively (Table 13). In contrast, average income obtained from self-employment decreased by about 40 per cent.

Table 11: Proportion of cereal net-buyers, autarkic and net-seller households (in %)

	1994	1999	2004	2009
Net-buyers	46.2	37.6	41.2	41.3
Autarkic	24.2	25.3	25.8	27.1
Net-sellers	29.6	37.1	33.0	31.5

Source: Authors' computation from ERHS panel data

Table 12: First and second order welfare effect by major cereal net-marketing position (1994-2009)

		All HH	Low	Middle	High
1st order	Net-buyer	-0.034	-0.035	-0.036	-0.039
		(0.004)**	(0.006)**	(0.006)**	(0.004)**
	Net-sellers	-0.038	-0.032	-0.031	-0.050
		(0.004)**	(0.009)**	(0.004)**	(0.005)**
	Autarkic	-0.051	-0.033	-0.056	-0.068
		(0.005)**	(0.008)**	(0.007)**	(0.006)**
2nd order	Net-buyer	-0.190	-0.072	-0.092	-0.269
		(0.011)**	(0.013)**	(0.014)**	(0.022)**
	Net-sellers	-0.257	-0.225	-0.094	-0.280
		(0.013)**	(0.021)**	(0.013)**	(0.022)**
	Autarkic	-0.257	-0.080	-0.094	-0.336
		(0.015)**	(0.016)**	(0.015)**	(0.026)**

+ $p<0.1$; * $p<0.05$; ** $p<0.01$
Note: Robust standard errors in brackets

Table 13: Average income from off-farm activities by survey round

	1994	1999	2004	2009
Self employment	452.5	114.2	286.8	167.8
wage income	98.3	151.3	120.4	283.2
Transfer income	63.9	107.3	165.2	204.8

5 Conclusion and policy implications

The paper demonstrates welfare impact of rising food prices for rural households in Ethiopia based on Quadratic Almost Ideal Demand System (QUAIDS), followed by estimation of compensation variation (CV) taking into account the substitution effects. We make use of the Ethiopia Rural Household Survey (ERHS) panel data collected before and after unprecedented increase in food prices; i.e. the 1994, 1999, 2004 and 2009. The QUAIDS model was estimated for ten food commodities; *teff*, barley, wheat, maize, sorghum, root crops, fruits & vegetables, animals products and "*other foods*" for pooled data, the low price periods (between 1994 and 2004) as well as for high prices (the 2009). The study has shown that controlling for expenditure nonlinearity and endogeniety as well as selection bias due to censoring in observed zero consumption improve the significance of expenditure parameters. We also found that price and income elasticities, in particular income elasticities, are improved (in absolute terms) in the periods of unprecedented increase in the food prices, as compared with the low price periods of 1994-2004.

The estimated price elasticities are used to compute compensating variation for the observed changes in real price for the period of 1994-2004 as well asthe2004-2009. At aggregate level rural households in Ethiopia have virtually been benefited from rising food prices both before and after soaring food prices. In the period of 1994-2004, real prices of food commodities had increased, on average, by about 1-2per cent, with the exception of animal product that rose by 30per cent; results in aggregated welfare gains of rural households by about 1 per cent. The welfare gain further improved to 7.2per cent while controlling for substitution effects; 3.1 percent for low and middle income and about 10.9per cent for high income groups. Between 2004 and 2009, the real prices of food commodities increased, on average by about 17 percent and results in about 10.5 percent increase in welfare gains at aggregate level; it further increased to about 18per cent with substitution effects. We also compute aggregate welfare gains for households in lower, middle as well as higher income groups. Welfare gain for households in high income group is greater than middle income which in turn greater than lower income group.

Theoretically rural households should benefit from rising food prices as they are producers as well as consumers of food commodities. However, household net market position (as net buyers, autarkic and net sellers) determines whether or not they are actually benefiting from rising food prices. Although rising food prices results in welfare gains for rural households at aggregate level, the benefits may not be equally distributed among rural households as 37-46 percent of sample households were net cereal buyers (major staple crops) over the survey periods. The analyses, however, have revealed that high food price benefit not only net-cereal sellers but also autarkic and net-cereal buyers. The autarkic and net cereal buyers could diversify income sources and benefit for high prices of other commodities such as pluses, fruits &vegetables and animal and animal products. They could also diversify to off-farm activities such as wage and self-employment as well as transfer income household received. In 2009, the average income from wage and transfer has indeed increased by 130 and 25 per cent respectively. In contrast, average income from self-employment decreased by about 40 per cent. In general, the overall impacts of income from various sources, including off-farm activities could be well understood from studies adopting computable general equilibrium models that incorporate all sectors of the economy.

Increasing production and/or productivity of rural poor households are the plausible option to improve welfare gains for majority of net buyers. However, rural farming households in Ethiopia are cultivating, on average, less than 2 ha of land per head and the productivity of cultivated land has eventually declined over time. It is also hard to find additional land for cultivation due to high population pressure. Thus, agricultural intensification through improved technologies such as fertilizer, improved and hybrid seeds technologies are indispensable. Although improved technologies such as fertilizer and improve seeds have been used since 1960's, the existing fertilizer application rate is much lower than the recommended rate and less than 4 percent of cultivated land have been covered by improved and hybrid seeds technologies. More importantly, Dercon and Ruth (2009) emphasized that with the existing very low utilization of improved and hybrid seed technologies, further expansion of fertilizer based yield growth is unlikely to be profitable for many farmers. Exploring household simultaneous decision of fertilizer and improved seed adoption could give us more insight.

Between 2004 and 2009, fertilizer price was soared by more than 250 per cent. The large increase in the cost of fertilizer may possibly reverse welfare gains to the rural households. More importantly, it couldn't be afforded by the poor households. This may call the government thinking of introducing the new generation subsidies known as 'smart subsidies' to ensure the beneficiaries will be those who constrained by lack of resources for fertilizer purchase. This in fact will require novel financial resources from the government as well as donor communities. Furthermore, under the Ethiopian constitution the government owns all land and farmers have only user rights to the land. This creates land tenure insecurity to the farmers with no incentive for investment to improve productivity. The land certification policy that has been stared since 2002 in Amhara region should have to be strengthened and further expended to other regions of the country.

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Annex

Table A1: Food commodities classification

Grouping	Food items
Cereal crops	*teff*, barley, wheat, maize and sorghum
Pulses	horse beans, haricot beans, field peas, chick peas, cow peas, linseed, lentils, shifera, godere, adenguare
Root crops	enset, potatoes, sweet potatoes
Fruits & vegetables	bananas, pineapple, avocado, onions, spinach, garlic, yam, fasolia, mango, orange, tomato, cabbage, beet root, carrot, lettuce, tikilgomen, pumpkin, karia
Animal products	beef, mutton, butter, cheese, milk /yogurt, chicken, eggs
Other foods	cooking oil, groundnuts, sesame, sunflower, nug, spices, pepper, coffee, tea, chat, fenugreek, ginger, sugarcane, oats, dagussa, vetch, rice,shiro/kollo, bread, macaroni, local drinks (tella, tej, araqi), birra, soft drinks, sugar, honey, salt, turmeric

Table A2: Quadratic Almost Ideal Demand Systems parameter estimates

		All HH	All HH	All HH	Income groups (1994-2009)		
		1994-2009	1994-2004	2009	Low	Middle	High
Exp.	β_1	0.018	0.015	0.003	0.034	0.020	0.016
		(0.001)**	(0.001)**	(0.001)**	(0.002)**	(0.002)**	(0.001)**
	β_2	0.016	0.026	0.005	-0.002	0.040	0.015
		(0.001)**	(0.001)**	(0.001)**	(0.002)	(0.003)**	(0.001)**
	β_3	0.021	0.039	0.012	0.009	0.032	0.021
		(0.001)**	(0.001)**	(0.001)**	(0.001)**	(0.002)**	(0.001)**
	β_4	0.006	0.004	0.001	0.026	0.004	0.006
		(0.001)**	(0.001)**	(0.001)	(0.001)**	(0.001)**	(0.002)**
	β_5	0.023	0.026	0.004	0.064	0.037	0.019
		(0.001)**	(0.002)**	(0.001)**	(0.003)**	(0.003)**	(0.003)**
	β_6	-0.003	0.007	0.015	0.029	-0.065	0.019
		(0.003)	(0.004)+	(0.001)**	(0.005)**	(0.006)**	(0.005)**
	β_7	0.035	0.059	0.007	-0.009	0.033	0.037
		(0.001)**	(0.002)**	(0.001)**	(0.003)**	(0.003)**	(0.003)**
	β_8	0.026	0.031	0.037	0.116	-0.033	-0.012
		(0.004)**	(0.005)**	(0.003)**	(0.010)**	(0.007)**	(0.004)**
	β_9	0.126	0.080	0.234	0.178	0.045	0.074
		(0.005)**	(0.005)**	(0.006)**	(0.008)**	(0.009)**	(0.008)**
	$\beta 10$	-0.268	-0.287	-0.319	-0.444	-0.113	-0.196
		(0.007)**	(0.008)**	(0.010)**	(0.015)**	(0.013)**	(0.013)**
Exp. Sq	λ_1	-0.001	-0.000	0.276	0.000	-0.001	-0.001
		(0.000)**	(0.000)+	(0.008)**	(0.000)+	(0.000)**	(0.000)**
	λ_2	-0.001	-0.002	-0.075	-0.000	-0.003	-0.000
		(0.000)**	(0.000)**	(0.002)**	(0.000)**	(0.000)**	(0.000)*
	λ_3	-0.002	-0.003	0.021	-0.001	-0.003	-0.000
		(0.000)**	(0.000)**	(0.002)**	(0.000)**	(0.000)**	(0.000)*
	λ_4	0.000	0.001	-0.141	-0.000	0.001	-0.000
		(0.000)	(0.000)**	(0.004)**	(0.000)*	(0.000)**	(0.000)*
	λ_5	-0.001	-0.001	0.041	-0.001	-0.002	-0.001
		(0.000)**	(0.000)**	(0.003)**	(0.000)*	(0.000)**	(0.000)**
	λ_6	-0.001	-0.000	-0.008	-0.003	0.005	-0.004
		(0.000)*	(0.000)	(0.001)**	(0.000)**	(0.001)**	(0.000)**
	λ_7	-0.002	-0.003	0.086	-0.001	-0.003	-0.000
		(0.000)**	(0.000)**	(0.003)**	(0.000)**	(0.000)**	(0.000)
	λ_8	0.004	0.000	-0.002	0.003	0.006	-0.001
		(0.000)**	(0.000)	(0.001)**	(0.001)**	(0.001)**	(0.000)**
	λ_9	-0.001	0.003	-0.119	0.003	-0.000	-0.004
		(0.000)	(0.000)**	(0.004)**	(0.001)**	(0.001)	(0.001)**
	λ_{10}	0.003	0.005	-0.079	-0.001	0.001	0.013
		(0.001)**	(0.001)**	(0.003)**	(0.001)	(0.002)	(0.001)**
Prices	γ_{11}	0.019	0.048	-0.128	0.023	0.003	0.032
		(0.001)**	(0.001)**	(0.003)**	(0.002)**	(0.001)**	(0.001)**
	γ_{21}	-0.013	-0.023	0.104	-0.026	-0.007	-0.013
		(0.000)**	(0.000)**	(0.002)**	(0.001)**	(0.001)**	(0.000)**
	γ_{31}	0.005	0.024	0.076	0.012	-0.003	0.003
		(0.000)**	(0.001)**	(0.002)**	(0.001)**	(0.001)**	(0.001)**
	γ_{41}	0.009	0.006	0.015	-0.002	0.013	0.008
		(0.000)**	(0.000)**	(0.001)**	(0.001)*	(0.001)**	(0.001)**

γ_{51}	0.007	0.006	0.068	0.015	0.003	0.004
	(0.000)**	(0.000)**	(0.001)**	(0.001)**	(0.001)**	(0.001)**
γ_{61}	0.005	-0.007	-0.043	0.001	0.009	0.007
	(0.000)**	(0.000)**	(0.001)**	(0.001)	(0.001)**	(0.000)**
γ_{71}	-0.028	-0.049	0.003	-0.002	-0.021	-0.047
	(0.000)**	(0.001)**	(0.001)**	(0.001)	(0.001)**	(0.001)**
γ_{81}	-0.001	0.003	0.053	-0.002	0.000	-0.001
	(0.000)**	(0.000)**	(0.002)**	(0.001)*	(0.000)	(0.000)*
γ_{91}	0.007	-0.009	-0.074	0.004	0.010	0.012
	(0.000)**	(0.001)**	(0.003)**	(0.001)**	(0.001)**	(0.001)**
γ_{101}	-0.010	0.002	-0.119	-0.022	-0.007	-0.005
	(0.001)**	(0.001)*	(0.002)**	(0.002)**	(0.001)**	(0.001)**
γ_{22}	-0.029	-0.018	0.069	-0.040	-0.035	-0.020
	(0.000)**	(0.000)**	(0.002)**	(0.001)**	(0.001)**	(0.001)**
γ_{32}	0.002	-0.002	-0.208	0.019	0.008	-0.006
	(0.000)**	(0.000)**	(0.002)**	(0.001)**	(0.001)**	(0.000)**
γ_{42}	0.033	0.034	0.046	0.056	0.028	0.013
	(0.000)**	(0.000)**	(0.001)**	(0.001)**	(0.001)**	(0.001)**
γ_{52}	-0.016	-0.018	-0.025	-0.013	-0.012	-0.005
	(0.000)**	(0.000)**	(0.001)**	(0.001)**	(0.001)**	(0.001)**
γ_{62}	0.010	0.011	0.027	0.005	0.012	0.011
	(0.000)**	(0.000)**	(0.001)**	(0.000)**	(0.001)**	(0.000)**
γ_{72}	-0.006	-0.010	0.083	-0.010	-0.016	-0.004
	(0.000)**	(0.000)**	(0.001)**	(0.001)**	(0.001)**	(0.001)**
γ_{82}	0.005	-0.003	0.001	-0.008	0.010	0.014
	(0.000)**	(0.000)**	(0.001)	(0.000)**	(0.001)**	(0.000)**
γ_{92}	0.005	-0.001	-0.093	0.002	0.009	0.008
	(0.000)**	(0.000)*	(0.004)**	(0.001)*	(0.001)**	(0.001)**
γ_{102}	0.010	0.029	0.064	0.017	0.001	0.001
	(0.001)**	(0.001)**	(0.002)**	(0.001)**	(0.001)	(0.001)
γ_{33}	-0.021	-0.024	-0.049	-0.027	-0.016	-0.011
	(0.000)**	(0.001)**	(0.001)**	(0.001)**	(0.001)**	(0.001)**
γ_{43}	-0.010	-0.026	0.051	-0.012	-0.025	0.002
	(0.000)**	(0.000)**	(0.001)**	(0.001)**	(0.001)**	(0.001)**
γ_{53}	-0.001	0.007	-0.027	-0.013	0.017	-0.003
	(0.000)**	(0.000)**	(0.001)**	(0.001)**	(0.001)**	(0.001)**
γ_{63}	0.006	0.004	-0.050	0.004	0.009	0.008
	(0.000)**	(0.000)**	(0.002)**	(0.000)**	(0.001)**	(0.000)**
γ_{73}	-0.008	-0.014	0.100	-0.009	-0.010	-0.006
	(0.000)**	(0.000)**	(0.003)**	(0.001)**	(0.001)**	(0.001)**
γ_{83}	-0.002	-0.005	0.025	-0.011	0.001	0.004
	(0.000)**	(0.000)**	(0.002)**	(0.000)**	(0.001)	(0.000)**
γ_{93}	0.002	-0.003	0.014	-0.001	0.005	0.006
	(0.000)**	(0.000)**	(0.001)**	(0.001)**	(0.001)**	(0.001)**
γ_{103}	0.026	0.039	-0.086	0.038	0.015	0.003
	(0.000)**	(0.001)**	(0.001)**	(0.001)**	(0.001)**	(0.001)**
γ_{44}	-0.027	-0.027	-0.008	-0.024	-0.041	-0.010
	(0.000)**	(0.000)**	(0.000)**	(0.001)**	(0.001)**	(0.001)**
γ_{54}	-0.004	0.004	0.025	-0.018	0.006	-0.024
	(0.000)**	(0.000)**	(0.001)**	(0.001)**	(0.001)**	(0.001)**

γ_{64}	-0.009	-0.004	0.117	-0.007	-0.006	-0.006
	(0.000)**	(0.000)**	(0.002)**	(0.000)**	(0.000)**	(0.000)**
γ_{74}	0.022	0.018	-0.074	0.047	0.027	0.013
	(0.000)**	(0.000)**	(0.001)**	(0.001)**	(0.000)**	(0.001)**
γ_{84}	-0.004	-0.001	0.051	-0.004	0.002	-0.009
	(0.000)**	(0.000)**	(0.001)**	(0.001)**	(0.000)**	(0.000)**
γ_{94}	-0.014	-0.001	0.016	-0.015	-0.014	-0.018
	(0.000)**	(0.000)**	(0.001)**	(0.001)**	(0.000)**	(0.001)**
γ_{104}	0.003	-0.003	0.023	-0.021	0.010	0.031
	(0.000)**	(0.001)**	(0.002)**	(0.001)**	(0.001)**	(0.001)**
γ_{55}	-0.002	0.002	-0.088	0.005	-0.040	0.021
	(0.001)**	(0.001)*	(0.003)**	(0.002)**	(0.001)**	(0.001)**
γ_{65}	0.020	0.016	-0.045	0.033	0.031	0.006
	(0.000)**	(0.001)**	(0.002)**	(0.001)**	(0.001)**	(0.001)**
γ_{75}	0.008	0.024	0.012	-0.001	0.007	0.006
	(0.000)**	(0.001)**	(0.001)**	(0.001)	(0.001)**	(0.001)**
γ_{85}	0.008	0.010	0.076	0.019	0.016	-0.001
	(0.000)**	(0.001)**	(0.002)**	(0.001)**	(0.001)**	(0.001)
γ_{95}	-0.011	0.007	-0.077	-0.008	-0.021	-0.013
	(0.001)**	(0.001)**	(0.003)**	(0.002)**	(0.001)**	(0.001)**
γ_{105}	-0.007	-0.058	0.127	-0.019	-0.007	0.009
	(0.001)**	(0.001)**	(0.002)**	(0.003)**	(0.001)**	(0.002)**
γ_{66}	-0.034	-0.027	0.103	-0.026	-0.057	-0.033
	(0.001)**	(0.001)**	(0.002)**	(0.001)**	(0.002)**	(0.001)**
γ_{76}	0.001	-0.004	-0.251	-0.020	0.009	0.013
	(0.000)+	(0.001)**	(0.005)**	(0.001)**	(0.001)**	(0.001)**
γ_{86}	-0.010	-0.000	0.130	0.006	-0.026	-0.026
	(0.001)**	(0.001)	(0.006)**	(0.002)**	(0.002)**	(0.001)**
γ_{96}	0.008	0.012	-0.323	0.006	0.002	-0.013
	(0.001)**	(0.001)**	(0.009)**	(0.002)**	(0.002)	(0.001)**
γ_{106}	0.003	-0.001	0.674	-0.002	0.017	0.033
	(0.002)	(0.003)	(0.017)**	(0.005)	(0.003)**	(0.003)**
γ_{77}	0.001	-0.001	-0.000	-0.046	-0.009	0.029
	(0.001)	(0.001)	(0.000)**	(0.002)**	(0.001)**	(0.001)**
γ_{87}	0.004	0.014	-0.001	0.018	0.000	0.004
	(0.000)**	(0.001)**	(0.000)	(0.001)**	(0.001)	(0.001)**
γ_{97}	0.020	0.019	-0.003	0.050	0.031	0.009
	(0.001)**	(0.001)**	(0.000)**	(0.002)**	(0.001)**	(0.001)**
γ_{107}	-0.014	0.002	-0.000	-0.028	-0.019	-0.016
	(0.001)**	(0.001)	(0.000)	(0.003)**	(0.001)**	(0.002)**
γ_{88}	0.046	0.007	-0.001	0.019	0.031	0.019
	(0.001)**	(0.002)**	(0.000)**	(0.004)**	(0.002)**	(0.001)**
γ_{98}	0.030	0.055	-0.002	0.015	0.028	-0.003
	(0.001)**	(0.001)**	(0.000)**	(0.004)**	(0.002)**	(0.001)+
γ_{108}	-0.076	-0.080	-0.007	-0.053	-0.063	-0.001
	(0.003)**	(0.004)**	(0.000)**	(0.009)**	(0.003)**	(0.003)
γ_{99}	0.007	0.037	-0.005	-0.027	0.002	0.033
	(0.003)*	(0.003)**	(0.001)**	(0.005)**	(0.003)	(0.004)**
γ_{109}	-0.054	-0.116	-0.022	-0.026	-0.052	-0.023
	(0.004)**	(0.005)**	(0.001)**	(0.010)**	(0.004)**	(0.006)**

	γ_{1010}	0.119	0.186	0.039	0.116	0.105	-0.033
		(0.008)**	(0.010)**	(0.002)**	(0.020)**	(0.008)**	(0.011)**
HH sex	z_{11}	-0.000	-0.000	-0.001	-0.000	-0.000	-0.000
		(0.000)	(0.000)	(0.000)*	(0.001)	(0.000)	(0.000)
	z_{21}	-0.001	-0.000	0.000	-0.000	-0.001	0.000
		(0.000)**	(0.000)+	(0.001)	(0.000)	(0.001)	(0.000)
	z_{31}	-0.001	-0.002	-0.001	-0.001	-0.001	0.000
		(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)
	z_{41}	-0.000	0.000	0.002	-0.002	0.001	0.000
		(0.000)	(0.000)	(0.001)**	(0.000)**	(0.000)*	(0.000)
	z_{51}	-0.001	0.000	-0.000	0.000	-0.001	-0.001
		(0.001)	(0.001)	(0.000)	(0.001)	(0.001)	(0.001)
	z_{61}	0.005	0.006	-0.003	0.007	0.006	-0.002
		(0.001)**	(0.002)**	(0.001)**	(0.002)**	(0.002)**	(0.002)
	z_{71}	0.001	0.002	-0.005	0.002	-0.000	0.002
		(0.000)**	(0.001)**	(0.001)**	(0.001)+	(0.001)	(0.001)*
	z_{81}	0.006	0.007	-0.001	0.009	0.007	-0.001
		(0.002)**	(0.002)**	(0.002)	(0.004)*	(0.003)*	(0.002)
	z_{91}	0.015	0.016	-0.017	0.013	0.018	0.010
		(0.002)**	(0.002)**	(0.003)**	(0.004)**	(0.003)**	(0.003)**
	z_{101}	-0.025	-0.029	0.026	-0.027	-0.028	-0.010
		(0.003)**	(0.004)**	(0.006)**	(0.007)**	(0.005)**	(0.005)+
HH age	z_{12}	-0.000	-0.000	0.000	-0.000	-0.000	0.000
		(0.000)	(0.000)**	(0.000)*	(0.000)**	(0.000)**	(0.000)**
	z_{22}	0.000	0.000	-0.000	0.000	0.000	0.000
		(0.000)**	(0.000)**	(0.000)	(0.000)*	(0.000)**	(0.000)**
	z_{32}	-0.000	-0.000	0.000	0.000	0.000	-0.000
		(0.000)**	(0.000)**	(0.000)	(0.000)	(0.000)	(0.000)**
	z_{42}	-0.000	-0.000	-0.001	-0.000	-0.000	-0.000
		(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**
	z_{52}	-0.000	-0.000	-0.000	-0.000	0.000	-0.000
		(0.000)**	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)**
	z_{62}	-0.000	-0.000	-0.000	-0.000	-0.001	-0.000
		(0.000)**	(0.000)**	(0.000)	(0.000)**	(0.000)**	(0.000)**
	z_{72}	0.000	0.000	-0.001	-0.000	0.000	0.000
		(0.000)	(0.000)	(0.000)**	(0.000)**	(0.000)*	(0.000)
	z_{82}	0.000	0.000	0.001	0.001	0.001	-0.000
		(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)*
	z_{92}	-0.000	0.000	-0.003	-0.000	0.001	-0.000
		(0.000)	(0.000)**	(0.001)**	(0.000)**	(0.000)**	(0.000)**
	z_{102}	0.000	-0.000	0.003	0.001	-0.001	0.001
		(0.000)**	(0.000)**	(0.001)**	(0.000)*	(0.000)**	(0.000)**
HHsize	δ_{13}	-0.000	-0.000	-0.000	-0.002	-0.000	-0.000
		(0.000)	(0.000)*	(0.000)	(0.000)**	(0.000)	(0.000)
	δ_{23}	0.000	-0.000	0.001	-0.000	-0.001	0.000
		(0.000)	(0.000)**	(0.000)*	(0.000)	(0.000)**	(0.000)**
	δ_{33}	0.001	0.001	0.000	0.000	0.001	-0.000
		(0.000)**	(0.000)**	(0.000)	(0.000)**	(0.000)**	(0.000)*
	δ_{43}	0.000	0.000	0.002	0.000	0.001	0.000
		(0.000)**	(0.000)**	(0.000)**	(0.000)	(0.000)**	(0.000)*
	δ_{53}	0.001	0.000	0.001	0.001	0.000	0.001
		(0.000)**	(0.000)	(0.000)**	(0.000)**	(0.000)+	(0.000)**
	δ_{63}	0.003	0.001	-0.000	0.001	-0.001	-0.003
		(0.000)**	(0.000)**	(0.000)	(0.000)**	(0.000)**	(0.000)**
	δ_{73}	0.000	-0.001	0.001	-0.000	0.001	-0.001
		(0.000)**	(0.000)**	(0.000)+	(0.000)	(0.000)**	(0.000)**
	δ_{83}	0.002	-0.002	-0.010	0.004	-0.000	0.001
		(0.000)**	(0.000)**	(0.001)**	(0.001)**	(0.001)	(0.000)*
	δ_{93}	0.007	0.008	-0.001	0.007	0.007	0.004

		(0.000)**	(0.001)**	(0.002)	(0.001)**	(0.001)**	(0.001)**
	δ_{103}	-0.013	-0.013	0.008	-0.010	-0.009	-0.005
		(0.001)**	(0.001)**	(0.003)**	(0.002)**	(0.001)**	(0.001)**
Endogenity	v_{19}	-0.001	-0.006	-0.001	-0.027	0.000	0.001
		(0.000)**	(0.001)**	(0.000)	(0.002)**	(0.001)	(0.001)*
	v_{29}	0.003	0.003	-0.004	0.013	0.001	-0.007
		(0.000)**	(0.000)**	(0.001)**	(0.001)**	(0.001)	(0.001)**
	v_{39}	0.002	-0.001	0.001	0.009	0.004	-0.012
		(0.000)**	(0.000)*	(0.000)	(0.001)**	(0.001)**	(0.001)**
	v_{49}	-0.003	-0.003	-0.001	-0.019	-0.002	-0.000
		(0.000)**	(0.000)**	(0.001)	(0.001)**	(0.001)**	(0.001)
	v_{59}	-0.011	-0.013	0.000	-0.053	-0.017	-0.003
		(0.001)**	(0.001)**	(0.001)	(0.003)**	(0.002)**	(0.001)*
	v_{69}	0.040	0.029	0.007	0.046	0.043	0.041
		(0.002)**	(0.002)**	(0.001)**	(0.004)**	(0.004)**	(0.002)**
	v_{79}	0.005	0.004	0.003	0.040	0.018	-0.009
		(0.001)**	(0.001)**	(0.001)*	(0.003)**	(0.002)**	(0.002)**
	v_{89}	-0.003	0.008	0.003	-0.084	0.020	0.044
		(0.002)	(0.003)**	(0.003)	(0.008)**	(0.004)**	(0.002)**
	v_{99}	0.042	0.039	0.020	-0.041	0.095	0.097
		(0.003)**	(0.003)**	(0.004)**	(0.007)**	(0.005)**	(0.004)**
	v_{109}	-0.075	-0.061	-0.028	0.116	-0.162	-0.154
		(0.004)**	(0.006)**	(0.007)**	(0.015)**	(0.009)**	(0.007)**
Constant	α_1	0.048	0.025	0.152	0.013	0.038	0.043
		(0.002)**	(0.003)**	(0.006)**	(0.006)*	(0.004)**	(0.003)**
	α_2	0.056	0.005	0.164	0.073	-0.018	0.055
		(0.003)**	(0.003)+	(0.005)**	(0.004)**	(0.006)**	(0.003)**
	α_3	0.052	-0.021	-0.004	0.053	0.029	0.064
		(0.002)**	(0.003)**	(0.003)	(0.004)**	(0.004)**	(0.004)**
	α_4	0.091	0.101	0.137	0.084	0.090	0.048
		(0.002)**	(0.002)**	(0.004)**	(0.004)**	(0.003)**	(0.004)**
	α_5	0.095	0.178	-0.026	0.003	0.091	0.074
		(0.004)**	(0.006)**	(0.004)**	(0.009)	(0.007)**	(0.007)**
	α_6	0.112	0.081	0.174	0.106	0.211	0.043
		(0.009)**	(0.012)**	(0.005)**	(0.014)**	(0.014)**	(0.013)**
	α_7	0.208	0.137	0.263	0.294	0.230	0.202
		(0.004)**	(0.004)**	(0.006)**	(0.009)**	(0.006)**	(0.008)**
	α_8	0.199	0.224	0.463	-0.020	0.355	0.365
		(0.010)**	(0.015)**	(0.009)**	(0.025)	(0.016)**	(0.012)**
	α_9	-0.173	0.004	0.361	-0.242	0.048	-0.045
		(0.013)**	(0.015)	(0.019)**	(0.022)**	(0.023)*	(0.023)+
	α_{10}	0.312	0.265	-0.684	0.635	-0.074	0.151
		(0.019)**	(0.025)**	(0.027)**	(0.040)**	(0.033)*	(0.035)**

+ $p<0.1$; * $p<0.05$; ** $p<0.01$
Note: Robust standard errors in brackets

Table A3: Marshallian own price elasticity matrix (1994-2004)

	Teff	Barely	Wheat	Maize	Sorghum	Root crops	Pulses	Fruits& vegetable s	Animal products	Other foods
Teff	**-0.945**	-0.027	0.027	0.007	0.006	-0.009	-0.056	0.002	-0.01	0.001
	(0.001)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.001)**	(0.000)**	(0.000)**	(0.000)**
Barely	-0.024	**-1.018**	-0.001	0.036	-0.018	0.012	-0.01	-0.002	0	0.03
	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**
Wheat	0.026	0.001	**-1.023**	-0.024	0.008	0.006	-0.013	-0.004	-0.001	0.04
	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**
Maize	0.006	0.033	-0.026	**-1.028**	0.003	-0.004	0.017	-0.002	-0.001	-0.004
	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**
Sorghum	0.006	-0.018	0.007	0.004	**-0.998**	0.016	0.025	0.01	0.008	-0.062
	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**
Root crops	-0.008	0.011	0.005	-0.004	0.016	**-1.028**	-0.005	0	0.013	-0.001
	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**
Pulses	-0.044	-0.006	-0.009	0.02	0.024	-0.002	**-0.999**	0.013	0.022	0.001
	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**
Fruits& vegetables	0.002	-0.003	-0.005	-0.003	0.007	-0.002	0.012	**-0.996**	0.054	-0.084
	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**
Animal products	-0.016	-0.007	-0.008	-0.013	-0.01	0.001	0.004	0.032	**-0.972**	-0.13
	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.001)**
Other foods	0.035	0.068	0.077	0.046	-0.015	0.045	0.062	-0.035	-0.14	**-0.643**
	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**

+ $p<0.1$; * $p<0.05$; ** $p<0.01$
Note: Robust standard errors in brackets

Table A4: Hicksian price elasticity matrix (1994-2004)

	Teff	Barely	Wheat	Maize	Sorghum	Root crops	Pulses	Fruits& vegetables	Animal products	Other foods
Teff	**-0.652**	0.295	0.499	0.459	0.3	0.381	0.607	0.506	0.424	1.01
	(0.004)**	(0.003)**	(0.004)**	(0.003)**	(0.003)**	(0.003)**	(0.003)**	(0.003)**	(0.003)**	(0.000)**
Barely	0.266	**-0.698**	0.467	0.486	0.274	0.399	0.649	0.498	0.431	1.034
	(0.004)**	(0.003)**	(0.003)**	(0.003)**	(0.003)**	(0.003)**	(0.003)**	(0.003)**	(0.003)**	(0.000)**
Wheat	0.317	0.321	**-0.553**	0.426	0.301	0.394	0.648	0.498	0.431	1.047
	(0.004)**	(0.003)**	(0.003)**	(0.003)**	(0.003)**	(0.003)**	(0.003)**	(0.003)**	(0.003)**	(0.000)**
Maize	0.297	0.353	0.443	**-0.578**	0.296	0.383	0.676	0.498	0.43	0.999
	(0.004)**	(0.003)**	(0.003)**	(0.003)**	(0.003)**	(0.003)**	(0.003)**	(0.003)**	(0.003)**	(0.000)**
Sorghum	0.299	0.304	0.479	0.457	**-0.704**	0.406	0.689	0.515	0.442	0.949
	(0.004)**	(0.003)**	(0.003)**	(0.003)**	(0.003)**	(0.003)**	(0.003)**	(0.003)**	(0.003)**	(0.000)**
Root crops	0.281	0.329	0.47	0.443	0.306	**-0.643**	0.65	0.497	0.441	0.997
	(0.004)**	(0.003)**	(0.003)**	(0.003)**	(0.003)**	(0.003)**	(0.003)**	(0.003)**	(0.003)**	(0.000)**
Pulses	0.251	0.319	0.467	0.477	0.322	0.391	**-0.329**	0.523	0.46	1.022
	(0.004)**	(0.003)**	(0.003)**	(0.003)**	(0.003)**	(0.003)**	(0.003)**	(0.003)**	(0.003)**	(0.000)**
Fruits& vegetables	0.3	0.324	0.475	0.457	0.306	0.394	0.685	**-0.484**	0.495	0.942
	(0.004)**	(0.003)**	(0.003)**	(0.003)**	(0.003)**	(0.003)**	(0.003)**	(0.003)**	(0.003)**	(0.000)**
Animal products	0.312	0.352	0.518	0.487	0.318	0.431	0.74	0.589	**-0.488**	0.983
	(0.004)**	(0.003)**	(0.004)**	(0.003)**	(0.003)**	(0.003)**	(0.004)**	(0.003)**	(0.004)**	(0.000)**
Other foods	0.254	0.309	0.43	0.384	0.205	0.336	0.558	0.342	0.185	**0.111**
	(0.003)**	(0.002)**	(0.003)**	(0.002)**	(0.002)**	(0.002)**	(0.002)**	(0.002)**	(0.003)**	(0.000)**

+ $p<0.1$; * $p<0.05$; ** $p<0.01$
Note: Robust standard errors in brackets

Table A5: Marshallian own price elasticity matrix (2009)

	Teff	Barely	Wheat	Maize	Sorghum	Root crops	Pulses	Fruits& vegetables	Animal products	Other foods
Teff	**-0.654**	-0.094	0.027	-0.177	0.052	-0.01	0.108	-0.003	-0.149	-0.098
	(0.009)**	(0.002)**	(0.001)**	(0.005)**	(0.001)**	(0.000)**	(0.003)**	(0.000)**	(0.004)**	(0.003)**
Barely	-0.096	**-1.164**	0.133	0.097	0.019	0.087	-0.055	0.004	0.067	-0.094
	(0.003)**	(0.006)**	(0.005)**	(0.004)**	(0.001)**	(0.003)**	(0.002)**	(0.000)**	(0.002)**	(0.003)**
Wheat	0.021	0.104	**-1.119**	0.069	-0.207	0.046	-0.025	0.026	0.082	0.002
	(0.000)**	(0.001)**	(0.001)**	(0.000)**	(0.001)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**
Maize	-0.175	0.094	0.086	**-1.116**	0.079	-0.06	0.063	-0.033	-0.062	0.124
	(0.008)**	(0.004)**	(0.004)**	(0.005)**	(0.004)**	(0.003)**	(0.003)**	(0.001)**	(0.003)**	(0.006)**
Sorghum	0.042	0.016	-0.212	0.065	**-0.974**	0.015	-0.088	-0.008	0.026	0.119
	(0.000)**	(0.000)**	(0.002)**	(0.001)**	(0.000)**	(0.000)**	(0.001)**	(0.000)**	(0.000)**	(0.001)**
Root crops	-0.009	0.068	0.047	-0.05	0.015	**-1.076**	0.051	0.014	0.021	-0.087
	(0.000)**	(0.001)**	(0.000)**	(0.001)**	(0.000)**	(0.001)**	(0.001)**	(0.000)**	(0.000)**	(0.001)**
Pulses	0.09	-0.042	-0.026	0.053	-0.088	0.054	**-1.043**	0.017	0.081	-0.086
	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**
Fruits& vegetables	-0.004	0.001	0.026	-0.027	-0.007	0.014	0.008	**-0.883**	0.095	-0.232
	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.001)**	(0.001)**	(0.001)**
Animal products	-0.076	0.045	0.08	-0.025	0.041	0.023	0.053	0.056	**-0.916**	-0.153
	(0.001)**	(0.001)**	(0.002)**	(0.000)**	(0.001)**	(0.001)**	(0.002)**	(0.002)**	(0.002)**	(0.003)**
Other foods	-0.011	-0.01	0.009	0.036	0.04	-0.014	-0.011	-0.056	-0.075	**-0.816**
	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.001)**

+ $p<0.1$; * $p<0.05$; ** $p<0.01$
Note: Robust standard errors in brackets

Table A6: Hicksian price elasticity matrix (2009)

	Teff	Barely	Wheat	Maize	Sorghum	Root crops	Pulses	Fruits& vegetables	Animal products	Other foods
Teff	**-0.354**	0.153	0.578	0.244	0.422	0.399	0.881	0.626	0.303	0.161
	(0.012)**	(0.007)**	(0.005)**	(0.006)**	(0.007)**	(0.005)**	(0.005)**	(0.006)**	(0.005)**	(0.006)**
Barely	0.204	**-0.917**	0.685	0.518	0.39	0.497	0.718	0.633	0.518	0.165
	(0.008)**	(0.010)**	(0.007)**	(0.008)**	(0.007)**	(0.006)**	(0.004)**	(0.006)**	(0.007)**	(0.006)**
Wheat	0.321	0.351	**-0.568**	0.49	0.162	0.456	0.748	0.655	0.533	0.261
	(0.008)**	(0.008)**	(0.004)**	(0.006)**	(0.007)**	(0.005)**	(0.003)**	(0.006)**	(0.006)**	(0.005)**
Maize	0.125	0.341	0.636	**-0.696**	0.449	0.349	0.834	0.595	0.389	0.383
	(0.011)**	(0.009)**	(0.006)**	(0.008)**	(0.008)**	(0.005)**	(0.005)**	(0.006)**	(0.006)**	(0.007)**
Sorghum	0.341	0.261	0.337	0.485	**-0.605**	0.423	0.683	0.619	0.476	0.378
	(0.008)**	(0.008)**	(0.004)**	(0.006)**	(0.007)**	(0.005)**	(0.003)**	(0.006)**	(0.006)**	(0.005)**
Root crops	0.293	0.317	0.602	0.374	0.388	**-0.663**	0.83	0.648	0.476	0.175
	(0.008)**	(0.008)**	(0.005)**	(0.006)**	(0.007)**	(0.005)**	(0.004)**	(0.006)**	(0.006)**	(0.005)**
Pulses	0.383	0.201	0.516	0.466	0.275	0.457	**-0.283**	0.636	0.523	0.17
	(0.008)**	(0.007)**	(0.004)**	(0.006)**	(0.007)**	(0.005)**	(0.003)**	(0.006)**	(0.006)**	(0.005)**
Fruits& vegetables	0.301	0.253	0.588	0.401	0.37	0.432	0.796	**-0.242**	0.554	0.032
	(0.008)**	(0.008)**	(0.004)**	(0.006)**	(0.007)**	(0.005)**	(0.003)**	(0.006)**	(0.007)**	(0.005)**
Animal products	0.273	0.334	0.722	0.464	0.47	0.502	0.951	0.788	**-0.384**	0.143
	(0.009)**	(0.009)**	(0.007)**	(0.007)**	(0.008)**	(0.006)**	(0.005)**	(0.008)**	(0.009)**	(0.006)**
Other foods	0.274	0.224	0.532	0.433	0.393	0.374	0.721	0.54	0.355	**-0.57**
	(0.007)**	(0.007)**	(0.004)**	(0.006)**	(0.007)**	(0.005)**	(0.003)**	(0.006)**	(0.006)**	(0.004)**

+ $p<0.1$; * $p<0.05$; ** $p<0.01$
Note: Robust standard errors in brackets

Table A7: First and second order welfare impact of rising food prices

	1994-2009		1994-2004		2009	
	1st order	2nd order	1st order	2nd order	1st order	2nd order
Haresaw	0.009	0.046	0.008	-0.053	0.104	0.820
	(0.020)	(0.034)	(0.031)	(0.029)+	(0.019)**	(0.170)**
Geblen	0.006	0.040	0.003	0.035	0.091	0.317
	(0.002)*	(0.017)*	(0.001)**	(0.010)**	(0.033)**	(0.127)*
Dinki	-0.017	-0.098	-0.003	-0.035	0.148	0.992
	(0.005)**	(0.019)**	(0.002)*	(0.016)*	(0.028)**	(0.176)**
Yetemen	-0.001	0.019	-0.004	-0.001	0.018	0.136
	(0.003)	(0.012)	(0.003)	(0.007)	(0.006)**	(0.037)**
Shumsha	-0.008	-0.064	-0.001	0.002	-0.056	-0.447
	(0.002)**	(0.011)**	(0.002)	(0.010)	(0.014)**	(0.082)**
SirbanaGodeti	-0.015	-0.105	-0.017	-0.113	-0.000	0.025
	(0.003)**	(0.014)**	(0.004)**	(0.015)**	(0.004)	(0.025)
Adele Kake	-0.067	-0.456	-0.067	-0.268	-0.064	-1.430
	(0.031)*	(0.035)**	(0.026)*	(0.028)**	(0.110)	(0.144)**
Korodegaga	-0.002	-0.021	-0.004	-0.036	0.007	0.037
	(0.000)**	(0.003)**	(0.001)**	(0.014)**	(0.003)**	(0.011)**
TrirufeKetchema	0.004	0.042	0.003	0.029	0.004	0.016
	(0.001)**	(0.011)**	(0.001)**	(0.009)**	(0.002)+	(0.003)**
Imdibir	-0.009	-0.089	-0.026	-0.159	0.025	0.158
	(0.002)**	(0.017)**	(0.006)**	(0.035)**	(0.008)**	(0.051)**
Azedebo	-0.029	-0.214	-0.064	-0.511	0.082	0.713
	(0.004)**	(0.028)**	(0.007)**	(0.048)**	(0.012)**	(0.093)**
Adado	-0.030	-0.234	-0.006	-0.041	-0.019	-0.433
	(0.007)**	(0.012)**	(0.002)**	(0.004)**	(0.017)	(0.121)**
GaraGodo	-0.005	-0.033	-0.016	-0.242	0.158	0.289
	(0.002)**	(0.014)*	(0.015)	(0.023)**	(0.034)**	(0.102)**
Doma	-0.005	-0.050	-0.011	-0.092	0.057	0.316
	(0.002)**	(0.016)**	(0.003)**	(0.027)**	(0.018)**	(0.113)**
D.B.-Milki	-0.006	-0.055	-0.033	-0.308	0.256	1.398
	(0.001)**	(0.007)**	(0.003)**	(0.024)**	(0.047)**	(0.206)**
D.B.-Kormargefia	0.003	0.030	-0.076	-0.540	0.388	1.703
	(0.000)**	(0.005)**	(0.013)**	(0.054)**	(0.050)**	(0.272)**
D.B.-Karafino	-0.006	-0.059	-0.025	-0.254	0.109	1.089
	(0.001)**	(0.011)**	(0.003)**	(0.031)**	(0.022)**	(0.219)**
D.B.-Bokafia	-0.067	-0.574	-0.080	-0.562	0.193	1.437
	(0.010)**	(0.073)**	(0.013)**	(0.076)**	(0.043)**	(0.259)**

+ $p<0.1$; * $p<0.05$; ** $p<0.01$: Note; robust standard errors in brackets
Source: Authors' computation from ERHS panel data

Appendix

We have also examined sample attrition, which is necessary because non-random attrition can cause the panel sample to be unrepresentative of the population of interest and potentially bias the empirical results. Sample attrition is a common problem in panel survey data. The reason for sample attrition in developing countries include household migration, dissolution due to head death, household spit-off, or refusal to be interviewed (Deaton, 1997). Refusal rates are relatively low in developing countries, which may related to low opportunity cost of time or cultural attitudes (Maluccio, 2004). Sample attrition is very low in ERHS panel data. Between 1994 and 2004, the attrition rate was only 1.3 per cent per year (Dercon and Hoddinot, 2004). Limited access to land for cultivation in other areas could be one of the plausible reasons for low attrition rate.

In order to treat factors influencing attrition, the sample of households in the first round (1994) first divide into two subsamples; non-attritors in all survey rounds and attritors at least in one survey round. Table A8 present some basic descriptive for the two groups. A univariate comparison indicate that non-attritorshouseholds have higher family size, headed bymale and earned better income than their counterparts. Moreover, non-attritors have better access to road and transport facilities, have access to primary school, hospital, among others.

Table A8: Differences- of- means Tests between the Attritors and Non-attritors in ERHS 1994a

	Nonattritors (A)		Attritors (B)		Differences (A-B)	
	Means	(S.D)	Means	(S.D)	In Means[1]	(t-test)[2]
Household Characteristics						
Household size	6.24	(2.96)	5.04	(3.21)	1.19 ***	(5.71)
Gender of head (1 if male)	0.79	(0.41)	0.68	(0.47)	0.11***	(3.75)
Age of head (in years)	46.62	(15.51)	46.86	(16.82)	-0.25	(-0.22)
Head highest grade completed (in years)	0.96	(2.30)	1.14	(2.64)	-0.186	(-1.09)
Per capita monthly food expenditure	63.37	(66.21)	71.15	(107.97)	-7.78	(-1.12)
Per capital annual total income	544.87	(883.75)	475.09	(555.75)	69.78*	(1.66)
Community characteristics						
Improved road system	0.65	(0.49)	0.58	(0.49)	0.081*	(1.66)
Improved transporting system	0.52	(0.49)	0.43	(0.49)	0.082*	(2.51)
Number of primary school	1.34	(1.18)	1.19	(0.85)	0.208***	(3.38)
Distance to hospital	35.88	(35.07)	44.11	(39.36)	-8.23**	(-3.21)
Mean per capita food expenditure	46.32	(17.04)	47.71	(15.12)	-1.40	(-1.36)
Mean per capita income	410.01	(259.21)	363.04	(188.85)	46.97**	(3.47)

Sample size	1191	282

1. Two-sample t-tests with unequal variance. 2. The asterisks *** indicate significant at 1 per cent and * indicate significance at 10%.

Table A9 presents probit regression model for attrition between panel waves. Household with large family size is less likely attrite as leaving the original place is costlier with more population size. Similarly, male headed household are less likely attrite than female headed households as female became household head either when she is divorced or widowed and may be engaged in to re-marriageand move to partners residential areas. Educated family head is also more likely attrite for seeking better job opportunities in other areas, particularly in urban and pre-urban areas. Attrition increase with age of household head as the older head may be moved to children residents or major activities replaced by their children. There is no significant difference in consumption level, however, attritor households have lower income than non-attritor.

Table A9: A selection Probit Model for analyzing Attrition between ERHS panel waves

	Dependent var.=1 if attrited
Log(household family size)	-0.157
	(8.17)**
Sex of head; 1 if male	-0.059
	(2.45)*
Head education dummy; 1 if literate	0.014
	(0.47)
Log(age of head)	0.061
	(1.95)
Log(per capita food expenditure)	-0.027
	(1.92)
Log(per capita annual income)	-0.014
	(1.39)
Log(Distance of town from the PA (in km))	0.077
	(0.57)
Improved road system since 1984 EC; 1 if yes	-0.117
	(1.00)
improved transportation system since 1984 EC; 1 if yes	-0.184
	(1.85)
Log(distance to police station (in km))	0.185
	(3.49)**
Log(distance to telephone service (in km)	0.206
	(6.66)**
log(distance to post office (in km))	-0.451
	(4.38)**
Log(distance to bank service (in km))	-0.127
	(6.02)**
Log(distance to daily market (in km))	0.118
	(2.70)**
Increased number of primary school since 1984 EC	-0.030
	(1.46)
Do people from other communities migrate to PA; 1 if yes	0.153

	(1.89)
Log(distance to the government hospital)	0.161
	(2.91)**
Log(distance to the nearest gov't clinic (inkm)	0.126
	(1.54)
Log(per capita average village level expenditure)	-0.093
	(0.93)
Log(per capita average village level income)	0.111
	(0.87)
N	1,473

* $p<0.05$; ** $p<0.01$