UNIVERSITA' CATTOLICA DEL SACRO CUORE
MILANO

Dottorato di ricerca in politica economica
ciclo XXIII
S.S.D: SECS-P/02, SECS-P/01, SECS-P/05

Essays on Welfare, Demand and Resilience to Food Insecurity in Rural Ethiopia

Tesi di Dottorato di Uregia Nigussie Tefera
Matricola:3610949

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Coordinatore: Ch.mo Prof. Campiglio Luigi

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Overview

Agriculture is the mainstay of the Ethiopian economy; it generates almost half of GDP, 60 percent of exports and over 80 percent of the total employment. According to the Government Official Reports, the country has achieved strong economic growth, on average about 11.2 percent, in recent years but experienced higher inflation since early 2004. The overall inflation, mainly driven by food price inflation, has unprecedentedly increased since 2007/08 and peaked in October 2008. Ethiopian inflation plummeted in 2009 but remained higher than its historic norms. Since early 2010, it has started to rise again and already passed the October 2008 peak by April 2011 and remarkably increasing throughout the year of 2011.

Our key research questions are then who are benefiting and/or losing from high food prices, and to what extent. Obviously, urban poor households have been suffering from the rising food price inflation. For rural households, the distributional impacts of higher food prices are ambiguous as they are both producers and consumers of food products. On one hand, the recently increased output in production along with sound increased in output prices reinforced the belief that higher prices could be translated into higher income and welfare. On the other hand, welfare impact of food prices changes depends not only on production but also on the status of households as net buyers or sellers of food items, and on wage responses from labor market (Christiaensen and Demry, 2007). Thus, the thesis explores welfare impacts of high food prices on rural households and some other closely related topics through five self-contained papers.

Paper I examines welfare implications of rising cereal prices in 2008. The empirical results, using Ethiopia Agricultural Marketing Household Survey (EAMHS) 2008 dataset and based on non-parametric net benefit ratio (NBR) analysis, show that high cereal prices have positive impact on aggregate welfare of rural households in three of four major cereal producing regions in the country; a hypothetical 10 percent increase in cereal prices increase rural household welfare by about 0.6 percent at aggregate level.

Households often substitute one commodity for the other when relative prices changes, the NBR analysis, however, doesn't take into account substitution effects or changes in demand patterns of household's responsiveness to change in relative price and income. Moreover, measuring the actual welfare impacts of rising food prices require reliable income and price elasticities as well as the dataset that capture both before and after high food prices. **Paper II** further explores welfare impacts of rising food prices using Quadratic Almost Ideal Demand System (QUAIDS) approach and estimating Compensated Variation (CV) that take into account substitution effect and profit function. The empirical results, based on the Ethiopia Rural Household Survey (ERHS) panel dataset collected during low price (1994-2004) and high price (the 2009) period, show high food prices in recent years (between 2004 and 2009) increased the aggregated welfare gains of rural household by about 10.5 percent, compared to less than 1 percent during the period 1994 to 2004. The welfare gains further improved to 18 percent (high price period) with substitution effects, compared to 7.2 percent (low price period).

The gains from high food prices, however, were not evenly distributed among rural households: about 48 percent and 56 percent of sample households were net cereal buyers during the low price and high price period, respectively. **Paper I and II** argue that although there are numerous net cereal buyers, theoretically rural households should be benefited from rising food prices as they are not only consumers but also producers of the products. In this regards, promoting agricultural productivity, with appropriate price incentives, through intensification, diversification, resource-stabilizing innovation are important policy tools to overcome short-run and long-run impact of high food prices on rural net buyer households. Promoting agricultural productivity could also have long term trickle-down effects on poor urban households by increasing market supply and hence eventually decreasing the prices of the commodities.

Welfare as well as food security status of poor households in developing countries are adversely affected not only by high and volatile food prices but also by interaction of multiple shocks and stresses, including natural disasters, climate change, endemic poverty, ecosystem degradation and global trade, among others. The degrees to which households can recover from such upheavals without compromising their long-term livelihood security are determined by household resilience. **Paper III** discusses household resilience to food insecurity dynamics. The resilience scores, based on ERHS panel dataset, were estimated through principal component analysis based on household capacity to cope with short, medium and long-term shocks. These include amount of grain in stock, precautionary savings/investment (animals kept for sale or

replacement), investment in child education and participation in traditional risk sharing arrangement (*idir*).

The empirical results show that there is a "true" state-dependence on the dynamics of household resilience to food insecurity, i.e. the current level of household resilience depends on the past level of resilience. The results also demonstrated that household resilience to food insecurity is significantly and positively correlated with ownership of major assets such as land under cultivation, number of oxen, milking cows and transport animals owned, adoption of improved technologies, membership in traditional saving and credit association. The paper argues that agricultural and rural development policies that facilitate access to productive assets, promote intensification, ensure commercialization and formation of social capital have a more sustainable and significant impact on resilience.

Besides of external shocks and stresses that could affect welfare and resilience to food insecurity, rural households in Ethiopia could experience seasonal fluctuation in food consumption and nutritional status due to seasonality in crop production and also because of absence of formal insurance or financial market to mitigate production shortfall of consumption. **Paper IV** discusses food consumption seasonality and household market participation. The empirical results, based on Yearlong Monitoring Ethiopian Rural Household Survey (YLMERHS), show that seasonality in food consumption is pronounced. More importantly, household consumption rises not only during harvest season where the stock is relative high but also in the months of lean

season that coincide with Holidays. Households are participated in the markets either for consumption shortfall of production or to satisfy their preference. Furthermore, the paper argues that market participation will improve seasonality in consumption.

In spite of joint efforts to enhance welfare as well as resilience to food insecurity, there are some groups of households or individuals that couldn't endure as presumably lost their main productive assets to survive the shocks and hence in poverty trap. These households should be supported through social safety net programme. The government introduced Productive Safety Net Programme (PSNP) for these households in attempting for long-term solution through protecting asset depletion at household levels and asset creation at community levels. The programme offers primarily cash transfer to beneficiaries as cash would better enable the beneficiaries to diversify income sources and build asset levels. Moreover, increasing cash supply in rural communities would be supposed to stimulate the rural economy, benefiting everyone, including the destitute. However, less than 20 percent of beneficiaries prefer "cash only" transfer comparing with "in-kind only" or combination of "in-kind" and "cash transfer". **Paper IV** discusses why only one-fifth of beneficiaries prefer cash transfer in spite of the motivations. The empirical results, based on the 2006 Ethiopian food security baseline survey, show that recently escalating food prices, high local wage rate as compared to the amount of cash transfer per day, receiving free food aid in the most recent years, low levels of food consumption, distress assets sale and distance from local markets are major factors for preferences of the types of transfers. The paper argues the amount of transfer, Birr 5 per day per person, was insufficient to purchase basic food requirements. The paper

recommends transfer adjustment conditional to a local wage rates is crucial if the policies are dreaming for long-term impacts of the programme.

Acknowledgements

This dissertation is a product of joint efforts of many individuals, to whom I owe my sincere gratitude. I would like to start by conveying my deepest thanks to my advisor Professor Enrica Chiappero-Martinetti for her intellectual guidance, encouragement and support. My heartfelt thanks go to my co-author Dr. Mulat Demeke, from whom I benefited a lot at different version of the thesis. Mulat has been encouraging and supportive in all dimensions throughout the writing-up of the dissertation. His challenging questions on the usefulness of my research questions and their policy relevance as well as critical observations and suggestions helped me to sharpen my thinking of different issues raised in the thesis. His suggestions and comments are invaluable not only to this dissertation but also to my future career. Many thanks also go to his families: Selamawit, Nati, Saron and Ruth for always being hospitable and welcoming me into their home during my stay at FAO-Rome for two years.

My profound thanks go to two Senior Researchers: Dr. Shahidur Rashid and Dr. Alemayehu Seyoum with whom I had the privilege of working at International Food Policy Research Institute (IFPRI-Addis Ababa) as PhD intern, June 2008 to July 2009, and co-authoring. They emphasized the idea to explore welfare impacts of rising food prices. Your support and encouragement as well as well as useful comments on various version of the paper are gratefully acknowledged. I would like to thank Dr. Shahidur who enthusiastically insist me to finish my PhD on time while I was drifting apart from thesis writing for some time due to other commitment. I extend my deepest appreciation to my colleagues at IFPRI: Sindu, Dawit, Daniel, Zelekawork, Kibrom, Sinishaw, Sinafkih and

Gerawork for the good time we had together as well as for sharing your opinion and knowledge on various research questions. I am indebted to Workwuha, Almaz and Fekiru for their excellent administrative support.

Many thanks to my friends Mario, Francis, Chiara, Paulo, Ricardo, Marta and Milania for the great team with whom I shared the life of studying during the course work. They also deserve gratitude for all the discussions we had regarding the thesis, our future careers, and their friendship in all the years. Thanks, Mario, for always being there for me whenever I need your help and using the usual phrase "Please, do me favour". Moreover, the Thursday's pizza dinner we had together with Francis, Paulo and Ricardo, and then the Jazz Club we went at the Milestone have never ever forgotten. You are so dedicated for me throughout all these years; *betam amesegnalehu.* My sincere gratitude go to your "Mama" and "Papa" for their hospitality and support whenever I happened to be at your family's home, particularly for attending the prestigious Holidays. I felt as if I were at my home; *egiziabiher yestiligne*.

I would like to extend my profound gratitude to my colleague Fantu Guta for bringing an opening about this PhD program into my attention and professor Baussola Maurizio Luigi for his generous assistance to apply for the program and facilitating all administrative procedures. Many thanks go for Luciana for her efficient and excellent administrative support.

I would like to express my sincere gratitude to Luca Alinovi, Luca Russo and EC-FAO food Security Information System for Decision Making Team: Erdgin, Marco, Rachel, Winnie, Lavinia, Zoe and Oriane for being good friends during my stay at FAO; Rachel's "Friday Team Lunch" invitations with entertainments are memorable. My heartfelt thanks go to Denise, Carina, Beldina and Anna for excellent support and encouragement. Luisa Cruz deserves special thanks for funny and pleasant time we had while sharing office. Many thanks go to Shikur, Solomon, Yesuf, Mekdes, Miriam, Abeba, Saba and Berhie for very good time we had together.

I am grateful for the generous financial support from the Italian Ministry of Education through Catholic University.

My family back home was a big encouragement to me throughout my PhD studies. My father Ato Tefera Uregia and my mother W/ro Zewdie Mekonne have always believed in the power of education to make a difference and have always encouraged and supported me. I wish you long life; God bless you! Many thanks go to my bothers: Dejene, Gosaye and Wogene; and sisters: Aregash, Asnakech, Alemtehay, Fanos, Ethiopiawosen, Furno, Genet and Zemenay.

I am deeply thankful to my wife, Trisit Eshetu, for her support and encouragement as well as for putting up the challenging times of living apart during the period of my study as well as working at FAO; and to my sisters-in-law: Rahel, Helina and Maleda; and bothers-in-law: Abebe, Biniyam, Samuel, Fasil and Dereje for tirelessly take care of my

wife whenever she needs assistances while I have been away for so long. Many thanks go to her late brother Moges Eshetu for his love, support and encouragement. It was unfortunate that we lost him while both of us were simultaneously staying abroad. May God rest his soul in eternal peace! My heartfelt thanks go to her beloved mother w/ro Alemetehay Geber and her father Ato Eshetu Gebreyes for their encouragement and support all this time. God bless you all! I am also grateful to Mesfin, Lene, Girma, Tenagne, Yodit, Lili and to our folks living in Canada and Britain: Tigist, Alem, Mathias, Samuel, Abera and Alex, as well as in South Africa: Lili, Martha, Mokonnen, Neway and Daniel.

Nigussie Tefera

February 2012; Addis Ababa, Ethiopia

To my mother and father

Contents

Paper III: Rural Household Resilience to Food Insecurity: Panel Data Evidence

Paper IV: Food Consumption Seasonality and Household Market Participation in Rural Ethiopia

Paper IV: Emerging Cash Transfer and Beneficiaries Preference: the Case of Productive Safety Net Programme

Paper I

Welfare Implications of Rising Cereal Prices in Rural Ethiopia

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Abstract

Food, mainly cereal, prices in Ethiopia considerably rose over the years 2004 to 2008. The empirical results, based on Ethiopia Agricultural Marketing Household Survey (EAMHS) 2008 data, show that higher cereal prices have positive impacts on welfare of rural households at aggregate level in three of four major cereal producing regions in the country; a hypothetical 10 percent increases in cereal prices will increase rural household welfare by about 0.6 percent. However, the benefits are not evenly spread across all households; majority (about 54 percent) of households are net cereal buyers and could be adversely affected from increasing cereal prices in the short-run. Crops level analysis show that the poor households are affected by rising prices of maize and sorghum but benefited from higher prices of teff and wheat. The poor households often produce the latter crops to comply with their cash obligation, as they fetch better prices, rather than consumption. The poor households, however, are constrained by small landholding with limited use of improved technologies. Promoting agricultural productivity through intensification, diversification, resource-stabilizing innovation are the important policy tools to overcome short-run and long-run impacts of higher food prices on rural poor net buyer households.

Keywords: Rural Ethiopia, cereal prices, welfare

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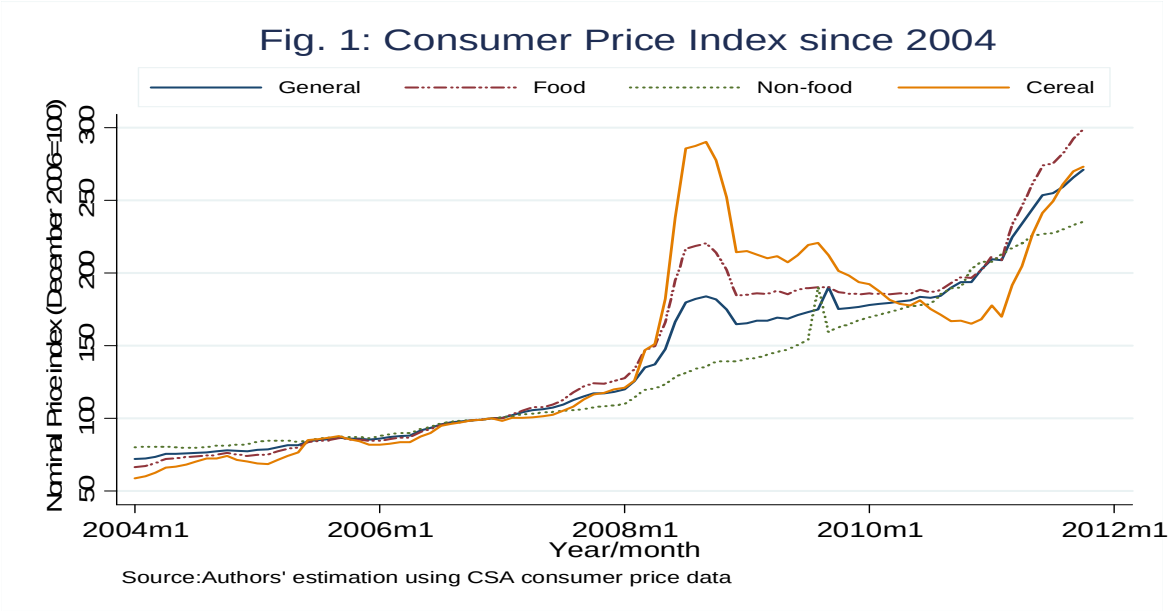
[¥] The authors are grateful for the many helpful comments from the participants at "EDRI-IFPRI Research Workshop, Market Dynamics and Cereal availability in Ethiopia: Producers, Traders, and the Policies" December 5, 2008; Addis Ababa, Ethiopia. The views expressed in this paper, including errors and omissions, are entirely those of the authors. Financial support from Italy government through Catholic University and logistic support from International Food Policy Research Institute (IFPRI) are gratefully acknowledged.

1 Introduction

Ethiopia has experienced increases in inflation, mainly driven by spike in food price, since 2004. The inflation has unprecedentedly increased since 2007/08 and peaked in October 2008. It had plummeted in 2009 but remained higher than its historic norms. Since early 2010, inflation has started to rise again and already passed the 2008 peak by April 2011 and remarkably increasing throughout the year of 2001. The food price inflation has shown almost the same trends with the general inflation. Cereals are the major components of food; its inflation has increased to historical peak in October 2008. Unlike food and general price inflation, it continued to decline until March 2011 but steadily increasing thereafter although not yet exceeding the 2008 peak (Fig. 1). The spikes in non-food prices are more or less below the general and food price inflation, however, it has shown continuously increasing trends since 2004.



Factors contributing to higher food prices inflation in Ethiopia are puzzling: First of all, prices were rising despite consecutive years of better weather conditions and good harvest[1], which confronted historical relationship between production and market prices. More importantly, food prices in Ethiopia started increasing long before food and oil prices began to spike in the world market (Rashid *et al.*, 2008; Ulimwengu *et al.*, 2009; Laderchi and Ticci, 2009). Moreover, given that the domestic products unlikely correlated with internationally traded goods, global developments[2] in the short to medium-run unlikely translated directly into Ethiopia food price inflation (World Bank, 2007) but more likely exacerbated it (Laderchi and Ticci, 2009). Inflation in Ethiopia was mainly derived from excessive money supply (World Bank, 2007).

Several studies have documented higher and volatile food prices in developing countries hit hardest the poorer net buyers in the short-run as food accounts for the largest share of household expenditure in those countries (von Braun *et al.*, 2008; Zezza *et al.*, 2008; Godsway *et al.*, 2008; FAO, 2008; ADB, 2008; Ivanic and Martin, 2008; Wodon *et al.*, 2008). In Ethiopia, urban households have been suffering from the rising food prices. In the rural areas, however, the distributional impacts are ambiguous. On one hand, the recently increased output in production along with sound increased in output prices reinforced the belief that higher prices could be translated into higher income and welfare. On the other hand, welfare impact of food prices changes depends not only on

[1]The economy had registered robust growth in double figures since recovering from the sever drought shock of 2002/03; on average, 11.8 percent growth in real GDP between 2003/04-2007/08.

[2] Global food crises are in response to rising demand in large developing countries, increases in the costs due to higher fuels and fertilizer prices, diversion of food crops to biofuels production, decline in world carry-over stocks, poor harvests in major exporting countries, the introduction of policies to restrict food exports by some countries and increased in the World population (Mitchell, 2008; von Braun et al., 2008; FAO and OECD, 2008; Hebling et al., 2008, Polaski, 2008).

production but also on the status of households as net buyers or sellers of food items, and on wage responses from labor market (Christiaensen and Demry, 2007). Accordingly, rising food prices may erode the purchasing power of poor[3] net buyers and landless rural workers who invariably rely on market to meet food needs for major parts of the year and whose subsistence wage may not increase apace with food price (Mulat *et al.*, 2007; Laderchi and Ticci, 2009). Furthermore, the rise in non-food prices, in particular fertilizers price, may also dilute income gained from rising food prices for farmers[4]. Market intermediaries may also be able to keep a large share of increase in prices for themselves without paying farmers much more for their crops (Wodon *et al.*, 2008b). Dercon *et al.* (2009), for instance, have indicated that farmers in Ethiopia haven't received more than half of consumer prices (in urban areas) because of higher transaction costs.

In spite of such uncertainty, only few empirical research have been conducted on welfare impacts of rising food prices for rural farming households in Ethiopia (e.g. World Bank, 2007). However, the study was based on the Welfare Monitoring Survey (WMS) 1999/00 that reflect information 7 years prior to years of soaring food prices. For appropriate policy decision, more regressive and robust analysis based on information (data) collected during soaring food prices is indispensable. This study is, therefore, intended to contribute for policy making based on the Ethiopia Agricultural Marketing Household Survey (EAMHS) 2008 data. Unlike other studies, we also extend the analysis

[3] Both the 2005 Poverty Assessment (World Bank 2006) and Leoning and Oseni (2007) have drawn attention to the low share of net food sellers even in rural areas (cited in Laderchi and Ticci, 2009).
[4] Although food prices declined very recently fertilizer cost still remain at higher price.

by crops; *teff*, maize, barley, wheat and sorghum. Employing nonparametric Net Benefit Ratio (NBR) analysis, we found that rising cereal prices increased rural household welfare at aggregate level; mainly due to the fact that the welfare gains by 44 percent of net sellers outweighs the loss by majority (54 percent). Crop level analysis have shown that the poor households are loser from rising prices of maize and sorghum but gainer from teff and wheat. The poor households often produce the latter crops to comply with their cash obligation, as they fetch better prices, than for consumption.

The reminder of the paper is organized as follows: Section 2 describes the methodology while section 3 discuses data sources and basic descriptive statistics. Section 4 explores production and consumption patterns of cereal crops. The simulation results are discussed in section 5 while section 6 concludes.

2 Methodology

Following the pioneering work of Deaton's (1989) nonparametric Net Benefit Ratio (NBR) analysis, a number of scholars have conducted research on the impact of rising food prices for low income countries using different survey data. In his own work, Deaton (1989) estimated that a hypothetical 10 percent increase in rice prices on distribution income of households in Thailand and found that higher prices could benefit all rural households but middle income class farmers are benefited most relative to either the poorest or wealthy rural households.

The method was subsequently applied to assess welfare impact of rising prices in sub-Saharan African. Barrett and Dorosh (1996), also using non-parametric techniques, have shown higher rice prices could have negative impacts on the welfare of the rural poor in Madagascar because the gains to net rice sellers were concentrated among higher income rice farmers. Budd (1993) also examine the impact of food price changes in rural Cote d'Ivoire and found that income elasticities with respect to food price changes are small and the effects are quite diverse and dependents on the composition of food basket and geographical location. He added that the effect of food price increase does not necessarily benefit only the rich farmer. Mude (2005) analyzed the welfare and distributional impacts of rice price policy in rural and urban Kenya and found that reduction in maize price would decrease rural and urban poverty.

Studies have also been conducted in Asia low income countries based on a hypothetical 10 percent increase in prices. Ravallion (1990) examines welfare effects of food price change in rural Bangladesh. The short-run distributional effects were likely to benefit the rural rich while the rural poor loose from price change. Ravallion and Van de Walle (1991) found that food prices raised the rate of poverty in Indonesia. Minot and Goletti (2000), with some modification of the model, estimated that rise in rice prices would increase the average household's real income as most of Vietnamese households cultivate rice. Nevertheless, they found that the higher rice prices slightly increase the rate of poverty.

More recently, Ivanic and Martin (2008) examined nine low-income countries and found that increased prices of staple foods would increase poverty in most, but not all, of those countries. Loening and Oseni (2007), based on WMS 1999/00 of Ethiopia, have found that a hypothetical 10 percent increase in the prices of staple food items increase rural households income by 1-2 percent[5]. Nevertheless the benefits are biased towards better-off households than low income smallholders. Wodon and Zaman (2008) argued that rising food prices are likely to lead to higher poverty in sub-Saharan African as the negative impact on the net poor consumers outweighs the benefit to the rich producers. Other studies have also emphasized that rising food prices could be potentially welfare improving in the medium to long-run (Zezza *et al.*, 2008) and transfer income from generally higher income net food buyers to poorer net food sellers[6] (Aksoy and Isik-Dikmelik, 2008).

In line with other studies, this paper also applies nonparametric NBR analysis to explore the welfare impacts in rural Ethiopia resulting from recently soaring food prices. We preferred the nonparametric analysis as it favors to let the data to speak for themselves as much as possible without imposing rigid assumptions about distribution of the observed data (Deaton, 1989; Budd, 1993; Barret and Dorosh, 1996). The NBR is derived from the indirect household utility function (Deaton 1989; 1997) as follows;

$$U_h = f(\omega T + b + \pi; \mathbf{p}c) \qquad (1)$$

[5] The aggregated welfare impacts of the observed food price changes at national level in Ethiopia are small, 0.7 (World Bank, 2007)

[6] Although there are more poor net food buyers than sellers, about half of these households are marginal net food buyers, and thus price increases will have a small effect on their welfare (Aksoy and Isik-Dikmelik, 2008)

where U_h is the utility of household h, which is a function of (full) income and the consumer prices of all goods pc (a vector), w is the wage rate, T is the total time (including leisure time) available to all household members, b is non-labor income, and π is the household's profit from agricultural or non-agricultural household businesses.

Suppose now that there is a small change in the i^{th} price, the effect can be analyzed through the derivatives of the indirect utility function (1). In particular, using the chain rule

$$\frac{\partial u_h}{\partial p_i} = \frac{\partial \psi_h}{\partial x_h}\frac{\partial \pi_h}{\partial p_i} + \frac{\partial \psi_h}{\partial p_i} \qquad (2)$$

For rural faming households that are producers and consumers, change in price affect both farm profits and the cost of living. The profit (π) of households, by standard microeconomic theory, is a function of the prices of both the inputs used and the outputs produced by the household's production activities. The effects of small changes in prices on profits (Hotelling's Lemma) are given by;

$$\frac{\partial \pi_h}{\partial p_i} = y_{hi} \qquad (3)$$

Where y_{hi} is the production of good *i* by household *h*.

Moreover, the effect on utility of an increase in price is give by Roy's (1942) theorem as:

$$\frac{\partial \psi_h}{\partial p_i} = -q_{hi}\frac{\partial \psi_h}{\partial x_h} \qquad (4)$$

Where q_{hi} is the amount of good *i* consumed by household *h*, and the quantity of $\partial \psi_h / \partial x_h$ is the marginal utility of money to household *h,* that produces benefit from a price change in proportion to the amount of their production and consumers loss in

proportion to the amount of their consumption. For rural farming households (that are both producers and consumers), the gain or loss is proportional to the difference between production and consumption, which is y_{hi} - q_{hi}.

If one substitutes (3) and (4) into (2) and multiply by p_i (as it is more convenient to work with proportional changes in prices (Deaton, 1989)), we can obtain

$$\frac{\partial u_h}{\partial \ln p_i} = \frac{\partial \psi_h}{\partial \ln x_h} \cdot \frac{p_i (y_{hi} - q_{hi})}{x_h} \qquad (5)$$

Where $\partial u_h / \partial \ln p_i$ percentage change in u_h,the indirect utility function of household *h*, with respect to small percentage change in price for *i*th commodity, p_i; $\partial \psi_h / \partial \ln x_h$ captures the private marginal utility of money; y_{hi} and q_{hi} household production and consumption of ith commodity, respectively and x_h is household total income (as measured by consumption expenditure). The terms y_{hi} / x_h and q_{hi} / x_h are defined as production ratio (PR) and consumption ratio (CR). Deaton (1989) refers the difference between the production and consumption ratio as Net Benefit Ratio (NBR). It measures elasticity with respect to price of money-equivalent utility. It uses to estimate the short-run welfare impact of prices changes on household welfare. The NBR will be positive for households which are net sellers (hence those households will benefit from a price increase) and negative for net buyers. These shares are calculated in value terms, so selling agricultural products at harvest times when the price are low, and buying exactly the same quantity later in the year when price are higher would make a household a net buyers (Landerchi and Ticci, 2009). However, our analysis is not subjected to these

effects as we have taken production and consumption data, rather than only sales and purchase, and evaluated them at the same price level.

The basic model is combined with Ravallion's (1990) approach (the last term in equation (6) partly to capture second-order effects stemming from induced wage response.

$$\Delta w_h = \Delta p \left[\left(\frac{y_{hi} - q_{hi}}{x_h} \right) + \eta L_i \right] \qquad (6)$$

Where Δw is welfare effect expressed as percentage of original incomes of household *h*, Δp is percentage change of food price change, η is wage rate elasticity with respect to food price change, L is labor share in household income; and the remaining variables are as defined above. The wage rate elasticity is based on an econometric analysis of time series data by Loening and Oseni, 2007; *"just -in-time" food price inflation policy note in Ethiopia*, while labor share is based authors' calculations from survey data (see Table A1).

3 Data Sources and Descriptive statistics

The study is based on the Ethiopia Agricultural Marketing Household Survey (EAMHS) data collected in April-March 2008. It was conducted by the International Food Policy Research Institute (IFPRI) in collaboration with the Ethiopian Development Research Institute (EDRI) and the Ethiopian Institute of Agricultural Research (EIAR) with technical support from the Central Statistical Agency (CSA). Funding for data collection was provided by the Joint Research Centre (JRC) of the EU. The survey was conducted to

better understand agricultural marketing patterns (cereal availability) and how they have changed in recent years following soaring food prices. In order to increase the precision the survey has collected information from households, traders and cross border trade of cereals and livestock using three sets of questionnaires.

The household survey, based on (HICES) 1999/000[7] as a sampling framework, covered main production areas across four regional states (Tigray, Amhara, Oromiya and the Southern Nations, Nationalities, and People's (SNNP))[8]. These regions account for 97 percent of grain production in the country (Rashid *et al.*, 2008). The survey used a three-stage stratified random sample approach: in the first stage, w*oredas* (districts) from each region were selected randomly from a list arranged by degree of commercialization as measured by the *woreda*-level quantity of cereals marketed. It is to ensure that *woredas* were uniformly distributed across the range of level of marketed cereal outputs. In the second stage, farmers' or peasants' associations (FAs or Pas) were random selected from each *woreda*. Sampled households were randomly selected in the third stage from list of PAs. There were 1707 surveyed households[9] in 63 *Woredas*. The sample is statistically representative (for respective regions) through HICES sampling weights.

[7]The Household Income and Consumption Expenditure Survey sample includes 8,660 rural and 8,672 urban households from 10 regional states and two city administrations (Addis Ababa and Dire Dawa). Of total rural sampled households this survey considered 25% of them as a sampling framework.

[8]The precise distribution of EAs across zones/*woredas* worked out in collaboration with the Central Statistical Agency (CSA) (see Rashid et al., 2008).

[9] This sample size is broadly consistent with results of sample size calculations using different 'significant' outcomes as criteria (see Rashid et al., 2008)

The household survey was designed to collect comprehensive information on consumption, production, storage and marketing behaviors, sales, among others. It, in particular, consists of food consumption sections to capture both own harvest and purchase. Besides of normal values and quantities of purchase, households were asked to report frequency of purchase in a month and number of months they do purchase in a year (just to improve the data quality).

Total value (quantity) of food purchased was the product of normal value (quantity) of purchase, number of months households do purchase in a year and frequency of purchase in a month. However, remarkably larger values (quantities) of total purchase revealed for some specific commodities, including (e.g. salt, *tella/tej*, coffee/tea, onion, spices, etc,). Effort was made to reduce the impacts through careful data cleaning and reconciliation across values, quantities as well as unit of measurement (whenever applicable). Some food items were also reported as if purchased and consumed in large volume on a daily basis throughout the year. Large volumes of purchase (for consumption) on a daily basis have never been practiced in almost all rural areas of the country. During slack months, however, households in SNNP do purchase in small quantity on daily basis from scant markets. For such cases, an adjustment was made either on number of times households do purchase in a year, frequency of purchase in a month or both, depending on nature of items bought and regions where purchases carried-out.

The implicit costs of own produced food is valued using median purchasing prices at *woreda* level. When such prices were not available, the median purchasing prices at the next level of geographical aggregation (i.e. zonal and/or regional) were used instead. Notice that purchasing prices are not directly reported in the household survey[10]. The unit values derived from values and quantities of food items purchased are used as estimated purchasing prices. The unit values have advantage over common prices collected from local markets as it takes in to account the rational quality of purchased food items; nevertheless, it varies within the same locality i.e. *woredas/*EAs[11]; appropriate measures were taken to reduce the impacts.

Non-food expenditures were recorded in two ways depending on nature of (non-durable) goods; in the past two weeks and in the past 12 months. Non-food expenditures in the last 12 months, therefore, complemented with non-food expenditures in the last two-weeks times twenty-six, to generate annual figures. We also included houses rental equivalent into non-food expenditure assuming it is linearly depreciated over the coming 15 years. Total household expenditure is the sum of food and non-food expenditures. Moreover, the nominal values are deflated using (December 2006=100).

[10] Quantities are also measured in local units and its equivalent conversions to kilogram missed. We adapted Ethiopia Rural Household Survey (ERHS) conversion factors and convert all quantities to kilogram (kg).

[11] Misplacing digits of either values or quantities during data encoding or verification might cause such variability in unit prices

In order to get insight on how prices change will affect welfare of rural households, it is also important to consider households production along with consumption. Output of harvest was reported in local units in the survey. It was converted to standard unit kilogram (kg), as usual. Values of production are supposed to be derived from output of harvest and sales prices but survey data doesn't include sales data for the production year. Instead, it is calculated as total output of harvest times purchasing prices derived from values and quantity of purchased food items.

4 Consumption and Production patterns of households

4.1 Household consumption pattern

Table 1 presents basic household demographics a long with household per capita consumption expenditure. If one considers per capita expenditure as a measure of welfare, households in Amhara have better living standard than households in Tigray, who in turn are better-off than households in Oromiya. In SNNP, with lower per capita expenditure, the average household consumption expenditure is nearly one and half times lower than that of household in Amhara. Fig.3 presents nonparametric kernel density distributions of per capita expenditure[12] and has shown that per capita expenditure is higher in Amhara and lower in SNNP. The kernel distribution, however, tailed to the right in all regions; implying that although, on average, households in SNNP have lower per capita expenditure, there are also some households in the region whose per capita expenditure is as high as that of households in other regions, including

[12]While the horizontal axis shows per capita consumption level, the height of the curve shows the concentration of households at any given level of per capita consumption

Amhara. Note that almost all households are headed by men aged in the middle of 40s. The average family sizes are estimated to be 6.52 persons but with considerable differences among regions; highest in Oromiya (7.04 persons). Furthermore, households are characterized by large number of children in a family as evidenced by lower average household sizes in equivalent adult (Table 1).

Table 1: Basic household characteristics by region

	Tigray	Amhara	Oromiya	SNNP	All
Family size	5.83	6.02	7.04	6.33	6.52
	(2.06)	(1.99)	(2.89)	(2.60)	(2.59)
Adult equivalent	4.78	5.05	5.72	5.21	5.36
	(1.79)	(1.75)	(2.36)	(2.21)	(2.16)
Head's age	45.13	45.68	43.56	44.28	44.42
	(12.43)	(12.21)	(12.65)	(13.93)	(12.78)
Female headed	0.93	0.93	0.92	0.87	0.92
	(0.26)	(0.25)	(0.27)	(0.34)	(0.28)
Expenditure per capita	884.82	978.74	809.24	647.55	832.51
	(429.75)	(521.81)	(469.30)	(504.24)	(500.72)
Observation (N)[13]	384	433	408	481	1706

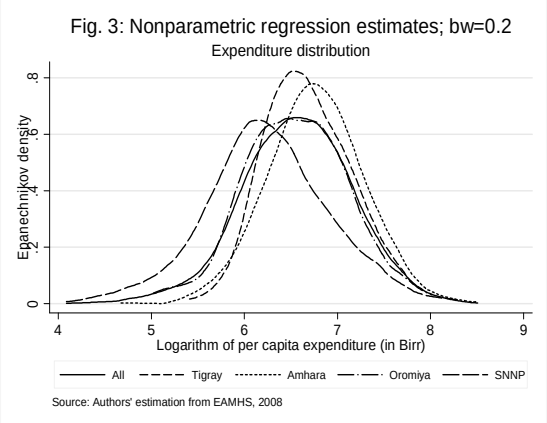
Source: Authors' calculations based on EAMHS, 2008
Note: Figures under parenthesis are standard deviation

Food accounts for the largest share (64.2 percent) of household budget; about 70 percent in Amhara and Tigray; and 60 percent in Oromiya and 64 percent in SNNP (Table 2). Food budget has increased by about 3 percentage points in 2007/08, as compared with 1999/00[14]. The recent double digit inflation rate in food prices could be the plausible reason for increase in the food budget share in recent years.

Food budget shares at each point of logarithmic of per capita consumption expenditure are presented in Fig.4. The curves are sloping downwards, reflecting the share of food in

[13] 1 observation dropped because it has no information on consumption data
[14] While food budget share was 61.1 per cent in 2000, the share of *teff*, maize, wheat, sorghum and barley account for 11.7 per cent, 12.8 per cent, 6.5 per cent 7.9 per cent and 4.9 per cent, respectively (see Loening and Oseni, 2007).

total budget declines as living standards rise although there are some disparities among regions. The poorest households spend more than 70 percent of their budget on food while the middle income households about 60 percent for a wide range of per capita expenditure. Household with higher per capita expenditure spend about 45-55 percent of their budget on food. In Tigray, it accounts for more than 70 percent of total expenditure at any level of per capita expenditure; rising food prices could have an adverse effect on rural net buyer households in the region. In Amhara, the poorest and middle level households spent about 70 percent on food. However, the share sharply declines with higher level of per capita expenditure. In Oromiya, food budget share ranges between 65 percent (for the poor) and 60 percent (for middle and higher level of per capita expenditure). In SNNP, it accounts for about 65 percent of the budget for a wide range of per capita expenditure but sharply declines for higher per capita expenditure.



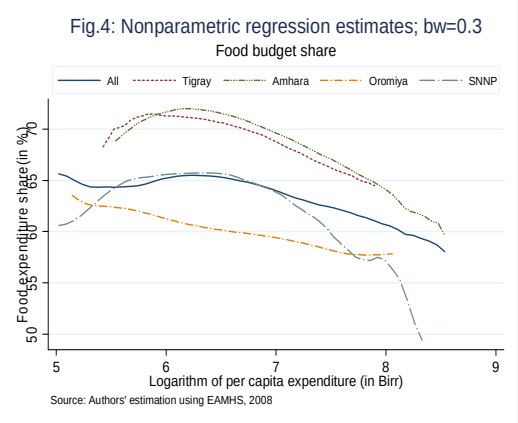


Table 2: Household food budget expenditure share by regions and expenditure quintiles (in %)

		Regions				Expenditure quintiles				
	All	Tigray	Amhara	Oromiya	SNNP	Q1	Q2	Q3	Q4	Q5
Total food expenditure	64.2	69.4	69.8	60.1	63.9	64.2	66.2	65.8	63.3	61.7
Cereals	47.6	64.9	49.7	48.9	33.6	47.8	49.6	49.4	47.8	43.5
Teff	11.6	14.9	14.8	11.3	6.2	8.6	9.6	12.4	13.4	13.6
Barely	4.4	12.3	5.9	2.8	2.4	3.8	4.0	5.0	4.6	4.5
Wheat	7.1	12.6	7.6	6.4	5.4	5.6	6.0	7.6	7.9	8.0
Maize	15.1	4.8	9.3	20.2	15.9	21.4	18.5	14.5	12.1	9.6
Sorghum	6.9	17.2	7.1	6.9	2.2	6.4	8.9	7.1	6.9	5.4
Millet	1.7	3.0	4.2	0.6	0.2	0.9	1.6	2.2	2.2	1.7
grain products	0.8	0.1	0.8	0.7	1.3	1.1	1.0	0.6	0.7	0.7
Pulses	8.5	7.9	10.4	6.8	10.6	8.1	8.1	9.2	8.6	9.2
Faba/horse bean	3.5	2.4	5.2	2.7	3.6	3.1	3.4	3.9	3.5	3.8
Field pea	1.5	2.3	1.1	1.2	2.2	1	1.7	1.6	1.3	1.8
Haricot beans	1.3	0.5	0.4	1.3	3.0	2.7	1.2	1.4	0.8	0.6
Chick peas	0.9	0.7	2.1	0.4	0.7	0.3	0.5	0.9	1.6	1.3
Lentils	0.6	0.8	0.6	0.6	0.9	0.3	0.5	0.6	0.8	1.1
Vetch	0.6	1.1	0.9	0.4	0.1	0.4	0.6	0.6	0.6	0.6
Other pulses	0.1	0.1	0.1	0.2	0.1	0.3	0.2	0.2	0.0	0.0
Root crops	7.3	0.6	3.6	5.9	19.5	11	7.4	6.4	7.3	4.8
Enset	4.3	0.0	0.0	4.6	12.2	6.5	4.5	3.4	4.6	2.7
Other root crops	3.0	0.6	3.6	1.3	7.3	4.5	2.9	3.0	2.7	2.1
Fruits &vegetables	8.6	8.4	8.7	8.2	9.6	8.5	8.7	7.9	8.7	9.3
Animals product	12.1	6.0	8.7	13.8	15.7	10.6	10.9	11	12.3	15.9
Beef/chicken/eggs	5.9	4.3	6.1	5.9	6.2	4.9	4.7	4.9	6.0	8.9
Butter/milk/cheese	6.2	1.7	2.6	7.9	9.5	5.7	6.2	6.1	6.2	7.0
Other foods	15.7	12.2	18.9	16.4	11.1	14.1	15.5	16.1	15.5	17.5
Cooking oil	3.6	2.7	4.6	3.7	2.4	2.5	3.3	3.7	3.5	4.9
Coffee/tea	4.2	5.1	6.4	3.2	2.9	3.1	3.9	4.3	4.3	5.4
Others	7.9	4.4	7.9	9.5	5.8	8.5	8.3	8.1	7.7	7.2

Source: Authors' calculation from EAMHS, 2008

Cereals (*teff*, maize, wheat, barley and sorghum) are the major staples in Ethiopia that account for about 50 percent of food budget, except in SNNP[15] (Table 2). Among cereals, maize has the lion share (15.1 percent) followed by *teff* (11.6 percent), wheat (7.1 percent) and sorghum (6.9 percent), respectively. While maize is the most important items in Oromiya, as does *teff* in Amhara and sorghum in Tigray (Table 2). In SNNP, root

[15] In SNNP permanent crop, *enset*, supplements cereals

crops, particularly *esnset*[16], dominates in the food budget (19.5 percent); maize is the second important items in SNNP. Pulses supplement main dish (cereal consumption) in Ethiopia[17]. It accounts for about 9 percent of food budget; about 11 percent in Amhara and SNNP, 8 percent in Tigray and 7 percent in Oromiya. While fruit & vegetable shares about 8.2 to 9.6 percent, animals product accounts for about 12.1 percent; higher in SNNP (15.7%) and Oromiya (about 14%). "O*thers foods*" including cooking oil, coffee/tea accounts for 11 to 20 percent.

Table 2 also presents consumption pattern by expenditure quintiles. Cereal consumption share mount in each quintile. The share, however, eventually increase from 48 percent in the lower quintile (1st quintile) to about 50 percent in the middle quintile before declines to about 43 percent in the higher quintile (5th quintile). Maize is important cereal in the lower quintile as *teff* does for higher income quintile (Table 2). Since cereal are the most important dietary for almost all rural households in Ethiopia, the remainder of this section focuses on consumption pattern of these crops (maize, *teff*, wheat, barley and sorghum).

More than three-fourths of rural households consume maize and about a third purchase on the market to satisfy consumption shortfall of production (Table 3). Maize consumer are as high as 90.7 percent in SNNP, 83.4 percent in Oromiya and 63.7 percent in Amhara (Table 3). The higher proportions of maize consumers presumably stemmed

[16] *Enset*, "false banana", is an important staple food in Ethiopia's southern and southwestern highlands. It produces large quantities of starch in its underground rhizome and an above-ground stem that can reach a height of several meters.

[17] Pulses are used primarily for making *wot*, an Ethiopian stew, which is sometimes served as a main dish

from consumption shift stimulated by soaring grain prices (maize is relatively cheaper than, for instance, *teff* and wheat[18]). Households who purchased maize were as high as 53. 4 percent in SNNP and 40 percent in Oromiya, compared with 8.8 percent in Amhara and 20.6 percent in Tigray.

Maize consumers decline across expenditure quintiles; about 83 percent in lowest quintile and 73 percent in highest quintile (Table 3). Moreover, about 50 percent of households in the lowest income quintile purchase maize as compared to only 20 percent in the highest quintile (Table 3).

The kernel density estimates have shown that maize budget share[19] in the lowest quintile are significantly greater than the share in the highest quintile; households in the lower quintile spend about 25 percent of budget on maize consumption, as compared with only 5 percent in the highest quintile (Fig. 5). At any point of per capita total expenditure, maize budget share in Oromiya is higher than in SNNP which in turn higher than in Tigray and Amhara. In Amhara and Tigray, it is not varied for a wide range of per capita total expenditure and accounts for less than 10 percent.

[18]Grain price assessment report, October 2008, observed consumption shift from *teff* and wheat to maize even in places where it was not formerly preferred options.

[19] Here, the budget share is computed in total consumption expenditure unlike in total food expenditure of previous discussion

Table 3: Proportion of households consuming major cereals: maize, *teff*, wheat, sorghum and barely

	Maize			*Teff*			Wheat			Sorghum			Barley		
	Purchase	Own harvest	Total	Purchase	Own harvest	Total	Purchase	Own harvest	Total	Purchase	Own harvest	Total	Purchase	Own harvest	Total
All	32.2	61.5	75.9	19.1	56.5	69.9	18.8	37.4	53.5	16.5	29.6	40.4	18.0	32.3	46.6
Tigray	20.4	26.7	43.0	10.7	67.6	73.5	18.6	58.5	66.6	25.6	60.4	76.8	12.4	56.7	62.4
Amhara	8.8	58.1	63.7	16.8	67.5	82.3	11.8	45.0	55.7	8.6	25.4	31.1	17.5	48.3	63.0
Oromiya	40.0	67.8	83.4	20.0	52.9	64.2	19.4	33.7	51.7	21.7	32.0	45.4	19.5	22.2	37.7
SNNP	53.5	66.8	90.7	24.0	43.6	63.3	28.0	25.6	48.7	11.6	16.3	26.3	17.8	22.0	36.1
Exp. Quin.															
Lowest	50.2	61.8	82.5	12.6	40.1	49.4	16.2	25.1	38.0	23.6	25.7	41.1	13.9	25.3	34.5
Q2	39.7	64.6	79.1	21.3	47.5	60.9	23.8	31.3	52.8	19.6	31.6	42.7	20.2	28.9	42.9
Q3	28.9	55.7	69.2	24.2	56.2	72.7	18.2	39.2	53.7	17.6	29.3	40.7	14.5	37.1	49.9
Q4	24.4	64.4	75.6	21.4	63.2	79.3	22.1	38.2	57.5	13.0	33.2	42.6	22.6	33.4	51.2
Highest	19.3	60.8	73.4	15.8	75.5	87.1	13.9	53.4	65.5	8.5	28.1	35.0	19.0	36.9	54.2

Source: Authors' calculation from EAHMS, 2008

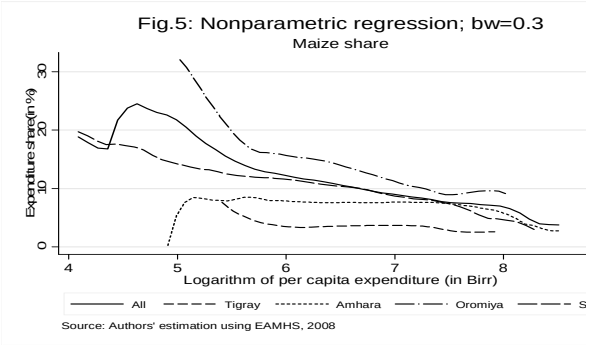
Teff[20] is the second most important items in rural areas (first choice for urban centers and better-off rural households). It is primarily used for making prestigious Ethiopian dish, *injera,* most commonly consumed in the highland areas as well as urban centers. The preference of consumers for best quality *injera* making has led *teff* being in high demand. About 70 percent of sample households consume *teff*; 82 percent in Amhara, 74 percent in Tigray and about 65 percent in Oromiya and SNNP (Table 3). About 20 percent purchase *teff* either for consumption short-fall of production or for their consumption preferences; selling other crops and buying *teff*.

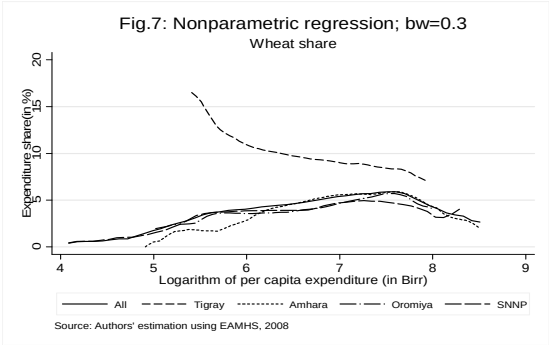
In contrast to maize, *teff* consumers has increased with expenditure quintile; about 50 percent in the lowest quintile, compared with about 90 percent in the highest quintile (Table 3). Larger proportions of households in the middle quintile do purchase *teff* for

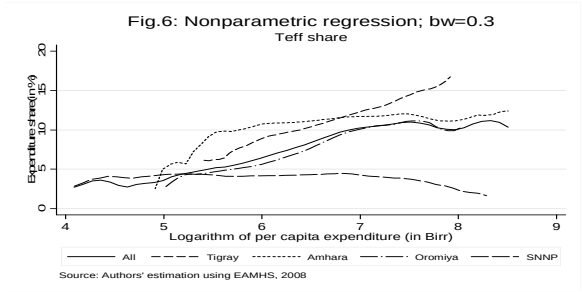
[20] It is indigenous crop to Ethiopia

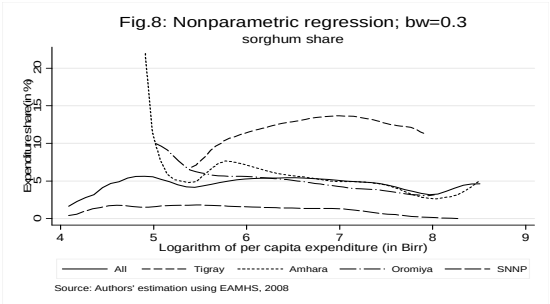
consumption than households in the lowest and highest quintiles; a higher price of *teff* could adversely affects households in the middle income groups. The poor households more likely produce *teff* for the market than consumption, to comply with their cash obligation as *teff* fetches relatively better prices, even in the domestic markets than other cereals grown in the country.

The kernel density estimates have shown that *teff* budget share monotonically increases with level of per capita consumption expenditure except in SNNP (Fig.6). The budget share of households in the highest quintile accounts for 10-20 percent, as compared with less than 5 percent for the lowest quintile. In Amhara, middle income households spend more on *teff* consumption than households of the same income brackets in the other regions. The general trends (without looking at the production side) have shown that rising *teff* prices would benefit more of poor net seller households, as they consume less, while may have an adverse effect on richest net buyers households. However, the economies of scale limit households in the lower quintile to produce larger volume for the markets as compared with richer households. In effect, rising *teff* prices could possibly benefit more of richer net sellers than the poor net seller households.









Wheat is the third most important items in the rural areas and consumed by more than 50 percent of sampled households; 67 percent in Tigray, 56 percent in Amhara and about 50 percent in Oromiya and SNNP (Table 3). As for maize and *teff*, nearly 20 percent of households purchase wheat for consumption. In SNNP, about 30 percent of households purchase wheat; its price increase could adversely affect these households.

Similar to *teff*, wheat consumption share monotonically increases with per capita expenditure but declinces in the highest quintile (Fig. 5). The consumption share of the poorest households in Tigray is significantly higher than other households within the same region or other regions. In general, wheat consumption shares for households in the middle income are higher than the poorest and richest households.

Sorghum is another staple food consumed by about 40 percent of rural households, in general, and by more than three-fourths of households in Tigray (Table 3). It is the first important staple food in Tigray; about a quarter of households purchase sorghum in this region. The proportions of households who purchase sorghum are higher in the lowest two quintiles; increase in the price of sorghum would possible affect poor households, in particular, the poorest households in Tigray. The budget share of sorghum accounts for about 5 percent at any level of per capita consumption expenditure (Fig.8). In Tigray, it accounts for 10-15 percent and increase along with per capita consumption expenditure. In Amhara and Oromiya, the share is declining across consumption quintiles. Barley is another cereals used in the highland of Ethiopia. Barley accounts for about 47 percent; 63 percent in Amhara and Tigray and about 37 percent in oromiya and SNNP (Table 3).

4.2 Households production patterns

Similar to consumption, cereal production income is relatively low in SNNP (Table 4). Among expenditure quintiles, households growing cereals (except maize and sorghum) and income from cereal production (including maize and sorghum) increased with expenditure quintiles; average income for the richest households are five (three) times higher than average income of poorest households for sample households (households with positive income).

Maize growers are noticeable higher than other crops as it is the first important staple crop in rural areas. However, average income from maize is less than that of *teff* as the latter fetches better prices in the market. In Oromiya and SNNP, more than 70 percent of

households are growing maize due to favorable weather conditions (for growing maize) of the regions. The larger producers in Oromiya can also be partly explained due to Agricultural Research Centers (Bako, Debrezeit and Ambo which mainly focuses on maize research) are found in the region. In this region, average income of maize from production was about Birr 682 (for the population[21]) and about Birr 965 (for positive producers). Households in Amhara also earned better income from maize production, second to Oromiya. In SNNP, although about 73 percent of households are producing maize, the income earned is limited to only Birr 400 and Birr 500 for the population and positive producers, respectively.

Teff is the most resilient cereal that grows in diverse agro-climatic conditions with a low risk of failure (Tefera *et al.*, 2003). It is, however, a very delicate and fragile crop that requires a lot of work and care. On average, about 53 percent of households are growing *teff* (Table 4). Average incomes of positive producers are twice higher than that of the population. In Tigray and Oromiya, about 60 percent of households are growing *teff* and positive producers, on average, earn about Birr 1,000. *Teff* producing households in the highest quintile are significantly greater than that of households in poorest quintile; and also income of richest groups are almost three times higher than income for households in the lowest income brackets.

Wheat is grown primarily as highland rain-fed crop in Ethiopia. Over 34 percent of households are growing wheat; higher in Tigray (55%) and for households in the highest quintile (48%). While wheat production earns income, on average, about Birr

[21]Population refers to the whole sample

255 for the population, it mounts to Birr 730 for positive producers. Positive producer in highest quintile earned more than a thousand Birr. Wheat production more benefits households in Amhara and Tigray followed by households in Oromiya.

Table 4 also presents production patterns for other crops. About 40 percent of households are growing sorghum in Tigray, compared with only a quarter of households at rural level. Barely is grown by about 30 percent at rural level and by about 50 percent of households in Tigray. The estimated average value of barely production is remarkably high for households in Tigray, particularly for those in the highest quintile.

Fig.9-Fig.12 present the kernel density estimates for household producing four major cereals. In order to predict the probability of households producing, we defined households producing using a dichotomous indicator that is unity for producers and zero for non-producers. Moreover, in order to estimate the probability of surplus producers, conditioning on being producers, we also defined another dichotomous indicator that is unity for households whose value of production is greater than consumption and zero for others. If we focus on the general pattern (ignore extreme values), the probability of *teff* and wheat production increased with level of per capita consumption expenditure (Fig.10 and Fig.11). In contrast, the probabilities of maize and sorghum production increased in the lowest two quintiles although it starts to decline then after and remain constant for wide ranges of per capita consumption expenditure (Fig.9 and Fig.12)[22]. The probabilities of being surplus producers are an increasing function of the logarithmic of per capita expenditure in most of the cases. In other words,

[22] Almost similar patterns were observed across regions for both probability of producing and surplus production; interested readers can find the result from authors'.

the benefits of rising cereal prices are higher among richer households; except for sorghum where middle income households seem to benefit more.

5 Simulating Welfare Impacts of Rising Cereal Prices

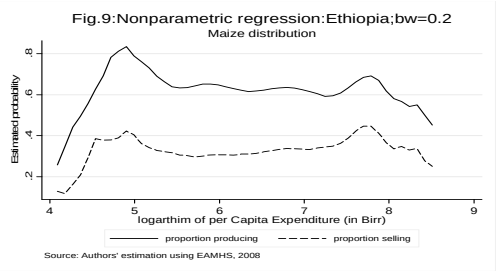
In this section we turned to examine welfare impact of rising cereals prices. Exploring the welfare impact of rising prices on rural households require a sound understanding of households net marketing positions (Deaton, 1989; Budd, 1993; Barrett and Dorosh, 1996; Minot and Goletti, 2000). Household's net marketing position could be defined through the relation between cereal production (income) and consumption share in the total household expenditure or by considering sales, purchase and available grains in the stocks. We adopted the former approach which is more robust for this survey as none of farmers surveyed have any grains in stock after 12 months of *Meher* harvest (see Minot *et al.*, 2008). Moreover, the survey data doesn't report sales from the year 2007/08 production year[23]. While production share is the value of cereals production as percentage of total consumption expenditure, consumption share is the value of cereal consumption as percentage of total consumption expenditure. Accordingly, households are net cereal sellers or buyers if income share outshines its budget share or vice-versa. Households whose income share approximately equal to its budget share are called zero net marketing position in cereals consumption (autarkic).

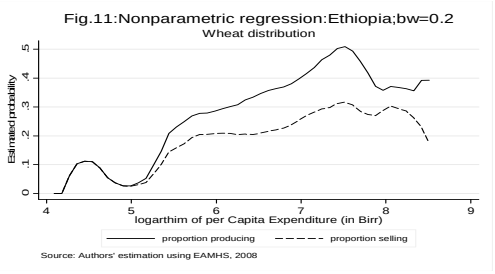
[23] The survey data report sales only from the year 2006/07

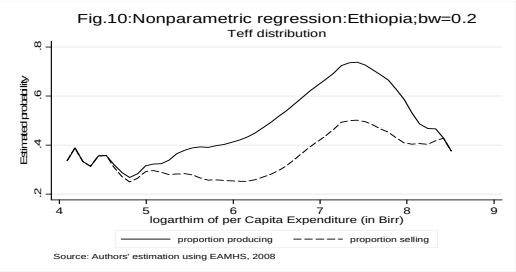
Table 4: Percentage of households producing and income from cereals by regions and expenditure quintile

	% HH with Maize income	Average income for all HH	Average income for households with positive income	% HH with *teff* income	Average income for all HH	Average income for households with positive income	% HH with Wheat income	Average income for all HH	Average income for households with positive income	% HH with Sorghum income	Average income for all HH	Average income for households with positive income	% HH with Barley income	Average income for all HH	Average income for households with positive income
All	63.1	526.72	835.04	53.8	554.17	1029.94	34.9	254.38	729.76	25.4	236.27	931.01	27.7	147.56	532.97
Tigray	23.6	163.2	692.29	64.3	665.22	1034.34	54.2	347.81	641.76	40.5	582.23	1436.45	50.9	396.68	779.62
Amhara	56.0	471.49	842.13	61.9	854.57	1379.82	39.7	355.52	894.90	21.7	315.82	1455.55	41.2	240.23	583.63
Oromiya	70.6	681.58	965.02	50.8	488.14	960.93	32.0	222.08	694.33	28.8	201.62	699.31	19.0	81.12	426.65
SNNP	73.1	400.64	548.12	44.2	215.38	487.47	25.9	139.36	539.06	15.9	46.86	295.34	18.0	57.44	319.06
Quintile															
Lowest	65.8	347.31	527.72	38.5	205.81	534.7	25.2	134.29	532.42	21.5	66.94	310.70	20.8	79.72	383.27
Q2	61.4	414.74	674.99	44.9	286.24	637.72	30.3	153.69	507.98	29.4	199.9	680.55	24.4	97.78	400.89
Q3	60.9	535.65	879.44	52.7	466.25	884.88	35.8	204.56	570.63	22.4	218.92	976.08	31.0	149.44	481.32
Q4	67.6	688.63	1018.6	60.5	777.58	1286.16	34.8	289.82	833.51	29.5	327.17	1109.33	29.0	163.51	564.39
Highest	59.6	647.6	1086.55	72.6	1036.58	1428.43	48.2	490.37	1016.55	24.1	368.94	1533.72	33.2	247.64	745.21

Source: Authors' calculation from EAMHS, 2008







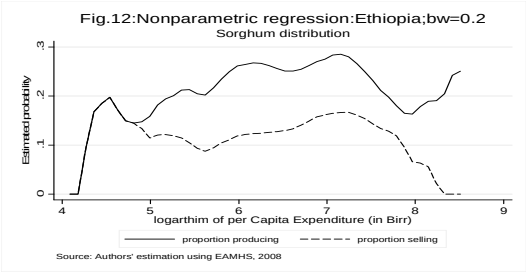


Table 5 presents cereal income and budget share as well as the Net Benefit Ratio (NBR) (cereal income share minus its budget share). Cereals production, on average, is equivalent to 35.9 percent of total consumption expenditure, while the mean budget share is 32.9[24] percent; implying that NBR is 3.0. Thus, in a short- run, a hypothetical 10 percent increase in cereal prices would raise rural farmers real income, on average, by about 0.3 percent. The long-run impact (with wage responses) slightly increased to 0.39 percent. These benefits are much lower than what estimated by World Bank (2007); 1-2 percent, this could be presumably because of the different dataset, including price data, we used as well as the data coverage. As we stated earlier, World Bank (2007) analysis was based on dataset 7 years prior to soaring food prices.

[24] Cereals budget share reported here is somewhat less than what we reported before as millet and other grains are not included here.

The share of cereal production (in the total expenditure) varies across regions; 46.4 percent in Tigray, 40 percent in Amhara, 34 percent in Oromiya and 27 percent in SNNP. Similarly, cereal consumption share varies across regions; 46.8 percent in Tigray, 34.4 percent in Amhara, 33 percent in Oromiya and 23 percent in SNNP (Table 9 columns (2) and (3)). The NBR is positive for Amhara, Oromiya and SNNP whereas negative for Tigray. At aggregate level, while households in Tigray loss from rising cereal prices, households in other regions (with positive NBR) benefit. However, there are regional disparities; in a short-run, a 10 percent increase in prices would raise real income of households in Amhara, SNNP and Oromiya by about 0.55, 0.43 and 0.09 percent, respectively. In the long-run (with wage responses), it slightly improved to 0.64 for households in Amhara, 0.53 percent in SNNP and 0.18 percent in Oromiya. In Tigray, aggregate income of rural households is raised by about 0.08 percent in the long-run (with the wage responses) (Table 5).

Table 5: Grain production, consumption, and net sales position by household groups

	Productio n ratio (PR) (1)	Consumptio n ratio (CR) (2)	Net benefit ratio (NBR) (3)	Net buyers of grain (4)	Zero net position in grain (5)	Net sellers of grain (6)	Welfare gain/loss Without wage response (7)	With wage response (8)
	(Average percentage)			(percentage of households)			(10% increase)	
All	35.90	32.90	3.00	54.32	1.43	44.25	0.30	0.39
Tigray	46.40	46.80	-0.40	58.33	0.29	41.38	-0.04	0.08
Amhara	39.90	34.40	5.50	47.20	1.41	51.39	0.55	0.64
Oromiya	34.00	33.10	0.90	59.03	0.30	40.66	0.09	0.18
SNNP	27.20	22.90	4.30	54.29	1.62	44.09	0.43	0.53
Exp. Quintile								
Lowest	36.1	31.9	4.2	57.46	0.81	41.73	0.42	0.57
Q2	33.7	33.3	0.4	57.12	1.51	41.37	0.04	0.16
Q3	33.3	34.3	-1	63.4	2.54	34.06	-0.1	0.01
Q4	37.4	32.7	4.7	47.87	1.62	50.51	0.47	0.52
Highest	39.1	32.6	6.5	45.74	0.67	53.59	0.65	0.7

Source: Authors' calculations from EAMHS data, 2008

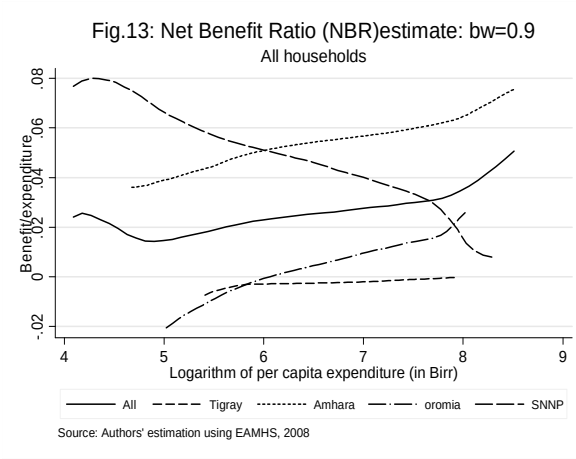
We also observed that while average cereals production share ultimately decrease up to third quintile and sharply increase thereafter, mean consumption shares are almost equally distributed in all quintiles (about a third of total expenditure) (Table 5). The NBR then decreases as we go from the first quintile to the third quintile and plausibly increases thereafter. In a short-run then, a hypothetical 10 percent increase in the prices would raise real income of households in lowest two quintiles by about 0.42 and 0.04 percent, respectively. Similarly, a hypothetical 10 percent increase in prices would raise real income of households in the 4^{th} and 5^{th} quintiles by about 0.47 and 0.65 percent. In contrast, real income of households in third quintile dropped by about 0.1 percent; in a short-run majority of households in third income brackets (middle income groups) hit moderately by rising cereal prices although they will gain in the long-run Table (5 column (8)). Households in the middle income brackets could be more diversifying income sources and hence net buyers of cereals. Further exploring the dataset has revaluated that majority of households in the first quintile (59 percent) are from the SNNP (Table A2). The raise in income for households in the first quintile is then modestly goes to households in SNNP.

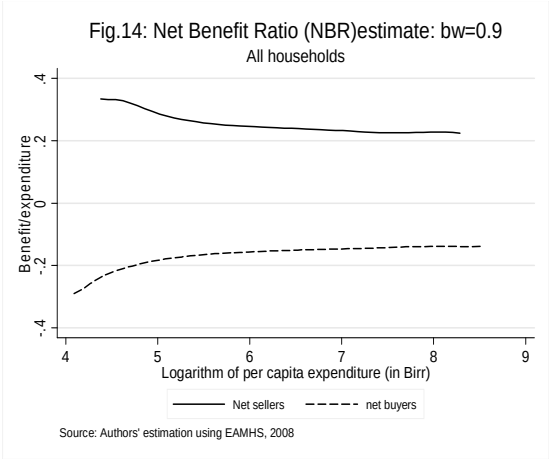
In analyzing welfare impact of rising cereal prices, however, it is essential to examine beyond the rural/regional averages. At aggregate level, although rising food prices benefit rural households, only 44 percent of them are net cereal sellers and majority (54 percent) are net cereal buyers and could be adversely affected by rising cereal prices (Table 9 columns (4)-(6)). Among regions as well as expenditure quintiles, the number of net buyers are more numerous; 60 percent in Oromiya and Tigray and 55 percent in

SNNP region. Among expenditure quintiles, about 57 percent of households in the lowest two quintiles, and 63 percent in the third quintile, and 46-48 percent in the 4th and 5th quintiles are net buyers and adversely affected by rising cereal prices.

Like production and consumption the nonparametric NBR density estimates are also presented at aggregate level as well as by four major crops. At aggregate level, NBR density estimates a long with logarithmic per capita expenditure reflect a positive trend, implying the more benefit that could be obtained with increase in the level of living standards (as measured by per capita total expenditure) (Fig. 13). This is mainly due to the fact that benefit gained by net sellers (44 percent of the households) outweighs loss by majority. The NBR density first fall (as we go from the lowest to middle income) and raise significantly in the 4th and 5th quintiles. It implies that rising cereal prices hit middle income households and tend to benefit the lowest and highest income households. In relative terms, the richer households benefit more than the poor, a 1 percent increase in prices of cereals generates benefit of about 0.05 percent for richest farmers, compared with 0.02 percent for poorest households. Among the regions and by income quintile, while the benefit increases from 0.04 to about 0.08 in Amhara, it falls from 0.08 to nearly 0.01 for households in SNNP (Fig.13). Almost all households in Tigray and poorest households in Oromiya are adversely affected by rising food prices (Fig 13). For richest households in Oromiya, a 1 percent increase in cereal prices would increase real income by about 0.02 percent. The poorest households in SNNP benefit from rising cereal prices than richest one in the region as well as any household in other regions (Fig.13). Poorest households in SNNP more likely consuming root crops,

particularly *enset*, and sells out cereals as it fetches better prices. Nevertheless, with increasing in the living standards (at higher income brackets), they are more likely consuming cereals.



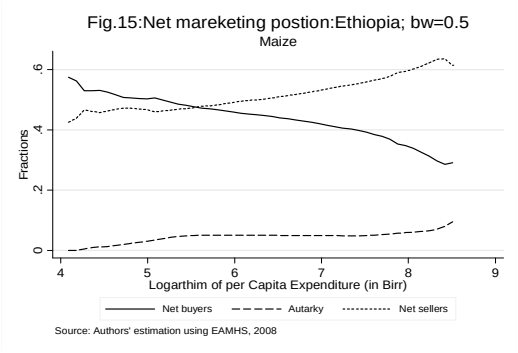


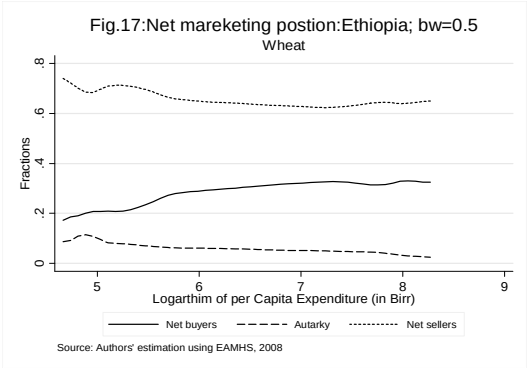
Further disaggregating households by net marketing position has shown that while net sellers benefits from rising cereal prices by about 0.2- 0.3 percent, net buyers lose by about 0.1-0.2 percent (Fig.14). Moreover, aggregate benefits (loose) of the poorest households are higher than richest once.

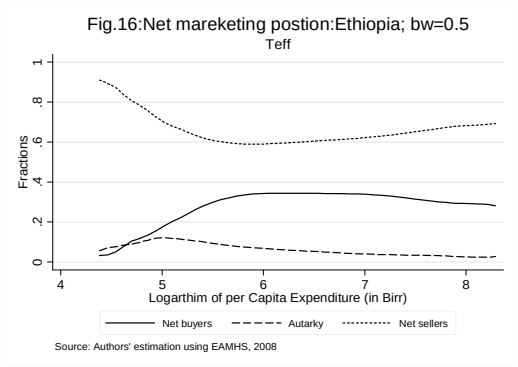
As a relative importance of cereal components are essential for policy making, the remaining discussions will focus on specific crop(s). We began our discussion with exploring net marketing positions of households by major cereals. The proportion of net sellers, net buyers and autarky households with respect to major cereals are presented in (Fig.15- Fig.18); the three proportions should be added to one. The general patterns are somewhat varied for poorest households but almost similar for richest and middle income households. More than 85 percent of poorest households are net sellers of *teff*, compared with almost negligible net buyers of *teff* in the same income groups (Fig. 15).

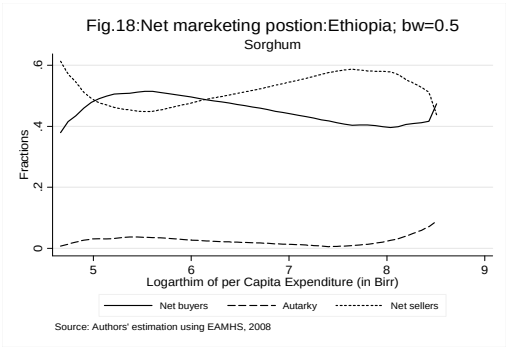
The proportions of net buyers, along logarithmic of per capita expenditure, gradually increase but not vary much beyond certain limit. Nearly 60 percent of middle income and about 70 percent of highest households are net sellers. Moreover, as we have seen earlier *teff* budget share of poorest households not exceeded 5 percent which in turn implies that poorest households are producing *teff* mainly for market than consumption. An increase in prices of *teff* could then raise real income of poorest households. However, as we have stated earlier, the poor household may be disadvantaged by economies of scale, compared with richest or middle income groups.

More than three-fourth of poorest households and nearly 60 percent of middle and highest income households are net sellers of wheat (Fig.16). Increases in prices of wheat equally benefit all households although middle income group losses (larger proportions of middle income households are net buyers of wheat). Poorest households hit by rising prices of maize as numerous of them are net buyers than net sellers. In contrary, middle and high income groups benefit from rising maize prices (Fig 17). While poorest households, middle and high income households gain from rising prices of sorghum, poor households tend to loss (Fig.18).



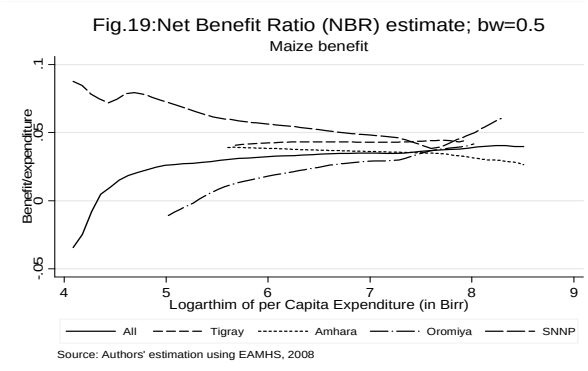


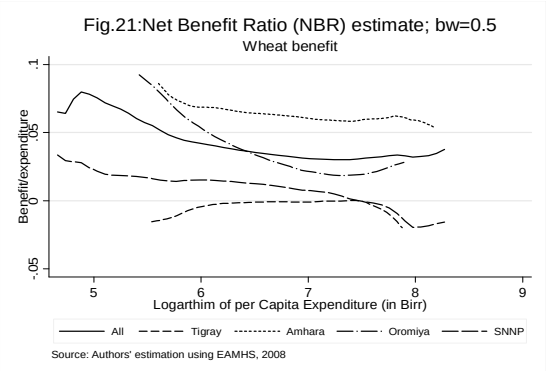


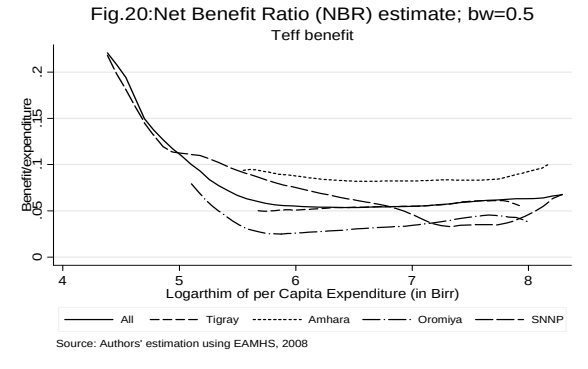


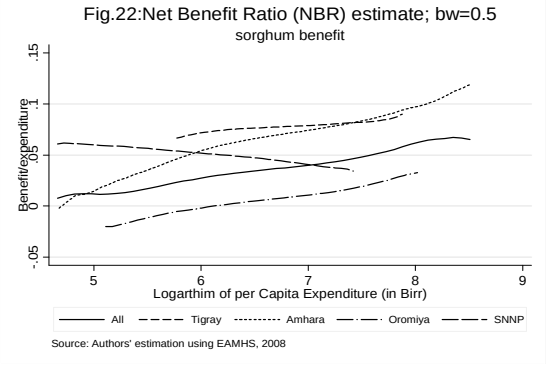
Similar patterns have been observed when we consider the nonparametric NBR analysis. Poorest households are more benefiting from rising prices of *teff* and wheat while richest does from maize and sorghum prices (see Fig.19-22). This result is consistent with Klugman and Loeing (2007) synthesis drawn for rural households in Ethiopia. In contrast, they indicated rising prices of maize could affect households in the higher income. Across region, rising prices of *teff* could benefit more of households in Amhara region. A hypothetical 1 percent increase in price of *teff* could raise real income of poorest and richest households in the region by nearly 0.1 percent; middle income households benefit less. Poorest households in Tigray and higher income households in Oromiya and SNNP benefit from rising price of *teff.*

Rising wheat prices more likely benefit low income households in three of four regions. It is so partly because wheat is often distributed in the form of food aid for the poorest households. Households in SNNP seem to be affected from rising prices of wheat. The net benefit from rising prices of wheat moderately declines in Amhara and Tigray and very sharply in Oromiya. Rising wheat prices tends to affect highest income households in Tigray. Higher prices of maize and sorghum benefit low income households in SNNP and higher income households in other regions. Last but not least, it is also important to consider household perception of their welfare status over the last four years, since the rising of food prices, as it gives insight for the analysis (see Appendix).









6 Conclusions and policy implications

The objectives of the paper are two-fold: (i) examine welfare impact of rising food prices and (ii) possible changes in consumption pattern as of soaring food prices. Food budget share accounts for larger proportion of total expenditure (about 64 percent). It has increased by about 3 percentage points since 2000. The double digit food price inflation magnificently increase food budget share in 2007/08. Maize, *teff*, wheat and sorghum are most important food items in rural areas, in that order. Whilst maize is major staple for the poorest households, *teff* does for the richest one. Nearly half of households reduced their consumption level (less than a quarter improved) between 2003/04 and 2007/08. Increasing prices and productivity was cited as major reasons for improving level of consumption whereas decreasing productivity leads to low level of consumption.

Using Net Benefit Ratio (NBR) analysis and applying parametric and nonparametric estimate, we have shown that at aggregate level the distributional impact of rising cereal prices will benefit households in three of four regions (except in Tigray). Moreover, households in poorest and highest income brackets are benefiting from rising cereal prices while households in middle income group worse-off. However, it is worth to note that benefit gained by few individuals/groups outweigh loose of majority. Indeed, more than half of households are net buyers of cereals and adversely could be affected by rising cereal prices.

Poorest households in Tigray could be benefited from rising prices of *teff*, maize and sorghum and affected by rising prices of wheat. In Oromiya, the poorest households benefit from rising prices of *teff* and wheat whereas adversely affected by rising prices

of maize and sorghum. It seems as if the poorest households shift their consumption preferences from high valued crops such as *teff* and wheat to relatively cheaper once such as maize and sorghum. Since cereals are less likely staple food in SNNP, compared with *enset,* poorest households in the region would benefit from rising cereal prices. Although poorest households benefit from rising prices of *teff* and wheat, they constrained by smallholdings, compared with middle/high income groups.

Promoting agricultural production and productivity through intensive use of modern technologies (fertilizer with improved farm management) are means to cope with rising food prices; to feed themselves as well as for their cash obligation. The study also urges further investigation on consumption dynamics as a given households could be net buyers in one year and net sellers in other year(s). In other words, examining consumption dynamics is also important to understand consumption pattern of households.

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Table A1: Labor and Cereals share of income by region and consumption expenditure quintile

	Labor share	Cereal share
All	9.40	56.30
Tigray	12.90	48.40
Amhara	8.40	60.90
Oromiya	9.60	55.00
SNNP	9.00	56.30
Expenditure quintile		
Lowest	16.70	52.30
Q2	11.50	53.50
Q3	8.70	55.80
Q4	4.80	57.80
Highest	5.90	62.10

Source: Authors' calculation from EAHMs, 2008

Table A2: Sample households by real consumption expenditure quintiles

Quintile	Tigray	Amhara	Oromiya	SNNP	All
Q1	34	36	71	201	342
	(9.94)	(10.53)	(20.76)	(58.77)	(100)
Q2	85	71	80	105	341
	(24.93)	(20.82)	(23.46)	(30.79)	(100)
Q3	103	87	77	74	341
	(30.21)	(25.51)	(22.58)	(21.70)	(100)
Q4	81	117	98	45	341
	(23.75)	(34.31)	(28.74)	(13.20)	(100)
Q5	81	122	82	56	341
	(23.75)	(35.78)	(24.05)	(16.42)	(100)
All	384	433	408	481	1,706
	(22.51)	(25.38)	(23.92)	(28.19)	(100)

Note: Figures under parentheses are percentages
Source: Authors' calculation using EAHMS, 2008

Appendix

During survey period, households appraised perception of their well-being as well as changes in consumption levels over the last four years, prior to the survey period. This could also help us to strengthen our understanding of the impact of rising cereal prices on rural households' welfare. Households well-beings were perceived as big or some improvements, no change, some or big deterioration between 2003/04 and 2007/08. While about 43 percent of sample households perceived as big or some improvements, about 9 percent reported as big deterioration (Table A3). A quarter of households remained in the same status or under some deterioration. While increased in crop prices, better yields and livestock income, in that order, reasoned out for big improvement, decreased in yields with increased crop prices are for big deterioration (see Tables A3 and A4, respectively).

Nearly half of households in Amhara and Oromiya professed big or some improvements in their well-being; it is not changed for about a quarter and big deterioration for 6-8 percent of households. In Tigray, where rising food prices have an adverse but marginal effect, about 42 percent alleged as some deterioration, a third as big or some improvement and a quarter as no changes. A large percentage of households (about 20 percent) in SNNP perceived as big deterioration[25].

[25] Majority of these households are excluded from welfare analysis because of very low level of food consumption.

Table A3: Reasons for improvement in well-being (multiple reasons)

	Tigray	Amhara	Oromiya	SNNP	All
Big improvement					
Increase in crop prices	34.58	26.91	23.26	23.06	24.42
Increase in crop yields	5.65	22.86	16.48	17.56	18.46
Changes in crops grown	19.92	11.80	13.92	16.11	13.56
Change in livestock income	25.57	15.36	17.61	13.13	16.48
Changes in non-farm income	8.62	7.48	14.66	15.81	12.58
Change in health of family members	5.65	15.58	14.07	14.32	14.50
Some improvement					
Increase in crop prices	21.24	25.27	26.62	27.04	25.80
Increase in crop yields	11.16	15.41	14.10	14.89	14.43
Changes in crops grown	14.32	11.38	10.67	14.65	11.73
Change in livestock income	22.40	17.25	19.26	12.86	17.94
Changes in non-farm income	19.98	10.51	14.51	12.39	13.26
Change in health of family members	10.91	20.18	14.85	18.18	16.83

Source: Authors' calculation from EAMHS, 2008

Table A4: Reasons for deterioration in well-being (multiple reasons)

	Tigray	Amhara	Oromiya	SNNP	All
Big deterioration					
Increase in crop prices	7.44	8.76	17.90	30.31	22.76
Decrease in crop yields	28.16	61.90	41.86	24.39	34.87
Changes in crops grown	18.50	10.15	2.97	14.36	11.20
Change in livestock income	24.22	12.44	15.00	9.43	11.93
Changes in non-farm income	7.49	2.40	7.93	9.92	8.09
Change in health of family members	14.18	4.35	14.34	11.59	11.15
Small deterioration					
Increase in crop prices	18.04	11.80	15.27	22.79	17.99
Decrease in crop yields	32.34	36.70	45.88	23.91	33.97
Changes in crops grown	20.45	14.38	9.26	21.73	16.54
Change in livestock income	22.93	18.32	13.10	12.46	15.15
Changes in non-farm income	2.80	11.85	8.64	13.23	10.05
Change in health of family members	3.43	6.95	7.83	5.88	6.29

Source: Authors' calculation from EAMHS, 2008

Households were also notifying changes in their level of food consumption (supplements their well-being perception) between 2003/04 and 2007/08. Consumption has increased for less than a quarter of households in three of four regions and less than 10 percent in SNNP (Table A5). In contrast, it decreased for more than half of households in Tigray and SNNP and about 40 percent in Amhara and Oromiya. A quarter of households in Tigray, about 40 percent or more in Amhara and

Oromiya and a third of households in SNNP maintain no changes in level of consumption.

According to their response, cereals consumption level declined for remarkable households over the years. Household reported decline in cereal consumption ranges 60-68 percent in Tigray, 41-67 percent in SNNP, 32-50 percent in Amhara and 30-40 percent in Oromiya. More importantly, significant households (about 70 percent) reduced *teff* consumption levels in Tigray and SNNP. The figures are about 50 percent in Amhara and about 40 percent in Oromiya. The reduction in *teff* consumption could be explained, among others, by relatively good prices farmers have been receiving from selling out of *teff* than use for consumption. Notice that consumption levels of any cereals increased for less than 1/5 of households and not changed, on average, for about 45 percent of households in any regions.

Households who perceived their well-being as deterioration and/or who consume less and seeking for consumption shortfall are vulnerable for soaring food price. Households who report "no change in consumption" but with increase in family sizes (between 2003/04 and 2007/08) are also vulnerable to surging food prices. Notice also that "no change" for either well-being or consumption rather ambiguous; households may consider their well being as no change possibly because either they are (i) leading better living standards between reference periods (ii) living under poverty in all period and (iii) an improvement in nominal consumption but there is also a proportional increase in family size that neutralize additional consumption or well-being. While households in former group may not be affected, those in latter groups, particularly in second group, are more vulnerable to soaring food prices.

Table A5: Comparison in level of consumption between 2003/04 &2007/08 (in %)

	Small quantity	About the same	Larger quantity	Total
Tigray	56.55	25.99	17.46	100
Teff	68.93	21.04	10.03	100
Wheat	61.96	25.36	12.68	100
Maize	62.55	26.34	11.11	100
Sorghum	57.83	28.75	13.42	100
Pulses	53.91	27.22	18.87	100
Fruits & vegetables	48.08	14.45	37.46	100
Meat	47.75	37.14	15.12	100
Amhara	42.25	37.95	19.8	100
Teff	50.25	30.79	18.97	100
Wheat	40.95	38.87	20.18	100
Maize	32.3	37.08	30.62	100
Sorghum	41.14	39.94	18.92	100
Pulses	44.79	38.54	16.67	100
Fruits & vegetables	44.1	38.76	17.13	100
Meat	41.03	41.96	17.02	100
Oromiya	38.41	45.76	15.84	100
Teff	39.9	44.89	15.21	100
Wheat	35.93	50.5	13.57	100
Maize	39.31	31.93	28.76	100
Sorghum	29.86	55.62	14.52	100
Pulses	33.92	54.36	11.72	100
Fruits & vegetables	37.66	46.88	15.46	100
Meat	51.49	36.32	12.19	100
SNNP	57.1	32.92	9.98	100
Teff	66.52	22.17	11.3	100
Wheat	56.72	35.31	7.97	100
Maize	68.54	17.29	14.17	100
Sorghum	41.23	50.86	7.9	100
Pulses	41.56	51.64	6.8	100
Fruits & vegetables	53.99	34.66	11.34	100
Meat	66.11	24.53	9.36	100

Source: Authors' calculation using EAHMS, 2008

Paper II

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

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Abstract

This paper assesses the welfare impact of rising food price in rural Ethiopia based on Quadratic Almost Ideal Demand System (QUAIDS) approach, followed by estimation of Compensated Variations (CV) which explicitly accounts for profit function and substitution effects. The results, based on the Ethiopia Rural Household Survey (ERHS) panel data that captures the low price period of 1994-2004 as well the high price year 2009, show that high food prices in recent years (between 2004 and 2009) increased the aggregated welfare gains of rural household by about 10.5 percent, compared to less than 1 percent during the period 1994 to 2004. The welfare gains further improved to 18 percent (high price period) with substitution effects, compared to 7.2 percent (low price period). Nevertheless, the gains from price increase were not evenly distributed among rural households: about 48 percent and 56 percent of sample households were net cereal buyers during the low price and high price period, respectively. The net buyers could be diversifying income sources to pluses, fruits & vegetables, animal products as well as off-farm activities to mitigate the impact of high food prices; the average income from wage and transfer, for instance, 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, benefiting net buyers. Meanwhile, many current net buyers could become net sellers if grain prices are stable and favorable and if productive inputs are made available and affordable.

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

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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; milkpowder 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 period, the price of maize increased by 74 percent; wheat by 84 percent; sugar by 77 percent and oils & fats by 57 percent. In the 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 millions of people into hunger and poverty, created global crisis, caused political and economic 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 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[26].

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 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 using the nonparametric Net Benefit Ratio (NBR) analysis (see Loening and Oseni, 2007; Kulgman and Leoning, 2007; World Bank, 2007; Tefera et al. 2009). Loenining and Oseni (2007), based on data from the 2000 Welfare Monitoring and the Household Income and Consumption Expenditure Survey (WMS/HICES), have estimated that 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

[26] 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.

NBR analysis, have shown that higher cereal prices have positive impact on aggregate welfare of rural household albeit majority (about 56%) of them are net cereal buyers.

The NBR analysis, which measures the elasticity 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. For instance, teff producers households in Ethiopia, for almost equal levels of quantity demanded of either teff or maize, are more likely sell out teff at higher price (for better revenue) and instead buy maize for consumption at lower price (lower cost) and hence will be better-off in terms of welfare, provided that they are indifferent between consumption of teff and maize. Moreover, Kulgman and Leoning (2007) pointed out that given the simultaneous production and consumption decisions of rural households, measuring welfare impacts of higher prices are challenging and needs further investigation in Ethiopia.

This paper investigates the welfare impacts of rising food prices in rural Ethiopia using Quadratic Almost Ideal demand Systems (QUAIDS) approach, followed by computing Compensated Variation (CV) that takes into accounts the profit and substitution effects. The study is based on the Ethiopia Rural Household Survey (ERHS) panel in four waves surveyed in 1994, 1999, 2004 and 2009. The ERHS data is more appropriate for analysis as it has information for the periods of both low and high food prices. The QUAIDS are estimated controlling for expenditure endogeneity and censoring for selection bias due to observed zero consumption. The results have shown that controlling for such factors improve significance of the expenditure parameters.

To the best of our knowledge most of the previous demand studies in Ethiopia, with the exception of Tafere et al. (2010) and Alem (2011)[27], 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 has found that income and price elasticities, in particular income elasticities, have increased (in absolute terms) in the period of high prices, as compared to low prices. The estimated elasticities are used to compute CV which explicitly accounts for profit and substitution effects. The CV results have shown that higher food prices (between 2004 and 2009) increased the aggregated welfare gains of rural households by about 10.5 percent, compared to less than 1 percent 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). Nevertheless, the benefits are unlikely to be equally distributed among rural households: about 48 percent and 56 percent of sample households were net cereal buyers during low price and high price period, respectively.

The reminder 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 4 and section 5 concludes.

[27] 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.

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 the utility-based demand models. They, however, imposed theoretical restrictions that are not flexible. In the 1970's researchers 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 (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.[28] Moreover, it allows a linear approximation at estimation stage and has budget shares as dependent variables and logarithm of prices and real

[28]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)

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. 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:

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

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.

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

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

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

where i= 1, ... , n represent commodities

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

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

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. Better parameters are estimated with inclusion of socio-demographic

factors in the demand system (Dhar *et al.*, 2003; Mazzocchi, 2003; Akbay *et al.*, 2007). Household demographic factors can be incorporated (in the demand model) using demographic transition method[29] (Pollak and Wales, 1981; Heien and Wessells, 1990). The QUAIDS can then be modeled 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 modeled in the following system of demand equations with limited dependent variables

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

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

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 otherwise; and w_i^* and d_i^* are the corresponding unobserved (latent) variables, x_i are

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

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 that 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;

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

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:

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

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 $\ln p_j$, such that

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

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

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:

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

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:

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

The 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 consumer 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):

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

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 behavioral 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 behavior (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[30] 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 to15 villages so as to cover the main agro-climatic zones and main farming systems in the country. The sample households were randomly selected from each village or Peasant Association (PA) through stratification techniques in order to have a

[30]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 forInternational 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.

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[31], with only 12.4 percent between 1994 and 2004 (or 1.3 percent 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

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

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 78 percent) in each period (Table 1). Food budget share of households in low income group34F[32] is greater than high income group by about two percentage points. Food consumption 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 and2009 (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[33]	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

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

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

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.

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*36F[34]. More importantly, *teff* consumption is important for households in high income group as maize and roots crop does 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.

[34] 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.

Pluses and animal products as well as fruits & vegetable 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).

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 200937F[35]. 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 percent) 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 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 percent. 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).

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

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 selections bias due to the 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).

Table 5: Expenditure elasticity for sample households and by income groups

	All HH	All HH	All HH	Income groups (1994-2009)		
	1994-2009	1994-2004	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

Table 6: 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 A3 and A5 report 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 percent 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	All HH	All HH	Income groups (1994-2009)		
	1994-2009	1994-2004	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	All HH	All HH	Income groups (1994-2009)		
	1994-2009	1994-2004	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 Table 9 as well as in Table A4 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 own-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 percent between 1994 and 2004 and about 17 percent 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 10.9 percent 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 impact rising real prices

	All	Income groups		
		Low	Middle	High
	Welfare impacts of change in real prices 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)**
	Welfare impacts of change in real prices 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 percent; 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 percent for low income, 23.9 percent for middle income and about 21.0 percent of high income group. We also compute welfare impacts of rising food prices by survey villages. For the period of 1994-2004, households residing in more vulnerable areas such as Haressaw and Gablen villages from Tigray region, Shumisha village from Amhara region and Adado from SNNP region, on average, are loser while households in less vulnerable villages are gainers (Table A9).

Although rising in food prices results in welfare gains for rural households at aggregate level, the benefits are not equally distributed among rural households, as about 48 percent of sample households were net buyers of five major cereals (*teff*, barley, wheat, maize and sorghum) even before soaring food prices and are remarkably increased to about 55.9 percent in 2009 (Table 10). These households could be adversely affected by food price hikes unless compensated through diversifying income sources to off-farm activities. We have 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 percent and 25 percent, respectively (Table 11). In contrast, average income obtained from self-employment decreased by about 40 percent.

Table 10: 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 11: 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 Conclusions 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 as the2004-2009. 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 1-2 percent, with the

exception of animal product that rose by 30 percent; results in aggregated welfare gains of rural households by about 1 percent. The welfare gain further improved to 7.2 percent as we controlled for substitution effects; 3.1 percent for low and middle income and about 10.9 percent for high income groups. Between 2004 and 2009, the real food commodities prices 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 18 percent 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 are not equally distributed among rural households as about 48 percent were net cereal buyers even before soaring food prices and were remarkably increased to about 55.9 percent after soaring food prices. These households could be adversely affected by food price hikes unless compensated through diversifying income sources to off-farm activities. we have explored income derived from off-farm activities such as wage and self-employment employment as well as transfer income household received. Between 2004 and 2009, the average income derived from wage and transfer increased by 130 and 25 percent respectively. In contrast, average income derived from self-employment decreased by about 40 percent. Increase in wage and transfer income may

not be satisfactory to combat the impacts of soaring food prices for the poor net buyer households. 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 indispensible. 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's 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 percent. The large increase in the cost of fertilizer may possibly reverse welfare gains to the rural households. More importantly, fertilizer cost 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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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, tikil gomen, 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 1994-2009	All HH 1994-2004	All HH 2009	Income groups (1994-2009) 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& vegetables	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)**
Sirbana Godeti	-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)**
Trirufe Ketchema	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)**
Aze debo	-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)**
Gara Godo	-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 percent 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-attritors households have higher family size, headed by male 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 percent 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-marriage and 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 (in km)	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

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

Paper III

Rural Household Resilience to Food Insecurity in Ethiopia: Panel Data Evidence

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Abstract

This study investigates household resilience to food insecurity based on the Ethiopia Rural Household Survey (ERHS) panel dataset collected in six waves, between 1994 and 2004. Resilience scores were estimated using principal component approach using selected variables that capture household capacity to cope with short, medium and long-term shocks in typical mixed farming conditions of Ethiopia. These variables included amount of grain in stock, precautionary savings/investment (animals kept for sale or replacement), investment in child education and participation in traditional risk sharing arrangement (*idir*). This is followed by identifying factors influencing the resilience scores. Using dynamic probit random effect model which accounts for lagged resilience, the study has shown that there is a true state-dependence on the dynamics of household resilience to food insecurity, i.e. the current level of household resilience depends on the past level of resilience. The results have also demonstrated that household resilience to food insecurity is significantly and positively correlated with ownership of major assets such as land under cultivation, number oxen, milking cows and transport animals, adoption of improved technologies, membership in traditional saving and credit association. In contrast, we found that short-term loans from informal sources and food assistance have negative impact on household resilience in the long-run although both variables have a positive impact in the short-run. The paper concludes that agricultural and rural development policies that facilitate access to productive assets, promote intensification, ensure commercialization and formation of social capital have a more sustainable and significant impact on resilience.

Keywords: resilience; food Insecurity; panel data; rural Ethiopia

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We would like to thank Luca Alinovi, professor Donato Romano, Professor Enrica Chiapero Martinnet, Simon Levine, Sara Pantuliano, Erdgin Mane, Marco Knowles, Gustavo Anriquez, Marco D'Errco and the participants at the workshop on "Resilience to Food Insecurity: Theory, Methods, and Applications", November 18, 2011,FAO HQ-Rome, for the very useful comments and suggestions. The views expressed in this paper are entirely those of the authors. The Authors gratefully acknowledge the financial supports from Italy government through Catholic University, and EC-FAO Food Security Information System for Decision Making Programme.

1 Introduction

Resilience is relatively a new concept and is basically the opposite of vulnerability[36]. While vulnerability determines the extent to which individuals or a community will potentially suffer from shock events, resilience refers to how individuals or communities function in ways that enable them not only to cope with added shocks and stresses but also address numerous challenges. Resilience refers to the capacity of households not only to absorb shocks but also learn from past events, and ensure food security at times of disastrous events. Resilience to food insecurity is about risk management and insurance to meet food consumption requirements at all times.

Rural households in Ethiopia are prone to drought and their survival depends on their resilience capacity. Household resilience to shocks depends on their asset positions and livelihoods strategies. Among the common strategies of ensuring resilience in rural Ethiopia are building food grain stocks, investing in precautionary saving/assets, enhancing social capital and educating children. Households with no adequate coping strategy of own often depend on food aid and support from friends and relatives.

Only few studies in Ethiopia have applied the concept of resilience in the assessment of rural livelihoods. Frankenberger *et al.* (2007), using qualitative information obtained through rapid rural appraisal, showed that households who were able to cope with shocks that regularly plagues the community are characterized by several factors, including diversification of income sources, savings and investment, good work ethic, access to food year round and place value on education, among others. However, the

[36]Food Security Policy Group Discussion Paper, Pathways to Resilience: Smallholder Farmers and the Future of Agriculture, November 2008. In contrast, others defines vulnerability as a function of resilience

study is based on perception of a few individuals and community elders at one particular period.

The major objective of this study is to investigate the resilience of rural households in Ethiopia using panel survey data in six waves over the period 1994 to 2004. Specifically, the study attempts to: (i) construct multidimensional household resilience index, (ii) compare and contrast resilience scores across surveyed years and villages, and (iii) investigate factors influencing household resilience dynamics.

The rest of the paper is organized as follows. The next section outlines the conceptual framework, while section 3 presents the conceptual framework and estimation strategies. Section 4 describes data and resilience indicators. Section 5 presents factors influencing household resilience dynamics and section 6 draws concluding remarks.

2 Conceptual framework

2.1 Shocks and the concept of resilience

Shocks are mostly defined as adverse events that lead to a loss of household income, a reduction in consumption and/or a loss of productive assets. There are different types of shocks: natural or climatic; market; political/social/legal; crime and arson; and health. Climatic shocks include drought, floods, soil erosion, frosts, hailstorm, and insects and diseases affecting crops and livestock. Market shocks arise as a result of problems in accessing inputs (due to physical access problems or high increase in prices), decrease in output prices, and difficulties in selling products and services. Political/social/legal shocks include confiscation of assets or arbitrary taxation, social

or political discrimination or exclusion or contract disputes. Crime and arson shocks include theft and/or destruction of crops, livestock, housing, tools or household durables as well as crimes against persons. Health shocks include bereavement due to death as well as illness.

Resilience is generally understood as 'the ability of a system to absorb shocks, to avoid crossing a threshold into an alternate and possibly irreversible new state, and to regenerate after disturbance' (Resilience Alliance, 2007). The concept is initially developed in ecology (Holling, 1973) and has been applied to social systems (Adger, 1997), and/or human-environment systems (Carpenter *et al.*, 2004; Folke, 2006)[37]. It has been recently introduced into food security literature (Folke *et al.*, 2002; Hemrich and Alinovi, 2004; Ericksen, 2007; Alinovi *et al.*, 2008).

Household resilience to food insecurity can be expressed as household's ability to maintain a certain level of well-being regardless of any disturbance/shocks (Alinovi *et al.*, 2008). Resilience strategies require building capacity not only to cope and recover from shocks but also to reorganize and make transition to a better form of livelihood. It encompasses anticipation of future shocks and making the necessary preparations to cope and manage shocks without suffering from food insecurity and losing production capacity. Thus, it focuses not only on current level of consumption but also on medium- and long-term livelihood options. Moreover, Dodman *et al.* (2009) emphasize that resilience is not only bouncing back from shocks and stresses but also bouncing forward to a state where challenges that constrain livelihoods are addressed and overall quality of human livelihoods improved.

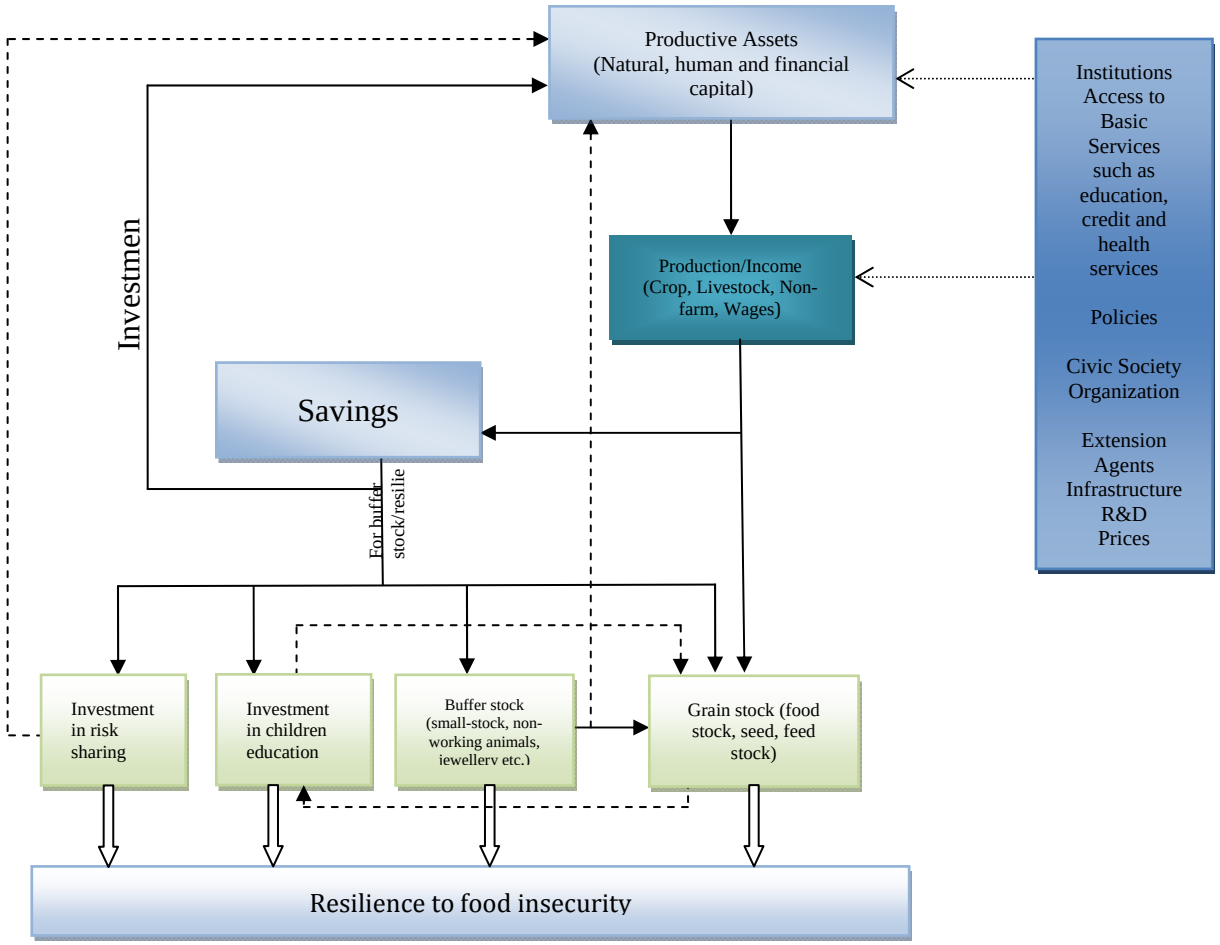
[37]See Holling (1973) and Adger (2000) for further definitions of ecological and social resilience.

2.2 Applying the concept of resilience to Ethiopia

Agriculture is the foundation of the Ethiopian economy; employing about 85 percent of the country's more than 81 million people. Drought-induced famine has threatened the lives and livelihoods of millions of these people over the last several decades. For instance, the 1958 and 1973 famines are reported to have claimed over 100,000 and 300,000 lives, respectively. During the 1984/85 famine, approximately 10 million people suffered from starvation and approximately one million are reported to have died (Alex, 1991). Millions were also affected by the 1999/00, 2002/03 and 2009/10 droughts. At present, the Southern and Eastern parts of the country are affected by a severe drought which is ravaging much of the horn of Africa. Moreover, the country has persistently failed to produce sufficient food (even under ideal weather condition) for its rapidly growing population and has been heavily reliant on food aid/assistant in recent years. About 8 million chronically food insecure people have been supported each year through food assistance and safety net programme known as Productive safety Net Program (PSNP) since 2005. The government and development partners are actively looking for strategies that would strengthen the resilience of households to manage and cope with shocks with little or no external assistance.

In view of the chronic problem of food security in Ethiopia, we have developed a simplified resilience framework (basis on our own experience) that elucidates the role of productive assets (natural, human and financial capital) and risk-sharing arrangement (Fig.1).

Fig.1. Food access, liquid assets and child education and risk sharing based resilience framework



The framework is drawn from the fact that subsistence-oriented farming households rely on their assets and investment portfolios in managing shocks. It integrates social resilience with asset based approaches to social risk management presented by Siegel and Alwang (1999) with the theoretical underpinnings of Sen's (1981) 'entitlement approach' and the sustainable livelihoods framework (e.g. Scoones, 1998; Devereux, 2003). It also draws from traditional risk management strategies: operate ex-ante by diversifying their livelihoods, reducing the magnitude of the shocks themselves, accumulate assets as buffer-stock, and share risk with others. The approach complements the traditional consumption-based vulnerability analysis but shifts the focus to building resilience on a sustainable basis. It is, thus, consistent with

multidimensional nature of food security as defined by the World Food Summit (1996): food security exists '*when all people at all times have access to sufficient, safe, nutritious food to maintain a healthy and active life'*.

For mixed farming system in Ethiopia, productive assets such as land, livestock[38], human and social capital play a crucial role in farm production, income generation and food supply. Gross income is the sum of revenue obtained from crop and livestock production, non-farm activities, wage employment and transfers. Income is mainly used for consumption; any surplus (in kind or cash) above immediate consumption needs is saved and invested in various forms to meet two critical objectives: (i) augment productive assets in order to expand productive capacity, and/or (ii) build resilience capacity (self-insurance) (Fig.1).

Household resilience is developed through savings invested in: (a) grain stock, (b) precautionary savings or buffer stock, and (c) education of school-aged children and (d) social risk-sharing arrangement. Grain stock is made up of own production (less sales), food transfers/aid and purchases. In Ethiopia, rural households often smooth their consumption using a strategy of stocking food grains to last them at least until the next harvest season (i.e., short term strategy). For subsistent producers, with underdeveloped and inefficient markets, buying food from market can be costlier than retaining and consuming own production.

[38]Livestock is categorized into major productive assets; oxen, cow and transport animals and precautionary saving; small stocks and cattle other than oxen and cow. In order to be resilient household should protect major productive assets as losing these stock will results in everlasting poverty trap.

Resilient families often hold sufficient quantity of grain stock but poor storage facilities and insect attacks do not favor keeping a large volume of stock over a longer period of time. Accordingly, they need precautionary assets/savings (livestock) that can be easily liquidated[39] to protect them against adversity in the short- and medium-term. Livestock that can serve as precautionary stock may take the form of small stocks (sheep and goats) and cattle other than oxen and cows. These assets are sold as and when necessary to smooth consumption and/or protect major livestock assets (e.g. oxen, milking cows and transport animals). Protecting major productive assets such as oxen is very crucial since households with no oxen are often forced into poverty traps with limited chance of recovery (see, for instance, Carter et al. 2005). Families lacking oxen may lease out their land for very low return (because rental markets are underdeveloped and the situation often involves distress rent) or enter into labor-oxen sharing arrangements which are extremely unfavourable[40]. Hence, households make a distinction between livestock that can be liquidated and livestock that need to be protected at all costs.

In the long term, investment in human and social development is crucial to be resilient. Education fosters innovative ideas for transforming farming practices, improving consumption and general wellbeing, and/or promotes diversification into non-farm activities. Educated children assist in better managing health risk, improving nutrition-related decisions and enhancing efficient management of family assets. In a traditional rural setting, investment in child education not only helps parents to benefit from

[39]The role of durable assets and jeweler in consumption or production smoothing is very limited in rural Ethiopia. Cash holdings are also limited, with less than 1% of the sample household reporting to have bank accounts.

[40]Labor-oxen sharing arrangement involves working two days for the owner of oxen in return for using the pair for a single day (Bevan and Pankhurst, 2007). Devoting two-third of their time on tilling for oxen owner is not a preferred option.

remittances (in the long-term) but also ensures the next generation is able to make a transition to a better livelihood in non-farm sector. It has also been reported that rural households invest in their children's education because they do not want them to depend on agriculture which is failing to provide decent livelihood (Rigg, 2006). While better-off and more resilient households invest in their children, poorer families may be forced to withdraw their children from school.

Investment in social network serves to manage risks and ensure resilience both in the short, medium and long terms. Traditional social organizations such as *idir* are a form of indigenous social insurance systems whose main function is to help members undergoing bereavement or suffering from loss of major assets. Households invest in *idir* through regular monthly or weekly contributions in return for reciprocal payments (e.g., cash and in kind assistance) in time of needs.

Institutional environment in the form of government policies, programs and civil society organizations enhance resilience through improving productive capacity (e.g. investment in research & extension), augmenting income (e.g. income transfer), improving market access (e.g. building infrastructure) and improving basic services which contribute towards the betterment of living standards and income (Fig. 1). Favourable government policies ensure resilience through increasing opportunities to gain and maintain secure access to production assets, especially land and other natural resources, and improving access to health care and education that would assist households to generate more income and savings.

3 Methodology

3.1 Constructing resilience index

Resilience is a dynamic multidimensional concept that integrates important information about how people actually withstand shocks (Almedom, 2009). However, there are no well defined variables that can be used to measure resilience[41] (Gallopin, 2006) and the question of how to quantify resilience remains controversial (Chan *et al.*, 2007). The classical approaches is to find easily accessible; 3-5 key variables that can demonstrate its concept very well (Walker *et al.*, 2006) as more complex variables likely obscure key patterns of resilience (Walker *et al.*, 2006; Yorque *et al.*, 2002). In this study, resilience score is constructed as a composite index based on aggregation of four variables; grain stock, buffer stock (small-stock and cattle other than oxen and cows), education of school-aged children and risk sharing strategies. Accordingly, the resilience index for household i at time t can be formulated as:

$$R_{it} = f(grainstock_{it}, bufferassets_{it}, avedu_{it}, network_{it}) \qquad (1)$$

R is latent variable representing household resilience index, *grainstock* is grain stock available for consumption, *bufferassets* is precautionary saving that includes the number of small-stocks and cattle owned (other than oxen and cow), *avedu* is average education of school-aged children and *network* refers to participation in *idir*.

Estimating resilience score through such proxy variables is not entirely a new idea. In measuring household resilience to food insecurity in Palestinian, Alinovi *et al.* (2008, for instance, used four pillars: income and food access, assets, access to public service and social safety nets with two additional dimensions (stability and adaptive capacity)

[41]Resilience is less easily measured than vulnerability in part because the former included elements like adaptive capacity and institutional learning (Adger, 1997; 2000)

that cut across four pillars and account for households' capacity to respond and adapt to shocks. In their framework, resilience index is developed after constructing an index for each pillar involving use of decision matrices and multivariate methods. Similarly, Keil *et al.* (2008) have quantified household resilience towards ENSO-related drought in Indonesia using the degree of drought-induced expenditure reductions for basic necessities and the absolute differences in the consumption of selected food items between the 'normal' and the drought situation as a basic indictor for resilience.

In order to derive the uni-dimensional resilience indicator, standard values of individual indicators can be summed up, but this assumes that all individual indicators are weighted equally. A better alternative is to use multivariate analysis, i.e. factor analysis (FA) and principal component analysis (PCA), which can give appropriate weight for each indicator. Both FA and PCA are used to reduce a number of variables into a smaller number of 'dimensions'. However, while FA assumes that covariation in the observed variables is due to the presence of one or more latent (unmeasured) factors that exert causal influence on observed variables, PCA is computed without assuming any underlying structure caused by latent variables (Ford *at al.*, 1986). This study has applied PCA in constructing index as it has been used for aggregating food security indicators in the literature. PCA linearly transforms the indicator variables of resilience into smaller component which account for most of the information contained in the original indicators (Dunteman 1994). In mathematical terms, from an initial set of n correlated variables (X_1, X_2, X_3,..., X_n), PCA creates uncorrelated indices or components whereby each component is a linear weighted combination of the initial variables as follows:

$$pc_m = a_{m1}X_1 + a_{m2}X_2 + a_{m3}X_3 + \ldots + a_{mn}X_n \qquad (2)$$

where a_{mn} represents the weighted for the m^{th} principal component and the n^{th} variable. The components are ordered so that the first component explain the largest amount of variable in the data subject to the constraint that the sum of the squared weight ($a_{m1} + a_{m2} + a_{m3} + \ldots + a_{mn}$) is equal to one. Each subsequent component explains additional but less proportion of variation of the variables. The higher degree of correlation among the original variables, the fewer components required to capture common information (see also Vyas and Kumaranayake, 2006). Once the components are identified, we can derive the resilience index as follows:

$$y_i = \sum F_i[(x_{ji} - x_i)/s_i] \qquad (3)$$

where y_j is the estimated resilience index, which follows a normal distribution with mean of 0 and standard deviation of 1, F_i is the weight for the i^{th} variable in the PCA model, X_{ji} is the j^{th} household's value for the i^{th} variables, and X_i and S_i are the mean and standard deviation of the i^{th} variable for overall household. Finally, the PCA is estimated for the pooled data from all rounds and households are re-classified into resilient and less resilient groups based on the mean value of the resilience score as a decision point: households with a factor score ≥ 0 are categorized as relatively resilient to food insecurity and non-resilient, otherwise.

3.2 Model Specification: Explaining Household Resilience Dynamics

Once the resilience index is predicted and households are reclassified into resilient and non-resilient groups, our interest is also to explore factors that might explain resilience dynamics. Dynamic probit random-effects model is used for the analysis as it has been applied in many empirical discrete choice models, including welfare (Chay and Hyslop, 1998; Bane and Ellwood, 1983), labour participation (Chay and Hyslop, 1998; 2000;

Heckman and Wills, 1977; Sousounis, 2008), poverty dynamics (Islam and Shimeles, 2005), and unemployment and low-wage employment (Auralampalam, 1999; Auralampalam *et al.*, 2000; Stewart, 2005; 2006; Auralampalam and Stewart, 2007), among others. The dynamic probit random-effects model[42] takes into account lags of the response variable and unobserved individual-specific heterogeneity[43] effects, as explanatory variables. The inclusion of these variables help us to distinguish the effect of underlying dynamic process, "true" state dependence, from the propensity to experience a certain outcome in all periods, unobserved individual-specific heterogeneity, (Heckman, 1981). The "true" state dependence arise from the fact that experience of event in the past influencing the occurrence of the same event in the future. The unobserved individual-specific heterogeneity can be considered as "spurious" state dependence, as the current events don't structurally affect the future events (Chay and Hyslop, 2000).

Household resilience that accounts for "true" state dependence and unobserved heterogeneity can be specified as:

$$y_{it}^{*} = x_{it}'\beta + \gamma y_{i,t-1} + \alpha_i + u_{it}; \qquad \text{i=1, ... ,N; t=2, ..., T} \qquad (4)$$

$$y_{it} = \begin{cases} 1 \text{ if } y_{it}^{*} \geq 0 \\ 0 \textit{ otherwise} \end{cases}$$

where y_{it}^{*} is the latent indicator of resilience score and y_{it} is the observed binary outcome of resilience score as derived from PCA procedure. The subscript *i* indexes

[42] The dynamic random- effects estimators are used under variety of specification if the stochastic restrictions of the error terms are appropriate. , "..., the fixed effects approach can only be used if the errors have an i.i.d. logistic distribution."(Chay and Hyslop, 1998).And also, "... there [is no] sufficient statistic allowing the [probit] fixed effects to be conditioned out of the likelihood. Unconditional fixed-effects probit models may be fit with the probit command with indicator variables for the panels. However, unconditional fixed-effects estimates are biased." (StataCorp., 2009).

[43] The heterogeneity may be either permanent or serially correlated transitory differences.

individuals and t indexes time period (survey period); $y_{i,t-1}$ one period lagged resilience score used to measure dynamic process or state dependence; X_{it} is vector of explanatory variables; α_i is unobserved individuals specific time-invariant heterogeneity effect; $u_{it} \sim iid\ \mathrm{N}(0\ \sigma_u^2)$ is the error terms. The parameter γ represents true state dependence whereby household resilience in the past can influence the persistence of the present resilience; and β is a set of associated parameters to be estimated.

Although the errors u_{it} are assumed to be serially independent, the composite error terms, $v_{it} = \alpha_i + u_{it}$, will be correlated over time due to the individual-specific time-invariant, α_i, terms (Stewart, 2006). The individual-specific random effect specification adopted implies the correlation between the two successive error terms, v_{it} and v_{it-1}, for the same individual is assumed to be constant:

$$\lambda = corr(v_{it}, v_{it-1}) = \frac{\sigma_\alpha^2}{\sigma_\alpha^2 + \sigma_u^2}; \qquad \text{t=2,...,T} \qquad (5)$$

The standard (uncorrelated) random effect model assumes that α_i is uncorrelated with observed variables (X_{it}). However, this assumption unlikely holds in most cases. For instance, unobserved heterogeneity may capture individual motivation or ability which is reasonably correlated with at least some of the explanatory variables. Following Mundlak (1978) and Chamberlain (1984), the assumption of no correlation between α_i and observed variable are relaxed by expressing α_i as a linear function of either the means or the combinations of means with lags and leads of time varying covariates as follows;

$$\alpha_i = \lambda_0 + \bar{X}_i'\lambda_i + w_i \qquad (6)$$

where $\bar{X}_i$ is a vector of means of the time-varying covariates, $w_i \sim \text{iid } N(0, \delta_w^2)$ is uncorrelated with observed variables and u_{it} for all *i* and *t*. If we substitute equation [6] into equation [4], we obtain:

$$y_{it}^* = X_{it}'\beta + \gamma y_{it-1} + \bar{X}_i'\lambda_i + w_i + u_{it}; \qquad i=1,...,N; \quad t=2,...,T \qquad (7)$$

where the intercept λ_0 is observed in β. This model is similar with the random effects probit model which accounts for the dependence between unobserved household specific with additional vectors, $\bar{X}_i$. Various studies have applied these strategies to control for unobserved individual-specific heterogeneity effects (see, Chay and Hyslop, 1998, Sousounis, 2008; Islam and Shimeles, 2005, Auralampalam, 1999; Auralampalam *et al.*, 2000; Auralampalam and Stewart, 2007; Stewart, 2005; 2006).

In panel data with large observations (N) and short time dimensions (T), initial conditions/observations, y_{i1}, is likely to be correlated with, α_i, and affect y_{it}. The initial conditions problem arises due to the fact that the start of the dynamic process may not coincide with the start of the observation periods. For instance, resilient households in the first survey round, the 1994, may be resilient before the survey period. Misspecification of the initial conditions results in drastically overstated estimates of the state dependence while understating estimates of short and long-run effects (Chay and Hyslop, 2000).

In order to correct for the initial condition problem, three methods of estimations have been suggested: Heckman (1981), Orme (2001), and Wooldridge (2005). All the three estimators provide the same results (Auralampalam and Stewart, 2007; Sousounis,

2008). We apply Heckman (1981) approach that involves specifying a linearized reduced form equation for the initial value of the latent variable:

$$y_{i1}^{*} = z_{i1}'\pi + \eta_i; \qquad i=1,\ldots, N \qquad (8)$$

where z_i is a vector of exogenous instrumental variables (and include, x_{i1}, which are relevant in period t_1, in 1994), pre-sample information influencing the probability of being resilient in period t_1; and η_i is correlated with α_i, but uncorrelated with u_{it}, for t ≥ 2. Using an orthogonal projection, it can be specified as:

$$\eta_i = \theta\alpha_i + u_{i1} \qquad (9)$$

Given the fact that α_i and u_{i1} are orthogonal to one another; and $\theta=\rho\frac{\sigma_n}{\sigma_\alpha}$, after simplification and substitution, we can obtain $\text{var}(u_{i1}) = \sigma_\eta^2(1-\rho^2)$. Furthermore, we assume that $corr(y_{i1}, u_{it}) = 0$ and $corr(X_{it}, u_{i1}) = 0$ for all *i* and *t*. After substituting equation [9] into equation [8], the 'initial conditions' equations becomes.

$$y_{i1}^{*} = z_{i1}\pi + \theta\alpha_i + u_{i1} \qquad (10)$$

Finally, since y_{it} is a binary variable, normalization is required (Stewart, 2006). A convenient one is $\sigma_u^2 = 1$. Moreover, since u_{it} is normally distributed, the joint probability of the observed normalized binary sequence of individual *i*, given α_i, in the Heckman approach is given by:

$$\Phi[(z_{i1}' + \theta\alpha_i)(2y_{i1} - 1)]\prod_{t=2}^{T}\Phi[(\gamma y_{i,t-1} + x_{it}'\beta + \alpha_i)(2y_{it} - 1)] \qquad (11)$$

Hence for a random sample of individuals that likelihood to be maximized is given by

$$\prod_i \int_{\alpha^*} \left\{ \Phi[(z_{i1}' + \theta\alpha_i)(2y_{i1} - 1)]\prod_{t=2}^{T}\Phi[(\gamma y_{i,t-1} + x_{it}'\beta + \alpha_i)(2y_{it} - 1)] \right\} dF(\alpha^*) \qquad (12)$$

where F is the distribution function of $\alpha^* = \alpha / \sigma_\alpha$. Under the normalization used, $\sigma_\alpha = \sqrt{\lambda/(1-\lambda)}$. With α taken to be normally distributed, the integral over α^* can be evaluated using Gaussian-Hermite quadrature (Stewart, 2005; 2006).

3.3 Estimation strategies

Equation [12] is estimated using "redprob" Stata program written by Stewart (2005) through two-steps procedures. The first step involves estimating the reduced form model, using simple probit model, for the initial observation, y_{i1}, and then predict a generalized residual. The estimated residual will be included as regressor in the random effect dynamic probit models in the second step. In addition to the lagged dependent variable and generalized residual from the first step, the model used include a set of household demographic, assets, agricultural inputs, access to information and marketing, off-farm activities as well as coping strategies. It also includes villages and survey dummies.

4 Data

The Ethiopia Rural Household Survey (ERHS) panel data is used for analysis. The data has been collected by the Economics Department of Addis Ababa University (AAU) in collaboration with the Centre for the Study of African Economies (CSAE) at Oxford University and the International Food Policy Research Institute (IFPRI)[44]. The United States Aid for International Development (USAID) and the Ethiopia Development

[44]The survey has conducted with various institutions individually or collectively as follows; the 1994-1995 surveys with the CSAE, the 1997 survey with IFPRI and CSAE, the 1999 survey with USAID and CSAE, the 2004 survey with IFPRI and CSAE and the 2009 survey with IFPRI and EDRI.

Research Institute (EDRI) has also been involved in most recent surveys[45]. It is one of the few panel datasets available at the household level in Africa. The survey started in 1989 when IFPRI team visited 450 households in seven farming villages in Central and Southern Ethiopia (see Dercon and Hoddinott, 2004).

The survey was expanded, in 1994, to included nine additional villages (three villages in D/Brihan and also other villages in the Southern part of the country) to cover the main agro-climatic zones and main farming systems in the country. In total, 1,477 households from 15 villages across four regional states, Tigray, Amhara, Oromiya and Southern Nations, Nationalities and People (SNNP), were surveyed in 1994. Households were randomly selected within each Peasant Association (PA). Stratification was used to include a sufficient coverage of the farming systems (Dercon and Hoddinott, 2004). These households have been re-interviewed in the late 1994, 1995[46] and 1997. In 1999, the sample frame was further expended to cover 1681 households in 18 villages[47]. In 2004, however, the additional (three) villages were excluded although independently surveyed in 2005. In 2009, the 7th round survey was conducted for 1681 households. This study uses the 1994a, 1995, 1997, 1999 and 2004. Moreover, only households observed in each of these survey waves are used. This gives a balanced panel with 1,240 households observed in each five waves and hence a sample size of 6,200 households. The dataset provides detailed information on production, consumption, purchase, sales, land holding and livestock ownership as well

[45]These data 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 or interpretation.

[46]Round one, two and three were conducted within 18 months of each other in the 1994/5 periods

[47]The three additional villages were to cover the potential cereals and cash crops producing areas.

as basic household demographics. Information on market prices, access to health and education and other infrastructure facilities were also collected at community level.

4.1 Descriptive statistics: Indicators and computation of Resilience scores

Household resilience to food insecurity indicator is constructed based on the amount of grain in stock (potentially use for consumption purpose), precautionary savings (animals kept for sale or replacement that can also be easily liquidated), investment in children education and participation in traditional risk sharing arrangement (locally known as *iddir*). Table 1 provides a descriptive for resilience indicators. Grain stock (in wheat-equivalent) per household increased from 6.94 quintal (696 kg)[48] in 1994 to 10.38qt in 1995 and further to 12.7qt in 1997. However, it slightly dropped to 11.81qt in 1999 but although increased to 12.11 qt in 2004.

Table 1: Household resilience to food insecurity indicators by survey years

	1994	1995	1997	1999	2004
Average grain in stock in wheat equivalent (in quintal)	6.94	10.34	12.70	11.81	12.18
Average precautionary saving (in TLU)	1.52	1.79	0.97	0.77	0.90
Average education level of children (in years)	0.48	0.59	0.94	1.08	2.16
Average contributions to *iddir*(in Birr)	24.35	21.00	29.31	33.21	41.09

There is also considerable heterogeneity among villages, mainly a reflection of production potentials (Table A1): in Haressaw and Gablen (more vulnerable sites), for instance, average stock per household was less than 1qt in 1994, and varied between 2 and 6 qt (wheat equivalent) between 1995 and 2004. In Dinki, Aze-debo and Gara-Godo), it was less than 3.0 qt in 1994, and varied between 5.42 and 11.62 qt between

[48] A quintal is 100 kg

1997 and 2004. On the other hand, average stock in Sirban Godeti (better-off site) varied between 22 and 25qt (though declining) over the period 1999 to 2004.

Precautionary savings, on average, increased from 1.52 TLU in 1944 to 1.8 in 1995 but decreased to 0.98 in 1997 and to 0.77 in 1999 but slightly improved to 0.91 in 2004 (Table 1). On average, households in D/Brihan and Korodegaga villages have 2 or more TLU, compared to less 0.5 in Adado and Gara Godo (Table A2).

The average education of school-aged children improved from about 1 year of schooling in 1994 to about 2 years in 2004 (Table 1). The level of education was relatively better in Turfe Ketcheme, Imdiber and Azedebo (on average, about 3 years of schooling) (Table A3). *Idir* is an association established among neighbors to raise funds that will be used during emergencies, such as death within these groups and their families; it is a long term association. Average annual contribution to iddir was less than Birr 50 although it eventually increased from about Birr 21 in 1994 and 1995 to about Birr 30 in 1997 and 1999 and further to Birr 41 in 2004 (Table 1). The contribution to iddir varies substantially among villages (Table A4).

The resilience score/index is computed through principal component analysis (PCA) using the four indicators. The PCA is estimated for the pooled data from all rounds and the resulting weight is then applied to the variable values for each round of the data. Since the variable used to construct the index and their respective weights remain the same in all rounds, we can use it to compare changes over time (Vyas and Kumaranayke, 2006). Using eigenvalues greater or equal to 1, as a critical point, we can retains the first two factor loadings that explains about 61.4% of the total variation

in the data (Table 2). Moreover, almost all indictors have loading factors (either first or second factor loadings) greater or equal to 0.4, critical value suggested by Stevens (2002) (Table 3); implies that all indicators have a crucial role in estimating the resilience index.

Table 2: Eigenvalue of the correlation matrix

Component	Comp.1	Comp.2	Comp.3	Comp.4
Eigenvalue	1.35	1.11	0.85	0.69
Proportion (in%)	33.7	27.7	21.4	17.2
Cumulative (in %)	33.7	61.4	8.28	100.0

Source: Authors' calculation from ERHS data

Table 3: Principal components factor loadings

Variables	Comp1	Comp2	Comp3	Comp4
Food grain stock per adult equivalent (in '000)	0.67	-0.11	0.22	-0.70
Precautionary saving per adult equivalent	0.56	-0.49	0.12	0.66
Average education level of school-age children	0.20	0.73	0.59	0.26
Total contribution to *idir* (social network)	0.44	0.46	-0.77	0.11

Source: Authors' calculation from ERHS data

The resilience score has mean value of zero and standard deviation of 1. It is re-scaled to have values lies between 0 (less resilient) and 1(highest resilient). Accordingly, average household resilience scores increased from 0.47 in 1994 to 0.52 in 1995 and 1997 but dropped to 0.51 in 1999 and increased 0.53 in 2004 (Table 4). However, there are variations among villages. Households in D/Birhan villages (Milki, Kormagefia, Karafina and Dokafia), Sirbana Godeti, Korodegaga and Turufita Kecheme have greater scores. By contrast, households from Haresaw, Geblen and Doma have lower scores.

Table 4: Resilience scores by villages and survey period

	1994	1995	1997	1999	2004	Pooled data
All	0.47	0.52	0.52	0.51	0.53	0.51
Haresaw	0.37	0.50	0.50	0.47	0.50	0.47
Geblen	0.39	0.46	0.49	0.48	0.50	0.46
Dinki	0.45	0.40	0.49	0.47	0.53	0.47
Yetmen	0.56	0.61	0.56	0.58	0.56	0.57
Shumsha	0.47	0.55	0.50	0.46	0.50	0.50
Sirbana Godeti	0.60	0.59	0.51	0.53	0.53	0.55
Adele Keke	0.47	0.49	0.52	0.51	0.54	0.51
Korodegaga	0.50	0.61	0.59	0.51	0.54	0.55
Trirufe Ketchema	0.51	0.59	0.56	0.55	0.53	0.55
Imdibir	0.34	0.32	0.40	0.33	0.42	0.36
Aze Deboa	0.44	0.47	0.47	0.48	0.48	0.47
Adado	0.39	0.43	0.48	0.48	0.46	0.45
Gara Godo	0.34	0.41	0.47	0.50	0.49	0.44
Doma	0.39	0.49	0.49	0.48	0.53	0.48
D/Brihan – Milki	0.60	0.63	0.64	0.65	0.64	0.63
- Kormargefia	0.63	0.64	0.65	0.65	0.64	0.64
- Karafino	0.61	0.64	0.62	0.61	0.64	0.63
- Bokafia	0.64	0.66	0.66	0.64	0.66	0.65

Source: Authors' calculation from ERHS data

Furthermore, using the original resilience scores, households are classified into relatively resilient (with score ≥ 0) and less resilient (with score <0) to food insecurity groups. The index performed well in categorizing households into resilient and less resilient groups; using the base year survey (1994) as a reference, we observed that resilient households owned significantly more livestock (oxen, cow and transport animals) and cultivate larger size of land, and have less dependent household members (see next section for discussion of these variables). The proportions of household using fertilizer and manure are significantly greater for resilient households than otherwise. Moreover, resilient households have better access to information and markets as measured by whether households have radio or not, whether any family member has been in a leadership position or not, and/or whether any family member

has received extension advice or not. Non-resilient households, on the other hand, are more likely to participate in low return casual wage employment (Table 5)

Table 5: Difference-of-Means Tests between resilient and non-resilient households; 1994

	Non-resilient (B)	Resilient (A)	Difference (B-A)
	Means (S.D)	Means (S.D)	In Means[49] (t-test)[50]
Household assets			
Number of oxen owned (in TLU)	0.83 (1.27)	1.41 (1.73)	-0.58*** (-5.66)
Number of cows owned (in TLU)	0.27 (0.61)	0.61 (0.99)	-0.33*** (-6.09)
Number of transport animals owned (in TLU)	0.41 (0.69)	0.78 (1.50)	-0.67*** (-4.58)
Total cultivated land (in ha)	1.23 (1.29)	1.66 (1.63)	-0.44*** (-4.64)
Agricultural inputs use			
Fertilizer use; 1 if yes	0.09 (0.23)	0.17 (0.38)	-0.08*** (-3.47)
Manure use; 1 if yes	0.45 (0.49)	0.55 (0.49)	-0.92*** (-3.01)
Irrigation use; 1 if yes	0.03 (0.18)	0.15 (0.12)	0.018* (1.98)
Access to Information and income diversification			
Have advised extension agents; 1 if yes	0.31 (0.46)	0.44 (0.49)	-0.13*** (-4.24)
Radio ownership; 1 if yes	0.09 (0.28)	0.21 (0.41)	-0.11*** (-5.14)
Household members in a leadership position	0.49 (0.33)	0.53 (0.32)	-0.05*** (-2.38)
Participation in casual wage employment; 1 if yes	0.25 (0.43)	0.19 (0.39)	0.06*** (2.34)
Household demographics			
Sex of household head	0.76 (0.42)	0.87 (0.34)	-0.11*** (-4.84)
Age of head (in years)	44.6 (15.6)	50.35 (14.7)	-5.72*** (-6.16)
Head completed primary school; 1 if yes	0.14 (0.34)	0.16 (0.37)	-0.02 (-0.90)
Head competed secondary school; 1 if yes	0.03 (0.26)	0.08 (0.26)	-0.38*** (-2.50)
Higher dependency ratio	0.50 (0.21)	0.47 (0.18)	0.03** (2.20)

Source: Authors' computation from 1994 ERHS data

Further comparisons over the surveyed years have indicated that only22% of the households are resilient over the 10 year period, while majority (47%) are non-resilient throughout the entire period (Table 6). The status of other households change over time: about 12% are resilient only four times, 9% three time, 7% twice and 3.6% only once. About 90% in Imdibir, more than 60% of households in Haresaw, Geblen and Dinki and about 75% in Gara Godo and Doma are consistently non-resilient during

[49]Two-sample t-tests with unequal variances

[50] The astriks *** indicates significance at 1 percent; ** and * indicate significant at 5% and 10%, respectively

the 10 year period while 50% from Yetmen and more than 70% from D/Brihan villages are consistently resilient.

Table 6: Household's resilience status over the course of the survey periods (in %)

	Non-resilient in all times	Once	Twice	Three times	Four times	Resilient in all times
All	46.77	3.6	6.65	9.05	12.32	21.61
Haresaw	57.87	4.53	11.20	14.40	10.67	1.33
Geblen	67.46	7.12	6.78	14.24	2.71	1.69
Dinki	60.26	4.21	8.95	8.68	7.37	10.53
Yetmen	17.04	0.37	2.96	10.00	17.78	51.85
Shumsha	47.89	3.85	6.61	12.66	16.15	12.84
Sirbana Godeti	31.35	1.35	5.41	8.92	20.54	32.43
Adele Keke	44.09	3.18	8.18	12.27	16.36	15.91
Korodegaga	27.69	0.88	6.15	10.55	27.25	27.47
Trirufe Ketchema	28.86	1.59	5.00	12.95	20.91	30.68
Imdibir	91.80	4.92	3.28	0.00	0.00	0.00
Aze Deboa	67.54	5.51	11.01	9.57	3.48	2.90
Adado	76.34	6.10	9.76	5.85	1.95	0.00
Gara Godo	74.29	9.45	10.99	2.64	2.64	0.00
Doma	56.43	5.00	7.86	16.07	12.86	1.79
D/Brihan – Milki	7.02	0.00	0.70	3.16	15.44	73.68
- Kormargefia	6.42	0.00	0.00	2.26	19.62	71.70
- Karafino	10.91	0.61	1.21	7.27	7.27	72.73
- Bokafia	6.67	0	1.67	2.5	10	79.17

Source: Authors' computation from survey rounds

4.2 Descriptive statistics: Factors explaining resilience dynamics

Household resilience dynamics is influenced by a number of factors, including physical assets (stock of physical and human capital), income diversification and access to agricultural inputs as well as information. Physical capital consists of land, livestock, farm tools and equipment. Land is important household assets - for growing crops and raising livestock, among others. Since intensive agriculture is almost non-existent in the country, increase in size of land under cultivation is expected to be a major factor in determining whether a household has the capacity to produce more (for consumption) and save or invest in precautionary assets. Sample households cultivated, on average, 1.34 ha of land in 1994. It was slightly increased to 1.49 ha in 1997, but contracted to 1.2ha in 1999 and further to 1.06ha in 2004 (Table 7). The average cultivated land size

has declined by nearly 8% over ten years (Table A5). Among villages, the cultivated land size has declined for almost half of the surveyed villages and almost stagnated for the others (Table A6).

Table 7: Descriptive statistics

	1994	1995	1997	1999	2004	All
Physical assets						
Total cultivated land (in ha)	1.34	1.45	1.49	1.20	1.06	1.31
Number of oxen owned (in TLU)	1.01	1.02	1.24	1.32	1.22	1.16
Number of cow owned (in TLU)	0.37	0.40	0.83	0.81	0.82	0.65
Number of transport animals owned(in TLU)	0.52	0.55	0.35	0.35	0.36	0.43
Agricultural inputs						
Fertilizer use; 1 if yes	0.13	0.38	0.50	0.50	0.41	0.38
Manure use; 1 if yes	0.48	0.61	0.61	0.46	0.72	0.58
Irrigation use; 1 if yes	0.03	0.03	0.03	0.10	0.22	0.08
Access to information						
Advised by extension agents; 1 if yes	0.35	0.36	0.37	0.40	0.51	0.40
Radio ownership; 1 if yes	0.12	0.08	0.10	0.10	0.14	0.11
Any family member is/was in any leadership position(index)	0.51	0.51	0.51	0.51	0.51	0.51
Non-agricultural income diversification						
Participated in causal wage employment scheme; 1 if yes	0.23	0.33	0.16	0.18	0.24	0.23
Participated in casual self employment scheme ; 1 if yes	0.68	0.75	0.66	0.29	0.34	0.54
Household demographics						
Sex of household head; 1 if male	0.79	0.79	0.77	0.73	0.70	0.76
Adult family members (in number)	2.04	2.11	2.26	1.99	1.93	2.07
Age of household head (in years)	46.48	47.54	48.95	49.41	50.78	48.63
Age of household head squared (/100)	24.04	24.97	26.22	26.71	28.09	26.01
Household head education level; 1 if primary school	0.14	0.14	0.10	0.10	0.08	0.11
Household head education level; 1 if secondary school	0.05	0.05	0.02	0.02	0.04	0.04
Village characteristics						
Obtained income from chat growing; 1 if yes	0.07	0.08	0.13	0.06	0.11	0.09
Obtained income from coffee growing; 1 if yes	0.14	0.17	0.23	0.22	0.21	0.19
Social capital/coping strategies						
Received remittance from any sources ; 1 if yes	0.17	0.46	0.28	0.22	0.38	0.30
Received food assistance from gov't, NGO's and relatives	0.30	0.08	0.15	0.19	0.07	0.16
Received credit from informal credit scheme; 1 if yes	0.50	0.36	0.54	0.53	0.54	0.49
Lent to others through informal credit scheme; 1 if yes	0.04	0.05	0.08	0.07	0.08	0.07
Members in local saving scheme (*Iquib*); 1 if yes	0.19	0.15	0.15	0.14	0.17	0.16
Involved in work party (*debo or wenfel*) 1 if yes	0.34	0.44	0.12	0.55	0.43	0.38

Source: Authors calculation from ERHS data

Livestock are important sources of economic insurance as they represent durable (and often appreciating) assets with intrinsic value. Moreover, animal are relatively more adaptable to environmental shocks than crops, as they can be fed crop residues or straws (even when crops fail) and moved around in search of pasture or veterinary services. Livestock also allows fertilization of crop land (manure) at relatively lower cost and thus contributing to a greater degree of resilience. In Ethiopia, livestock can also serve as one of the best investment options in the absence of private ownership of land and hence limited incentives to invest on land. Livestock consists of oxen, cows, transport animals (horses, mules, and donkeys) and precautionary saving (including sheep, goats and cattle other than oxen and cow). The numbers of oxen owned is thought to have a major influence on the extent of farmers' net income (mainly derived from crop production) and hence resilience to food insecurity. For sample households, the number of oxen owned increased, on average, from 1.01 TLU in 1994 to 1.32 in 1999 but dropped to 1.22 in 2004 (Table 7). However, more than half of sample households (except in D/Brihan villages) have no oxen over the survey periods (Table A7).

Milking cows are also important assets as for household resilience as they provide not only milk for home consumption or sales but also calves that could be sold to generate income or kept to serve as buffer stock or replace or expand existing stock of oxen and cows. The number of milking cows owned increased from 0.37 TLU in 1994 to about 0.80 between 1997 and 2004 (Table 7). Transport animals play a vital role in rural areas as modern transporting system is under developed in the country. Households with pack animals are expected to incur less transportation costs and hence earn

greater earnings and savings. The number of transport animals owned is 0.52 TLU in 1995 but declined to 0.35 in the later years.

A well established institutional and infrastructural environment help to access basic services, market, inputs and information as well as income diversification opportunities that enhance precautionary savings and investments and hence household resilience to food insecurity. Poor institutions and infrastructure keep farmers in isolation and reinforce subsistence production and contribute to vulnerable livelihood. Markets and inputs are the primary tools to produce more than subsistence requirements. Distance to market place or main road is often uses as a proxy for market access but such information is not available in the survey data. Use of chemical fertilizer, manure and irrigation, over the courses of the survey periods, has been used to measure access to inputs. The proportions of households using chemical fertilizer have increased from about 13% in 1994 to about 50% in 1997 and 1999 but slightly declined to about 41% in 2004. Households using manure and irrigation have increased from 48% and 3% in 1994 to about 72% and 22% in 2004, respectively (Table 7).

In the context of rural households who are faced with the threat of drought and are caught in a poverty trap, basic services such as access to food assistance, education and health are expected to foster sustainable development by enhancing the capacity of households to weather shocks such as drought. One-third have received remittance from relatives and about 16% have received food assistance from either government, NGO's or relatives.

Access to information can facilitate the dissemination of locally appropriate innovations and risk-management strategies. More informed households are visionary and have more effective plans against shocks compared to less informed ones. The proxies for access to information are ownership of radio and any members of households (or head/spouse mother or father) being in a leadership position in any form of organizational structure. Information can also be accessed through extension services. During the survey periods, about 40% of households have advised extension workers and about 10% have reported ownership of radio (Table 7).

Access to income diversification opportunities is necessary to stabilize income flows and consumption, especially in the presence of weak financial systems. Non-farm sources of income augment farm income and enhance savings under normal circumstance. Income diversification activities in the survey areas include non-farm business activities, wage work and earning remittances. Households participating in wage employment account for nearly 23% of during the course of the survey periods (declined to about 16% and 18% in 1997 and 1999, respectively). However, households participated in self-employment declined from about 70% between 1994 and 1997 to 30% between 1997 and 2004.

Due to absence of formal insurance and financial markets, informal risk sharing arrangement such as access to informal credit scheme are important for rural households. In this regard, two groups of households are identified: those who borrowed (borrower) and those who gave out loans. Borrowers are not expected to have higher resilience score since the reason for resorting to high cost informal loan is likely to be limited precautionary savings. On the other hand, lenders are more likely to

have good savings. Social capital such as stock of social ties, norms, mutual understanding, shared values, and networks that people draw upon to solve common problems are also equally important for households to be resilient. Networks of civic engagement such as neighborhood associations, farmer unions, national association commodity producers, and cooperatives increase entrepreneurial activity, and the denser these networks, the more likely members save and protect their assets, partly to present themselves as better off.

Sample households have access to a few traditional associations: *debbo* and *wonfel*- labor sharing arrangement, and *Iquib*- rotating saving and credit association (ROSCA). Membership in *debbo* and *wonfel* is used as proxy for social capital to explain resilience. *Iquib* is an association established by a small group of people in order to provide substantial rotating funding for members in order to improve their lives and living conditions; it provides the necessary funding for activities such as weddings, building houses, or starting a micro-business. About 17% of sample households have participated in a Rotating Saving and Credit Association (ROSCA) scheme (*Iquib)* and about 40% involved in work party (*debo and wonfel*). While about half of households have borrowed money from local informal money lenders, only 7% have given out loan through traditional money lending scheme.

Human capital includes family labor as well as health and nutritional status, education and skill of labor. Adult family member, which is a proxy for family labor, is expected to determine the family capacity to work. Educational level of the household head is thought to influence the return to family labor. Households headed by literate heads are thus expected to have better resilience score because of their better management

know-how. Male headed households are also expected to have higher resilience score than female headed ones because males have more access to resources and less vulnerable to exploitation and corruption than females. The proportion of household heads with primary and secondary school level of education is 11 and 4%, respectively. On average adult family members are limited to about 2 persons (economically inactive family members account for more than half of the family) and about 25% of the sample households are headed by females.

5 Empirical results

Table 8 presents estimation results for pooled as well as dynamic random-effects probit models. Column (A) presents estimation from a simple pooled probit model (without random effects) while column (B) and column (C) report the random-effect dynamic probit models with initial conditions to be exogenous and endogenous, respectively. The Heckman's estimator is used for endogeniety of the initial conditions. Column (D) reports the Heckman estimators as in column (C) but include additional explanatory variables. The panel-level variance component and exogeneity of the initial condition in the random effects probit model can be tested by simple significance test under the null of ρ=0 and θ=0, respectively. Moreover, it is worth to not that random-effect probit model and pooled probit model use different normalization (Stewart, 2006; Arulampalm, 1998). The random effects model use a normalization of $\sigma_u^2=1$ while the pooled probit estimator used $\sigma_v^2=1$. When comparing them with probit estimates, random effect model estimates therefore need to be multiplied by an estimate of $\sigma_u/\sigma_v=\sqrt{1-\lambda}$.

The coefficient of the lagged resilience is positive and highly significant indicating strong feedback from the past resilience that could help household learn more about how to ensure present and future resilience. However, assuming unobserved heterogeneity and initial conditions as exogenous overstates the effects of state dependence as obvious from rather inflated pooled probit model (column A) and dynamic probit model without controlling for initial condition (column B). Once controlling for both effects, the coefficient are almost halved for the rest of estimations. Moreover, inclusion of additional explanatory variables will not lead to change the coefficient of the state dependence that much once controlling for both unobserved heterogeneity and initial conditions (see column C and D). The next sub-sections discuss the impact of physical and human capital, agricultural inputs, access to information and market, informal risk sharing/management on household resilience to food insecurity.

5.1 The impact of physical and human capital, agricultural inputs, access to information, market and non-farm activities

a) Physical assets

Household resilience is increase with physical capital household owned: the coefficient of total size of cultivated land is positive and significant at 1% level of significance (Table 8). Given the present low rate of technology application, expanding land under cultivation is the main option to increase production, income or saving levels. Nevertheless, high population pressure and the restrictive land markets (farmers have only use right over their land) do not allow consolidation.

The number of oxen owned is positive and significant at 1% level of significance in both models. Household who own oxen are more likely to invest in resilience-

enhancing portfolios. Milking cow ownership contributes positively and significantly to the likelihood of being resilient (Table 8). As indicated above, milking cows provide milk and offspring that serve as precautionary savings and/or replacement of major stocks (oxen and cows). A study by Aune et al. (2006) also found that milking animals earn more profit than oxen in the highlands of Ethiopia. The contribution of cows to income and resilience would have been much higher had farmers used crossbreds which give higher milk yield.

The number of transport animals owned increase household resilience at 5% level of significance. Given that motorized transport services are underdeveloped in rural areas, pack animals play a critical role in transporting outputs and inputs to and from the markets. Households who own transport animals can also supply larger quantities to the market and benefit from better price offers. They can also transport products to central markets (beyond village markets) and obtain better prices.

b) Access to agricultural inputs

Although appropriate packages such fertilizer, improved seeds and pesticides are crucial for increasing crop productivity, fertilizer is the only modern input widely used by rural households in Ethiopia[51]. The coefficient of fertilizer is positive and significant at 1% level of significance (Table 8). Fertilizer is used to overcome the decline in soil fertility associated with continuous cultivation of the same plot every year. Most farmers have no chance of using the traditional method of maintaining fertility because of their small land sizes. As expected, manure use has positive and significant impact on the probability of being resilient to food insecurity at 10% level of significance.

[51]Only 3-4% of the total cultivated land in Ethiopia is covered by improved seeds

c) Human capital

Farmers need human capital to make use of their physical capital and generate income and ensure resilience. Education level and age of household head constitute a major part of the human capital. The results show that education has positive but insignificant impact on resilience (Table 8). According to Shultz (1975), education has a positive role mainly in a modernizing environment where farmers have access to new technologies and favourable market and price environment.

Age of household head (squared) is found to have positive impact although insignificant. Resilience capacity increases with age. Older household heads may have more assets and capacity of coping with shocks relative to younger heads.

Labor availability, as measured by adult population of the households, has a positive and significant coefficient. In other words, the higher the proportion of economically active members, the more possibility of investment in grain stock, precautionary savings or child education.

Male headed households have greater probability of being resilient than female headed households (the coefficient of gender is positive and significant in the dynamic model). The result confirms that female heads face cultural and social barriers in managing their resources and building in their resilience capacity. They also face particular problem in mobilizing non-family male labor for land preparation, which is culturally viewed as the task of men in most parts of the country.

d) Access to information, market and non-agricultural income diversification

Accessing basic information, market and non-farm income sources are found to have positive impact on resilience to food insecurity. The coefficient of radio ownership is positive and significant (Table 8), implying that access to national and local news and other information is likely to help in creating awareness and building resilience capacity. The positive (although insignificant) coefficient of extension agents shows that the favourable role of advice on production and marketing. It is also possible that extension agents may prefer to visit households with better resources and management capacity (selection bias).

Access to markets with better facilities has positive and significant coefficient in both static and dynamic models. Better markets may improve the way households plan their work and their investment decision. Residing near bigger markets may also mean improved access to health and education facilities and favourable input and output prices.

Contrary to expectations, diversifying income sources to wage and self-employment activities were not found to have significant impact (although the coefficient is positive)(Table 8). The insignificance of the variables could be attributed to low return or low productivity of wage and self-employment in Ethiopia (Demeke, et al., 2003). A recent study for the World Bank (2008) has also shown that the average profit earned from running a nonfarm enterprise is low and less than a dollar a day. It appears that poorer households diversify into wage employment and off-farm activities to complement basic subsistence needs, not to make investment in resilience enhancing activities.

Diversifying into coffee and *chat* (plant native to tropical East Africa),on the other hand, has a negative but insignificant impact at 1% level of significance. Households in cash crop growing areas appear to have less resilience capacity than those in predominantly cereal growing areas.

Table 8 Household Resilience dynamics: Dynamic Probit estimation results

	Pooled Probit	RE Probit	RE Probit (Heckman)	RE Probit (Heckman)
	(A)	(B)	(C)	(D)
Lagged resilience index (first lag)	1.19	1.15	0.73	0.73
	(27.00)**	(25.81)**	(9.47)**	(9.41)**
Physical Assets				
Number of cow household owned(in TLU)	0.09	0.04	0.09	0.09
	(3.41)**	(1.27)	(2.91)**	(2.79)**
Number of transport animals owned (in TLU)	0.19	0.13	0.18	0.17
	(5.11)**	(2.68)**	(4.29)**	(3.83)**
Total land size cultivated (in ha)	0.11	0.09	0.12	0.12
	(5.21)**	(4.49)**	(5.05)**	(4.93)**
Agricultural inputs				
Use of fertilizer; 1 if yes	0.32	0.30	0.34	0.33
	(6.95)**	(6.23)**	(6.37)**	(6.05)**
Use of manure; 1 if yes	0.02	0.03	0.06	0.06
	(0.39)	(0.76)	(1.25)	(1.12)
Use of irrigation; 1 if yes	-0.04	-0.06	0.02	0.01
	(0.57)	(0.79)	(0.26)	(0.15)
Access to information				
Advised by extension agent; 1 if yes	0.07	0.08	0.06	0.05
	(1.68)+	(1.82)+	(1.07)	(0.98)
Radio ownership; 1 if yes	0.12	0.12	0.11	0.10
	(1.67)+	(1.64)	(1.42)	(1.19)
Head/wife or parents leadership position	0.12	0.09	0.15	0.15
	(1.96)+	(1.52)	(1.96)*	(1.91)+
Non-agricultural income diversification				
Participation in wage employment; 1 if yes	0.03	0.05	0.01	0.01
	(0.62)	(0.94)	(0.27)	(0.18)
Participation in self-employment 1 if yes	-0.04	-0.04	-0.03	-0.05
	(0.85)	(0.84)	(0.54)	(1.03)
Household demographics				
Head sex; 1 if male	-0.01	-0.12	0.02	0.02
	(0.22)	(1.26)	(0.33)	(0.29)
Family labour(number of active members)	0.05	0.05	0.06	0.06
	(2.75)**	(2.65)**	(2.80)**	(2.72)**
Age of head	-0.01	-0.00	-0.01	-0.01
	(0.73)	(0.20)	(0.92)	(0.73)
Age of head squared	0.00	0.00	0.00	0.00
	(0.96)	(0.33)	(1.12)	(1.00)
Head education; 1 if completed primary	0.10	-0.05	0.11	0.10
	(1.55)	(0.46)	(1.35)	(1.21)
Head education; 1 if completed secondary	0.06	-0.16	0.07	0.06
	(0.52)	(1.03)	(0.53)	(0.47)
Villages characteristics (cash crops growing)				
Obtained income from chat growing; 1 if yes	-0.03	0.18	-0.05	-0.09
	(0.41)	(1.55)	(0.61)	(0.97)
Obtained income from coffee growing; 1 if yes	0.09	-0.01	0.08	0.09
	(1.66)+	(0.05)	(1.19)	(1.37)
Social capita/coping strategies				
Received transfer income; 1 if yes				0.04
				(0.78)+
Received food assistance from gov't, NGO's and relatives; 1 if yes				0.13
				(2.16)*

Received informal credit; 1 if yes				-0.04
				(0.91)+
Lend to others (informal lenders); 1 if yes				0.36
				(3.96)**
Members in *Iquib* (local saving scheme) 1 if yes				0.12
				(1.64)+
Involved in working party "*debo* and/ *wenfel*"; 1 if yes				0.09
				(1.27)+
Lags in social capital/ coping strategies				
Received transfer income in period t-1; 1 if yes				0.08
				(1.51)+
Received food assistance from any source in period t-1; 1 if yes				-0.11
				(1.90)+
Received informal credit in period t-1; 1 if yes				-0.03
				(0.67)
Lent to other (informal lenders) in period t-1; 1 if yes				0.02
				(0.09)
Members in *Iquib* (Local saving scheme) in period t-1; 1 if yes				0.04
				(0.15)
Involved in working part "debo and/ wenfel" in period t-1; 1 if yes				0.06
				(0.73)*
Constant	-0.77	-0.91	-1.11	-1.14
	(3.66)**	(4.18)**	(4.46)**	(4.50)**
ρ		0.04	0.25	0.26
		(0.46)*	(0.05)**	(0.05)**
θ			2.17	2.13
			(0.54)**	(0.54)**
Loglikelihood	-2,576.83	-2,562.45	-3,198.78	-3,181.04
Number of observations	4,944	4,944	6,200	6,200
Wald Chi-square	1,679.46	1,383.50	574.67	605.23

+ $p<0.1$; * $p<0.05$; ** $p<0.01$
Note: The regression is controlled for villages and round interaction term but not reported

5.2 Impact of risk sharing strategies

Table 8 also present the impact of risk sharing/management strategies on resilience to food insecurity. These includes receiving remittance (transfer income), food assistance (mostly from relatives), participation in informal credit scheme (extending or receiving loans), involving in local saving arrangements and work-party, among others. We also included the lagged values of the variables (risk-sharing) so as to control for long term impacts[52].Among risk sharing strategies, households who lent out to others, participated in local saving scheme (*Iquib*) and joined work party are found to be more resilient to food insecurity at 1% and 5% level of significance, respectively. Lending

[52]There may be some correlation between the lagged and current values of regressors, but the pair-wise correlation matrix shows there is no significant correlation among those variables (Table A?)

money to others and participation in *iquib* are important means of saving in rural Ethiopia. The former can be considered as both saving and investment as the lenders benefit from higher interest rate, often 10% per month or 120% per year (Bevan and Pankhurst, 1996). Borrowers may also provide labor to lenders. *Iquib* is a forced saving mechanism and participants appear to invest their savings in resilience-enhancing activities. Households involved in work-party (*debbo* and *wonfel*) more likely resilient to be food insecurity at 1% level of significance. Such types of labor sharing arrangements[53] is particularly useful during peak farming seasons (e.g. planning and harvesting) and households using *debbo* or *wonfel* have a better chance of completing seasonal operations on time, thus minimizing losses due to delays. In general, lending to other and involving in work party are found to have a significant long-term impact on household resilience to food insecurity.

The coefficient of lagged value of food assistance is negative and significant, implying that receiving food assistance could have a long-term adverse impact on household resilience. It is possible that poor households receiving free food aid may resort to dependence on external assistance rather than reliance on own means of survival. There are also empirical findings reporting that food assistance may create dependence, especially at low level of income (Sharp and Devereux, 2004). Borrowing from informal credit schemes seems to have a negative impact in the long-run as borrowers are often pay exorbitant interest rates. Remittances have a positive and significant impact on household resilience in the short as well as long-run. Remittances

[53]Debo and/wonfel is often called by better-off household as who call for such labor sharing often prepare lunch and dinner including drinks for participants which the poor couldn't afford.

are largely obtained from educated family members living in urban areas and engaging in off-farm activities.

6 Conclusions and policy implications

This study has developed a score of household resilience to food insecurity based on: (i) amount of grain stock kept; (ii) level of precautionary investment (buffer stock); (iii) investment in child education (proxied by average educational level of school-age children); and (iv) participation in traditional risk sharing arrangement (*idir*). In the absence of safety net programs or insurance protections, households rely on self-insurance options that refer to accumulating a reserve out of one's income or assets. The principle of self-insurance essentially deals with whether households anticipate shocks and develop own short and long term plans for mitigating shocks and enhancing resilience to food insecurity. The approach combines asset based approaches to social risk management with the theoretical underpinnings of Sen's 'entitlement approach' and sustainable livelihoods framework. It also complements the traditional consumption-based vulnerability analysis and shifts the focus to building resilience of households to food insecurity.

We constructed resilience scores and identified factors influencing the scores using the Ethiopia Rural Household Survey (ERHS) panel data collected in five waves between 1994 and 2004. The analysis is based on a balanced panel with 1,240 households observed in each of five wave and hence a sample size of 6,200 households. The principal component analysis is used to generate resilience scores at household levels. On average, the resilience scores were found to be higher in the villages from Oromiya

and Amhara regions and lower in SNNP and Tigray regions. The result is consistent with the agricultural potential of the regions.

We estimated dynamic random-effect probit model which account for lagged resilience. The results have shown that past level of resilience affects current resilience. In other words, there is a significant true state-dependence on the dynamics of resilience to food insecurity. Household resilience is also influenced by a number of physical, human, financial and social capital as well as access to basic services, information, input, markets and income diversification.

Physical capital such as land and livestock are positively related to household resilience. For instance, farm size is one of the major assets influencing household resilience. Expanding land under cultivation improves resilience. However, there is no idle land for expansion in most of the survey villages. Further expansion of land could also result in deforestation and cultivation of fragile lands. Households can expand their farm size through buying or leasing land (land consolidation). In other words, non-resilient households eventually exit farming while resilient and efficient farmers expand and grow. However, the current land policy does not encourage land purchase or long-term lease (because of restrictive land tenure policy). Revisiting the existing land policy has the potential of contributing to the emergence of a dynamic farming sector.

Milking cows are found to have a positive and significant contribution to resilience. The return from milking cows is high because of their contributions to better diet, cash income (from sales of milk and butter), and calves (which serve as buffer stock).

Milking cows can also be less vulnerable to drought than crops under mixed farming conditions (e.g. field crops that fail to mature due to lack of rains are commonly fed to animals). Moreover, milking cows can be more profitable where farm sizes are too small. Dis-economies of scale may render crop production on very small farms unsustainable. However, productive small dairy farm requires improvement of breed, better feeding and management practices, and improved access to markets.

Transport animals are crucial for transporting inputs and output from and to the markets and contribute positively to resilience. However, these animals create pressure on scarce pasture land used by other animals. In this regard, alternative transporting system can reduce both cost of transport and the negative impact of too many animals on land degradation. Provision of better feeder roads is necessary to allow modern transport and contribute to increased availability of feed available for livestock such as milking cows.

Access to agricultural inputs is generally positively related with resilience to food insecurity. Intensification using inputs such as fertilizer appears to enhance resilience. Users of fertilizer are probably more market-oriented and are more likely to be aware of the need for investing in self-insurance portfolios. However, fertilizer is mainly used along with traditional seeds and optimum rate of fertilizer application is constrained by high cost and limited access to credit. Improving the profitability of fertilizer can contribute to greater degree of resilience. Hence, successful intensification requires careful considerations of the implications input use on profitability and resilience.

As expected, non-agricultural income diversification have positive impact on resilience although found to be insignificant. The insignificance of wage and non-farm employment demonstrates the low level to off-farm employment. Engagement in low-paying activities signifies limited capacity and need for investment in self-insurance portfolio. A positive and significant contribution of wage and non-farm employment to resilience and sustainable growth would be achieved only if there are commercial activities within and outside agriculture that offer remunerative market opportunities.

Households in the survey areas have access mainly to informal credit services[54] that often charge high interest rates and short loan durations. Households are likely to resort to short-term and high cost loans only when faced with critical food shortages or when they run out of food stock and are desperate.

Short-term loans from informal sources seem to have a negative impact on resilience (because they are probably very expensive). A corollary to this finding is that the role of a more affordable and longer term formal credit (including micro credit) in assisting poor households to build their resilience capacity and asset base cannot be overemphasized.

Social capital in the survey areas is limited to a few traditional arrangements such as savings and credit association, and labor sharing. Both were found to have significant contribution to resilience. Measures aimed at supporting farmer organizations need to be given adequate attention.

[54] This does not include input loans provided by regional governments.

The evidence does not support that food assistance has contributed to improved resilience in the long-run (although it has significant impact in the short-term). This is possible because the level of assistance was too small to prevent asset depletion. Those who received food assistance (from individuals, government and NGOs) may also be the poorest of the poor for the most part. Safety net programs based on transfer of food or income to meet food consumption requirements during critical or lean seasons may not help if households involved have little or no asset to start with. It takes much more than small food and cash transfer to build household assets and invest in resilience-enhancing activities. As shown above, agricultural and rural development investment to promote intensification, commercialization and social capital formation have a more sustainable and significant impact on resilience. Safety net programs and insurance schemes cannot be sustained if farming systems are not resilient, dynamic and on a growth trajectory[55].

[55] According to Katharine Vincent of the Regional Hunger and Vulnerability Programme, "Insurance companies are not answerable to any public sector organizations or governments, and thus are entitled to (and do) withdraw their products should they no longer become financially viable, .. [Insurance] may discourage farmers from engaging in their traditional self-reliance, preparedness, and risk-spreading activities. If this happens and then the insurance product is removed, they will arguably be in a more precarious situation – both worse off economically and more vulnerable to risk - than they were before the insurance was available," http://www.wahenga.net/node/1919.

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Table A1: Average grain stock in wheat equivalent (in quintal) by years and villages

	1994	1995	1997	1999	2004
All	6.96	10.38	12.71	11.81	12.11
Haresaw	0.46	5.07	8.82	4.61	3.50
Geblen	0.78	1.97	1.74	1.44	2.53
Dinki	2.76	2.30	5.47	6.81	8.51
Yetmen	11.07	15.90	22.94	21.53	21.96
Shumsha	3.75	5.38	6.72	7.89	6.91
Sirbana Godeti	22.86	25.26	23.82	19.57	17.74
Adele Keke	6.96	8.30	10.08	10.58	16.12
Korodegaga	4.04	15.57	18.17	8.03	14.82
Trirufe Ketchema	14.09	36.90	37.05	32.91	19.09
Imdibir	2.05	2.45	2.53	1.16	2.33
Aze Deboa	2.26	6.38	7.70	7.20	8.37
Adado	3.50	4.09	10.06	8.96	6.56
Gara Godo	1.53	5.00	8.42	10.81	9.87
Doma	4.34	5.68	10.96	6.02	16.13
D/Brihan – Milki	9.02	9.76	11.37	17.77	21.84
- Kormargefia	13.00	6.62	12.38	13.19	12.53
- Karafino	8.65	8.51	13.95	18.85	26.02
- Bokafia	15.20	11.22	13.93	18.71	19.89

Source: Authors' calculation from ERHS data

Table A2: Average precautionary saving (in TLU) by survey years and villages

	1994	1995	1997	1999	2004
All	1.52	1.8	0.98	0.77	0.91
Haresaw	0.77	0.99	0.58	0.42	0.59
Geblen	1.13	1.35	0.48	0.61	0.44
Dinki	0.96	1.10	0.94	0.52	0.74
Yetmen	2.31	2.46	0.78	0.61	0.61
Shumsha	1.65	1.98	0.88	0.59	0.68
Sirbana Godeti	2.75	2.85	0.57	0.52	0.72
Adele Keke	0.55	0.70	1.00	0.39	0.58
Korodegaga	2.61	3.31	2.09	1.31	1.30
Trirufe Ketchema	1.88	2.11	1.08	1.03	0.60
Imdibir	0.79	0.92	0.63	0.44	0.66
Aze Deboa	1.40	1.57	0.65	0.63	0.70
Adado	0.39	0.46	0.18	0.10	0.16
Gara Godo	0.59	0.65	0.29	0.42	0.45
Doma	1.05	1.13	0.40	0.61	0.69
D/Brihan – Milki	2.31	2.92	1.96	1.85	1.97
- Kormargefia	2.89	3.66	2.11	1.96	3.21
- Karafino	2.45	3.03	2.18	1.72	2.11
- Bokafia	3.06	3.87	2.66	1.92	3.00

Source: Authors' calculation from ERHS data

Table A3: Average education level of children (in years) by survey years and villages

	1994	1995	1997	1999	2004
All	0.86	0.95	1.16	1.28	2.27
Haresaw	0.77	0.99	0.58	0.42	0.59
Geblen	1.13	1.35	0.48	0.61	0.44
Dinki	0.96	1.10	0.94	0.52	0.74
Yetmen	2.31	2.46	0.78	0.61	0.61
Shumsha	1.65	1.98	0.88	0.59	0.68
Sirbana Godeti	2.75	2.85	0.57	0.52	0.72
Adele Keke	0.55	0.70	1.00	0.39	0.58
Korodegaga	2.61	3.31	2.09	1.31	1.30
Trirufe Ketchema	1.88	2.11	1.08	1.03	0.60
Imdibir	0.79	0.92	0.63	0.44	0.66
Aze Deboa	1.40	1.57	0.65	0.63	0.70
Adado	0.39	0.46	0.18	0.10	0.16
Gara Godo	0.59	0.65	0.29	0.42	0.45
Doma	1.05	1.13	0.40	0.61	0.69
D/Brihan – Milki	2.31	2.92	1.96	1.85	1.97
- Kormargefia	2.89	3.66	2.11	1.96	3.21
- Karafino	2.45	3.03	2.18	1.72	2.11
- Bokafia	3.06	3.87	2.66	1.92	3.00

Source: Authors' calculation from ERHS data

Table A4: Households participating in *iddir*(in %) and average contributions (in Birr) by villages and survey years

	1994		1995		1997		1999		2004	
	%	mean	%	mean	%	mean	%	mean	%	mean
All	56.2	24.12	57.3	20.79	68.6	29.25	73.7	33.45	70.6	41.58
Haresaw	-	-	5.3	14.25	-	-	-	-	-	-
Geblen	-	-	-	-	-	-	11.9	14.13	-	-
Dinki	5.3	22.5	2.6	19.5	28.9	10.65	52.6	19.62	21.1	10.14
Yetmen	27.8	18.51	31.5	26.91	44.4	23.88	50	24.33	75.9	71.13
Shumsha	79.8	61.44	69.7	36.84	86.2	87.21	95.4	117.48	86.2	118.8
Sirbana Godeti	94.6	58.77	91.9	65.73	100	87.51	100	84.33	97.3	121.59
Adele Keke	9.1	47.07	21.6	19.41	52.3	32.88	72.7	41.19	46.6	15.3
Korodegaga	86.8	19.5	87.9	25.5	90.1	28.56	92.3	23.7	93.4	44.91
Trirufe Ketchema	84.1	37.92	89.8	53.04	96.6	48.27	95.5	52.62	95.5	75.33
Imdibir	98.4	81.6	95.1	75.63	95.1	73.98	88.5	71.1	96.7	92.28
Aze Deboa	89.9	65.28	95.7	41.19	97.1	35.76	98.6	26.7	78.3	81.12
Adado	63.4	40.62	61	20.94	95.1	42.36	89	48.12	79.3	37.41
Gara Godo	74.7	46.38	80.2	20.4	94.5	9.03	100	9.57	94.5	21.63
Doma	46.4	22.68	3.6	7.5	16.1	37.32	3.6	31.5	71.4	22.68
D/Brihan – Milki	75.4	4.32	70.2	14.34	84.2	15.09	84.2	15.51	84.2	19.17
- Kormargefia	64.2	9.87	88.7	15.72	96.2	14.46	92.5	13.38	84.9	15.51
- Karafino	15.2	27.6	33.3	20.85	24.2	14.82	81.8	14.28	81.8	11.67
- Bokafia	41.7	18.15	79.2	22.29	79.2	12	75	14.1	75	12.33

Source: Authors' calculation from ERHS data

Table A5: Households average total cultivated land (in ha) by survey rounds

	land (in ha)	Change in pervious rd	Change on rd one	High potential areas (in ha)	Low potential areas (in ha)
1994a	1.40			1.01	2.04
1994b	1.40	0.00	0.00	1.01	2.04
1995	1.49	0.06	0.06	1.09	2.22
1997	1.52	0.02	0.09	1.17	2.18
1999	1.30	-0.14	-0.07	0.98	1.67
2004	1.12	-0.14	-0.20	0.84	1.54

Source: Authors' calculation from ERHS data

Table A6: Households average total cultivated land (in ha) by survey villages and rounds

	1994	1995	1997	1999	2004
Haresaw	0.52	0.51	0.49	0.6	0.59
Geblen	0.31	0.37	0.38	0.3	0.45
Dinki	1.11	1.31	1.38	0.96	1.21
Yetmen	1.24	1.39	1.8	1.27	1.49
Shumsha	1.61	1.48	1.78	1.1	1.17
Sirbana Godeti	1.72	1.62	1.58	1.51	1.66
Adele Keke	1.23	1.43	1.45	1.36	1.21
Korodegaga	3.13	3.2	3.46	3.04	2.24
Trirufe Ketchema	1.04	1.13	1.22	1.07	1.24
Imdibir	0.18	0.26	0.15	0.37	0.05
Aze Deboa	0.66	0.69	0.75	0.75	0.4
Adado	0.59	0.72	0.65	1.43	0.73
Gara Godo	0.68	0.6	0.65	0.61	0.38
Doma	1.39	2.03	2.18	1.11	0.87
D/Brihan – Milki	2.95	3.04	3.2	2.12	2.1
- Kormargefia	3.79	4.07	3.35	2.3	1.98
- Karafino	2.97	3.35	2.57	2.22	2.0
- Bokafia	3.54	3.93	3.86	1.99	2.28

Source: Authors' calculation from ERHS data

Table A7: Households owned oxen (at least one) by villages and survey years (in %)

	1994	1995	1997	1999	2004
All	48.3	48.9	58.5	60.1	54.4
Haresaw	16.0	18.7	56.0	56.0	56.0
Geblen	28.8	28.8	71.2	81.4	57.6
Dinki	42.1	43.4	60.5	63.2	64.5
Yetmen	55.6	55.6	75.9	74.1	74.1
Shumsha	52.3	52.3	66.1	60.6	50.5
Sirbana Godeti	39.2	39.2	79.7	79.7	71.6
Adele Keke	54.5	54.5	30.7	38.6	30.7
Korodegaga	57.1	57.1	93.4	76.9	69.2
Trirufe Ketchema	59.1	59.1	61.4	70.5	63.6
Imdibir	47.5	49.2	11.5	11.5	1.6
Aze Deboa	55.1	55.1	44.9	50.7	49.3
Adado	8.5	9.8	9.8	7.3	6.1
Gara Godo	37.4	38.5	41.8	50.5	51.6
Doma	25.0	26.8	41.1	62.5	64.3
D/Brihan – Milki	86.0	86.0	87.7	80.7	80.7
- Kormargefia	92.5	92.5	94.3	94.3	75.5
- Karafino	87.9	87.9	81.8	87.9	81.8
- Bokafia	87.5	87.5	95.8	91.7	83.3

Source: Authors' calculation from ERHS data

Paper IV

Food Consumption Seasonality and Household Market Participation in rural Ethiopia

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Abstract

This study examines food consumption seasonality and household market participation in an attempt to improve the level of consumption. The empirical results, based on a unique Yearlong Monitoring Ethiopian Rural Household Survey (YLMERHS) conducted at every fortnight for a period of one year, show that food consumption seasonality is profound in rural areas of Ethiopia. More specifically, household calorie intakes rise not only during harvest season where the stock is relative high but also in the months of lean season that coincide with Holidays. In the month of September, for instance, households colorfully celebrate two National Holidays: the Ethiopia New Year (*Enkutatash*) and the Founding of True Cross (*Meskel)* festivals; Easter Sunday is celebrated in the month of April. During these festivals animals are slaughtered to lavishly feed not only own family members but also visitors and relatives outside of the family. Moreover, using instrumental-variables regression that account for potential endogenous relationship between household consumption and share of output sales, a proxy for market participation, we found that household market participation improves food consumption through raising disposable income and hence the demand of variety of goods and services.

Keywords: food, seasonality, markets, rural household, Ethiopia

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1 Introduction

Transitory, chronic and cyclical food insecurity is the widespread challenges for most of households in rural Ethiopia. While high dependence on erratic rain-fed subsistence agriculture and the recurrent drought generally results in transitory and/or chronic food insecurity, food consumption seasonality causes cyclical food insecurity. Because of seasonal crops production, food consumption of rural households in Ethiopia are expected to be better during harvest season, when grain stock is relatively high, than lean season, when the stock runs low and food prices are at annual peaks.

Seasonal fluctuations in the amount and quality of food consumption are one of the challenges for food security (Arndt *et al*., 2006). Accordingly, investigating the nature of food consumption seasonality is important for policy intervention as to whether variation is due to seasonal consumer preferences or markets failure (Basu and Wong, 2009).Market participation helps to smooth consumption shortfall as well as to improve the quality and quantity of consumption through raising disposable income and hence demands for variety of goods and services. Using cross-sectional data from Ethiopia and Tanzania, Asfaw et al. (2011)have shown that teff and wheat market participation increases household consumption expenditure and reduce poverty in Ethiopia. The same holds for pigenopea and maize market participation in Tanzania. Market participation also offers households the opportunity to specialize according to the comparative advantage and thereby enjoy welfare gains from trade (Boughton *et al*., 2007).

Only few studies have explored food consumption seasonality in Ethiopia (see, for instance, Dercon and Krishnan 2000), mainly due to limited availability of appropriate

data[56]. This study tries to bridge the gaps using Yearlong Monitoring Ethiopia Rural Household Survey (YLMERHS) conducted every fortnight, for more than a year, during the period of April 2000 to June 2001. We also further explore household market participation in an effort to improve welfare of rural households as measured by consumption expenditure. The study has shown that there is seasonality in food consumption. Moreover, we found that market participation improves household level of consumption through increasing household income.

The reminder of the paper is organized as follows. Section 2 briefly discusses methodology while data and basic descriptive are presented in section 3. Section 4 discusses empirical results and section 5 concludes.

2 Methodology

The study analyzes seasonality in food consumption as well as household market participation in an attempt to improve household welfare through raising households dispensable which in turn increase the demand of goods and services. Seasonality in food consumption is examined using simple OLS regression; log per capita calorie consumption as a function of seasonal (monthly) and village dummies. The regression is controlled for household demographics such as age, sex and education of household head as well as distance to the nearest markets. The model can be specified as:

$$\ln(kcalcons_i) = \alpha + \beta_1 X_i + \beta_2 S_i + \beta_3 V_i + e_i \qquad (1)$$

[56] Most of the available data are based on information collected shortly after harvest season

where ln(kcalcons$_i$)is log per capita calorie consumption (in kilo calorie); $X_i$is a set of variables including age, sex and education of household head and distance to the local market; $S_i$and V_i *are* vectors of monthly and village dummies, respectively; e_i is the error term; and α and β_i are parameters to be estimated.

Using the Engle curve as a tool for analysis, we also analyzed seasonality in food consumption by food groups (cereals, pulses, root crops, fruits & vegetables, animal products and "*other foods*"). The Engle curve helps to relate budget share of each food groups into total expenditure that can be estimated based on commonly known as the Working-Leser model; its applications is broadly discussed in Deaton & Muellbauer (1980) and Handa (1996), among others. The model can be expressed as:

$$w_{ji} = \alpha + \beta \ln(kcalcons_i) + \lambda(\ln kcalcons_i)^2 + \eta X_i + \gamma S_i + \tau V_i + e_i \qquad (2)$$

where w_{ji} is budget share of commodity j for household i, *ln(kcalcons$_i$)and ln(kcalcons$_i$)*^{2} are log per capita calorie intake and its squared and the other variables are as specified above. β, λ, η, τ and γ are parameters to be estimated and e_i is a random error term with mean zero and unit variance.

The impact of market participation on household welfare can be specified as follows:

$$\ln(kcalcons_i) = \alpha + \beta_1 X_i + \beta_2 V_i + e_i \qquad (3)$$

where *ln(kcalcons$_i$)* is log per capita calorie consumption; X$_i$ is a set explanatory variables including share of income from crop output sales, productive assets

ownership (livestock), share of off-farm earning as well as household demographics; *Vi* is village dummies and e_i is a normally distributed error term with mean zero and unit variance. We use share of income from output sales to measure the impact of market participation on household food consumption. However, the random shocks that affect output sales could also affect household consumption expenditure. For instance, higher productivity could lead to higher market participation as well as higher level of consumption. More specifically, households with higher productivity are more likely to have higher market participation as they are more likely to have crops surplus above their consumption need. Alternatively, higher market participation could also lead to increase in productivity by providing incentives, information and cash flows for working capital (Rios et al. 2009) and hence improve household consumption. We use instrumental variables to account for potential endogenous relationship between household consumption and share of output sales. The instrumental variables, for share of output sales, include per capita cultivated land size of households and use of chemical fertilizer as they are used to improve crop productivity and hence market participation; distance to the nearest market place and use of animals or vehicle for transport that can help to reduce transaction costs and lead to benefit from prevailing market prices; whether households use radio for accessing information as prices and related issues often broadcast over radio; household demographics such as sex, age and education level of household head as well as household size. Male headed household could have higher market participation as they could have more access to information than female headed households. Obviously, household with more family size could spend more on consumption and less likely participate in the market as seller.

3 Data Source and Descriptive Statistics

A Yearlong Ethiopian Rural Household Survey (YLERHS) is utilized for this study. The survey is conducted by the Economics Department of Addis Ababa University in collaboration with the USAID/Ethiopia. The YLERHS is an extension to the 5th round panel data of the Ethiopia Rural Household Survey (ERHS) that covered 1685 households from 18 villages across four regions (Tigray, Amhara, Oromiya and SNNP). It collected information for a typical period, based on households recall either "for the last week" or "for the last four months" prior to the survey period. The YLERHS, however, purposely selected 4 villages (Yetmen and D/Brihan from Amhara region, Eteya from Oromiya region and Azedebo from SNNP region) and extended field work for the period of more than one year; April 2000 to June 2001[57]. These villages were selected to represent different agro-ecologies as well as crop diversifications: teff (Yetmen), wheat (Eteya) and perennials crop (Azedebo) and animal husbandry as integral to farming system (D/Birhan). A sample of 247 households[58] (62 households from each village) who had been interviewed in the 5th round were re-interviewed every fortnight to record the transaction as it was rather than based on recalls.

The YLERHS has detailed information on socio-demographic, consumption, crop output, livestock ownership, and non-farm and off-farm activities, among others. Table 1 presents major crops grown in the villages, percentage of households growing those crops and output (in qt/ha)[59]. Households in Yetmen (93 percent) and Azedebo (31 percent) are growing *teff*. For positive producers, average *teff* production was

[57] The survey launched in the month of April just to align with the beginning of the first plough.
[58] One household is dropped due to incomplete information.
[59] It is the actual measured quantity of output. During survey periods land cultivated and crops output was measured rather than depending only on the responses of household heads. The average is computed for positive producers.

9.21qt/ha in Yetmen (major *teff* growing village) and 4.5qt/ha in Azedebo. All households in D/Brihan and about 23 percent in Eteya are growing barely and produced about 14qt/ha. Wheat is cultivated in all villages that accounts for 30 percent of households in Yetmen and Azedeob, 84 percent in D/Brihan and 95 percent in Eteya. On average, about 19qt/ha of wheat was produced in Eteya (main wheat growing village), 9.5qt/ha in D/Brihan and 8qt/ha in Yetmen and Azedebo. Households growing maize account for 47 percent in Yetmen, 14 percent in Eteya, and 37 percent in Azedebo. The average yield is limited to 5.35qt/ha in Yetmen and about 9qt/ha in Eteya and Azedebo. Sorghum is growing by less than 10 percent of households in D/Brihan and about 20 percent in Eteya, with average yield responses of 10qt/ha and 13qt/ha, respectively.

Table 1: Percentage of households growing crops and average yield produced by households growing

Crop	D/Brihan		Yetmen		Eteya		Azedebo	
	% of hh growing crops	Quantity produced (in qt/ha)	% of hh growing crops	Quantity produced (in qt/ha)	% of hh growing crops	Quantity produced (in qt/ha)	% of hh growing crops	Quantity produced (in qt/ha)
Teff	-	-	93.4	9.2(3.4)	-	-	30.7	4.5(3.2)
Barely	100	13.4(5.8)	-	-	22.6	13.5(9.5)	-	-
Wheat	83.9	9.5(5.4)	29.5	7.8(3.1)	95.2	18.4(7.3)	30.7	8.3(4.4)
Maize	-	-	47.5	5.5(3..3)	14.5	8.4(3.3)	37.1	8.2(7.1)
Sorghum	8.1	10.5(4.6)	-	-	21.0	12.6(5.7)	-	-
Bean	74.2	11.4(8.2)	-	-	37.1	11.5(2.5)	6.5	3.8(1.6)
Vetch	-	-	41.0	8.1(5.6)	-	-	-	-

Source: Authors' computation from survey data
Figures under parentheses are standard deviations.

Households annual gross income is derived from crops output (value of total output), livestock/products sales, wage & self-employment as well as transfer income. On average, households earned (in per capita) about Birr 880.8 in Eteya, Birr 672.4 in D/Birhan; Birr 477.2 in Yetmen and Birr 114.1 in Azedebo (Table 2). The largest share of these income is obtained from crops output in three of four villages; 69 percent in

D/Brihan, 85 percent in Yetmen and 82 percent in Eteya. In Azedebo, crop income accounts for only 29 percent; transfer income has the largest share (36 percent) (Table A1). Livestock/product sales account for the second and third largest share of income in D/Brihan and Azedebo, respectively (Table A1). Wage & self-employment accounts for 13 percent of income in Azedeob albeit less than 5 percent in other villages (Table A1).

About 80 percent of households reported crop output sales (at least for one crop) (Table A1). *Teff* (in Yetmen) and wheat (in Eteya) are the two major crop output sales reported by more than 95 percent of households. This could be implying that these crops are mainly grown for cash requirement of the households as they are fetching better prices in the markets. Output sales of "other crops" are reported by about 89 and 86 percent of households in Eteya and Azedebo (Table A2). In general, sales account for 55 percent of total crop output in Azedebo, 36 percent in Eteya and 21 percent in Yetmen but only 5 percent in D/Brihan (Table 2). As cash crop such as coffee and chat are growing in Azedebo, the sales account for the largest share of crop output in the region.

Table 2: Sample mean of income, consumption expenditure and related variables by villages

	D/Brihan	Yetmen	Eteya	Azedebo
Per capita annual income(in Birr)	672.4	477.2	880.8	114.1
	(270.3)	(259.6)	(566.8)	(111.2)
Share of income from crop output (in %)	69.2	85.3	82.3	29.1
Share of crop output sales (in the total output)	4.7	21.2	36.8	54.8
Per capita annual food expenditure (in Birr)	505.1	385.3	405.8	168.3
	(144.3)	(162.8)	(143.1)	(61.7)
Food expenditure share (in %)	81.2	83.5	62.3	77.7
Age of household head (in years)	52.0	47.1	45.9	45.6
Sex of head; 1 if male	0.8	0.8	0.9	0.8
Family size	6.0	5.3	7.7	7.3

Source: Own computation from survey data.

Households were requested to report total quantity of food consumption from own harvest, purchase and received as gift (either from relatives or other sources). Consumption expenditure is also reported for purchased food items, which allows us to derive unit value as a ratio of consumption expenditure divided by quantities of consumption. The unit value (price) is used to impute consumption expenditure from own harvest as well as received from gift. Total quantity of consumption is also converted into calorie consumption based on Ethiopian Health and Nutrition Research Institute (EHNRI) calorie conversion factors. Total expenditure and calorie consumption are aggregated at household level and standardized into per capita expenditure and daily calorie consumption, respectively.

Household per capita food consumption was, on average, about Birr 405.8 in Eteya, Birr 505.1 in D/Birhan, Birr 385.5 in Yetmen and Birr 168.3 in Azedebo. Share of food in the total household budget is also computed to account for the importance of food in the total household budget. Food accounts for about 80 percent of household budget in three of four villages; in Eteya it accounts for 62 percent. Table 3 presents the share of food by seasons (lean, harvest and post-harvest). Food accounts for about 70 percent and 75 percent during harvest (Dec.- Feb.) and post-harvest (March- May) seasons, respectively, but about to rise to 80 percent in lean seasons (June-August as well as September-November) (Table 3). In harvest as well as post-harvest seasons, non-food expenditure accounts about 30 percent of household budget. This is presumably due to the fact that households often postpone most of their non-food demand to these seasons, as crop outputs are the major sources of rural income that could be used for various purposes. In the lean season, on the other hand, the larger share of the retained income is solely devoted for food consumption.

Table 3: Food budget shares by seasons (in %)

	Jun.-Aug.	Sep.-Nov.	Dec.-Feb.	Mar.-May
Food share	79.3	79.8	68.1	74.1
Cereals	51.9	54.2	49.9	48.7
Teff	24.2	19.7	20.9	27.2
Barley	14.6	16.0	22.5	18.9
Wheat	24.0	24.5	24.1	24.1
Maize	29.0	32.2	23.5	23.1
Sorghum	4.7	3.6	3.7	3.6
Other cereals	2.2	2.7	2.4	2.7
Pluses	15.5	13.7	13.3	14.2
Horse bean	54.0	72.4	69.9	59.9
Other pluses	46.0	27.6	30.1	40.1
Root crops	10.7	12.1	11.5	10.5
Enset	27.5	35.1	26.6	22.0
Potato	72.5	64.9	73.4	78.0
Fruits & vegetables	0.9	0.9	2.2	0.9
Animal products	7.0	4.8	6.1	9.9
other foods	13.1	12.6	15.8	15.8
Coffee	21.7	21.3	22.7	21.9
Sugar	10.9	10.3	8.6	9.0
Cooking oil	16.4	16.4	13.8	14.7
Others	50.2	51.2	51.6	53.2

Source: Authors' computation from survey data

Cereal (teff, maize, wheat, barley and sorghum) are major staple crops account for more than 50 of food budget (Table 3). Maize has the lion share that ranges from 29 percent to 33 percent of cereal consumption in the lean seasons, followed by *teff* and wheat (about 24 percent). During harvest season, wheat, barley and maize accounts for about 23.5 percent of cereal consumption. *Teff* consumption dominates household food budget in April-February (27.2 percent). This could be presumably due to the fact that *teff* threshing has taken place in these months (often after all crops) as it need more intensive care and also because of the Easter Holiday that colorfully celebrating in the month of April. During Easter Holiday, most Ethiopian families are making prestigious pancake food, locally known as *Injera*, made from fermented *teff* flour.

In general, *Injera* is the Ethiopian staple bread which is also made from barely, wheat, maize, sorghum flour or a mixture of *teff* flour with others. While most of urban and

better-off rural households often use *teff,* majority of rural households use other cereals and/or a mixture with *teff*. The staple bread is often supplemented by sauces prepared from pluses, potato and animal products as well as fruits & vegetables. Pulses accounts for about 13.7-16.9 percent of food budget while fruits & vegetables for about 1.1-2.3 percent and animal products ranging from 4.4 percent in June-August to 11.9 percent in March-May. Other foods such as coffee, sugar and cooking oil accounts for 16.5-20.4 percent; coffee shares nearly a quarter of other foods share, as almost all households are commonly making and drinking coffee at least three times a day.

Animals products consumption are essentially increased during months coincides with the Holidays: the Ethiopian New Year (on 11th of September), the commemoration of the Founding of True Cross (on 26th of September), Christmas (on 7th of January) and Easter Sunday (in April), among others. During these festivals animals are slaughtered to lavishly feed not only own family members but also visitors and relatives outside of the family. The New Year festival is more colorfully celebrated in the most part of the country. However, for Christian ethnic groups in the southern region, *Meskel* feast is the most important event of the year that lasts for entire week. Migrant workers return home, gifts are exchanged, new clothes are bought and a lot of feasting takes place. Moreover, the consumption of animal products considerably increase in March-May (about 10 percent) as the Easter Holiday is celebrating after 55 days of fasting and abstaining from eating meat and dairy products (particularly the Orthodox Christian worship) to commemorate the 40 days of fasting of Jesus experienced before crucifixion[60].

[60]There are also other colourfully celebrated Muslim holidays in Ethiopia which leads to have seasonal impact on food consumption of households.

Table A3 presents food budget share by villages. Obviously, food accounts for the largest share of household budget and cereals consumption mount in each village. However, the relative importance of these cereals varies among villages. Barley is more important food items in D/Brihan, teff in Yetmen and wheat in Eteya. Root crops, especially *enset*, are the second most important food item in Azedebo. The importance of crops in each villages largely dominated by the types of crops growing in the villages; for instance, barley is mainly growing in D/Brihan, teff in Yetmen, wheat in Eteya and maize in Azedeob (Table 1).

Food purchase accounts for about 30 percent of household expenditure, on average (Table 4). There are disparities among expenditure quintiles and villages, however. Households in the lowest expenditure quintile rely on market for about 34 percent of their consumption; in Azedebo, it accounts for about 40 percent. The share eventually declines to 23 percent in the third quintile before it increased to 27 percent in the fourth and further to 33 percent in the fifth quintiles. It is implying that the poor as well as better-off households more likely rely on market apparently for consumption shortfall or household consumption preferences than households in the middle income groups. Moreover, the share of purchase in total consumption eventually increases across income quintiles in three of four villages.

Table 4: Food purchased share in total expenditure by villages and expenditure quintiles (in %)

	Q1	Q2	Q3	Q4	Q5	Total
All	33.9	26.5	22.7	26.6	32.9	28.5
Debre Birhan	15.1	21.4	20.4	24.6	20.7	22.4
Yetmen	16.0	22.1	24.5	26.2	-	22.3
Eteya	-	16.6	21.9	31.2	33.9	32.7
Azedebo	40.3	31.2	-	-	-	36.6

Source: Authors' computation from the survey data.
Note: - means no household belongs to that specific income groups

Table 5 presents cereal purchase share in household food budget. Maize purchase accounts for the largest proportion (53 percent) followed by *teff* (17 percent) and wheat (12 percent). Among villages, while *teff* purchase dominates in D/Birhan (53 percent) and Eteya (33 percent), maize does in Yetmen (79 percent) and Azedebo (82 percent). Households in D/Brihan and Eteya depend on market for *teff* consumption, as they are not growing *teff* (Table 1). Maize is cultivated in Yetmen and Azedebo but less than half of households are reported growing. Accordingly, non-growers and growers with consumption shortfall depend on the markets. The demand and supply of food items may also depend on household wealth status and relative prices of food items. The poor households produce *teff* and wheat mainly for marketing as they fetch better prices; and instead demanding maize and sorghum at relatively lower prices. Households in Yetmen, for instance, produce *teff* and supply to distant market places such as Addis Ababa and instead purchase maize for consumption. For poor households, cheaper items could grant them to maintain more quantity of grain for consumption. Better-off households, on the other hand, may be demanding *teff* and wheat. Similarly, households in Eteya and D/Brihan are more likely supply wheat and barley, respectively, and purchase *teff*. Households in Azedebo are producers and consumers of roots crops, especially *enset*. They are also producing maize for

subsistence consumption. In case of consumption shortfall, they do also purchase maize as it is cheaper than other cereals.

Table 5: Cereals purchased by villages (in %)

	D/Birhan	Yetmen	Eteya	Azedebo	All
Teff	52.9	0.5	32.4	7.1	16.9
Barley	1.5	1.0	9.2	0.5	4.0
Wheat	2.9	7.0	14.7	9.6	11.4
Maize	0.0	78.5	10.8	81.5	52.6
Sorghum	10.7	0.9	29.9	1.3	12.7
Other cereals	32.0	12.0	3.0	0.0	2.4

Source: Authors' computation from survey data

Further analysis by expenditure quintiles and food items revealed that larger portion of *teff* purchase accounts for households in the higher income quintiles while maize does in the lower income quintiles (Table 6). Of the total amount of *teff* purchase, for instance, while 25 percent and 52 percent is accounted for households in the fourth and fifth quintiles, respectively, it is limited to 10 percent for households in the two lowest quintiles and about 7 percent in the middle quintile. For households in the lowest and highest expenditure quintiles, wheat purchase accounts for the largest share. Wheat is commonly used for making bread, which equally serve both the poor and better-off households. The share of wheat purchase is low for the middle income presumably they may use from their own harvest, rather than relying on markets. There is no clear pattern for barley; it accounts for about 20 percent in the middle income and 69 percent in the highest income but less than 5 percent in the remaining quintiles. *Enset* purchase is largely dominated by households in the lower income quintiles. Households in the highest income quintiles more likely purchase animal products, fruits & vegetables, coffee, sugar and cooking oil (Table 6).

Table 6: food purchase by expenditure quintiles (in %)

	Q1	Q2	Q3	Q4	Q5
Teff	10.5	10.8	0.7	25.8	52.1
Barley	5.6	1.0	19.4	4.9	69.1
Wheat	30.7	13.0	4.6	22.7	29.0
Maize	48.6	36.2	5.7	2.4	7.1
Sorghum	1.2	4.3	1.1	22.2	71.1
Other cereal	13.9	10.0	20.4	15.8	39.9
Horse bean	41.0	31.9	9.7	9.3	8.1
Other pluses	20.3	21.6	8.8	19.7	29.6
Coffee	2.9	13.0	19.3	29.5	35.4
Enset	77.0	19.7	0.4	0.3	2.6
Potato	19.6	19.8	11.2	17.9	31.5
Fruits & vegetables	8.3	3.7	5.2	35.2	47.7
Animal products	3.0	9.2	30.2	26.0	31.6
Sugar	0.5	4.7	12.9	36.4	45.5
Cooking oil	2.6	7.3	16.9	32.6	40.6
Other foods	10.6	13.9	19.4	27.1	28.9

Source: Authors' computation from YLERHS data

Fig.1 presents daily per capita calorie consumption over the course of the year by villages. Among village, there is a considerable fluctuation in the level of calorie consumption; it is quite remarkable among households in D/Brihan (Fig.1). Apparently, the lowest level of calorie consumption is observed in Azedebo. In general, calorie consumption rises in the months that coincide with Holidays (September and April) as well as during harvest season (December-February). In the months of September the Ethiopia New Year (Enkutatash) and the Founding of True Cross (*Meskel)* festivals are colorfully celebrating on September 11th and 26th, respectively. Figure 2 presents calorie consumption by expenditure quintiles. The level of calorie consumption increases with household expenditure quintiles as expected; households in the higher expenditure quintile consume more calories than households in the next lower income quintile. Moreover, the level of consumption proportionally increases, within each income quintile in the months of September, January and April. On average, about 1200, 2000 and 2500kcal/day/person is consumed for households in the lower, middle and higher income quintile, respectively.

Fig.3: Calorie consumption (in kcal/person/day) by months and villages

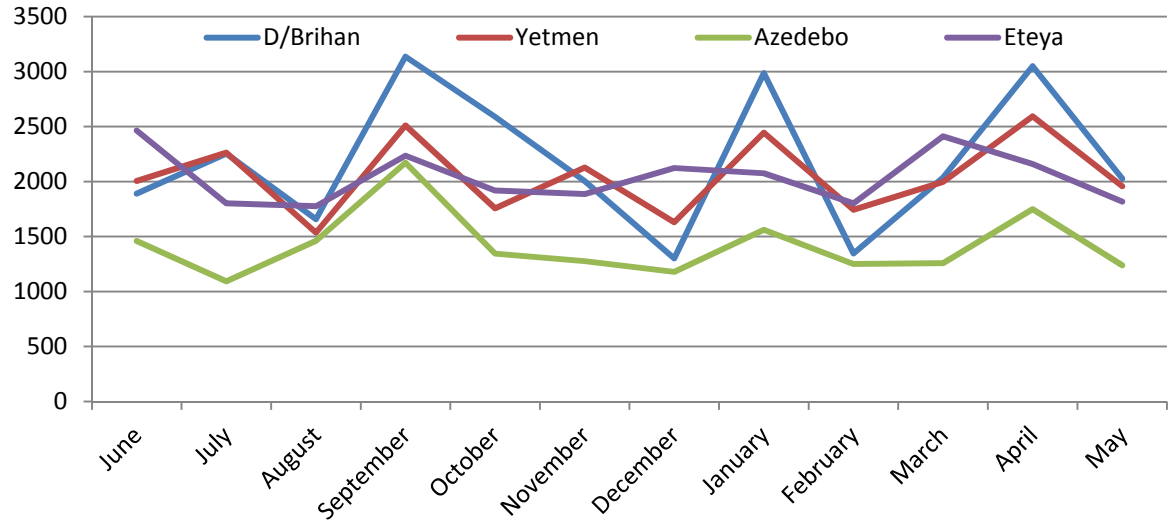
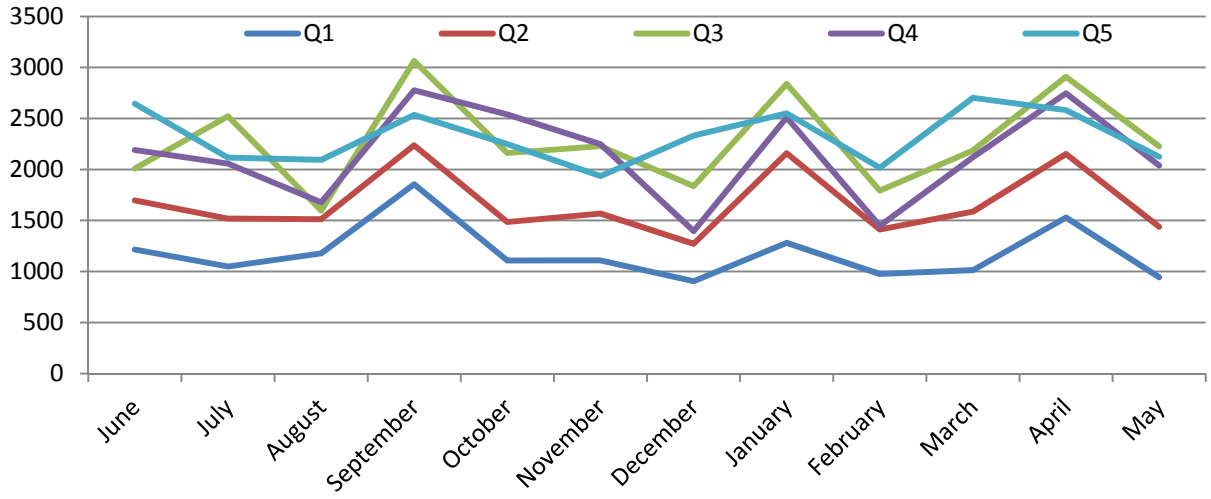


Fig. 4: Calorie consumption (in kcal/person/day) by months and income quintiles



4 Empirical Results

Table 7 and 8 present OLS estimates of log calorie consumption (in kcal/day/person) on monthly dummies controlled for household income and its squared, total livestock owned, household composition, age, sex and education level of head. While Table 7 presents the results for the 12 months (January 2001 is a reference), Table 8 presents for seasons (December-February is constant). The Wald tests for joint significance of monthly/seasonality dummies are significant for all estimates except for Eteya under

seasonal regression (Table 8). It implies that seasonality in calorie consumption is pronounced, which is consistent with our observation in Fig. 1 and Fig. 2. Most of monthly dummies are statistically significant at 1% level of significance except in Eteya. For households in Eteya, only four of monthly dummies are found to be statistically significant at 10 or 5 percent of level of significance. As most of households in Eteya are relatively better-off than other villages (most of them are in the middle and higher income groups), they can mitigate seasonality in food consumption. For households in D/Brihan and Azedebo, calorie consumption in the month of September is higher than in January. Calorie intake in the months of April is higher than the reference months although statistically insignificant. Similarly, calorie intake in the months of September-November, and March-May is higher than in the months of December-February as it is inflated by calorie consumption in the months of September and April, respectively.

Table 7: OLS coefficient estimates of monthly calorie consumption (in kcal/day/person)

	Full sample	All but Azedebo	D/Birhan	Yetmen	Eteya	Azedebo
June	-0.177	-0.187	-0.528	-0.282	0.241	-0.149
	(0.043)**	(0.050)**	(0.066)**	(0.065)**	(0.100)*	(0.083)+
July	-0.300	-0.242	-0.383	-0.204	-0.140	-0.476
	(0.053)**	(0.060)**	(0.088)**	(0.092)*	(0.124)	(0.106)**
August	-0.429	-0.511	-0.698	-0.667	-0.184	-0.195
	(0.052)**	(0.062)**	(0.087)**	(0.098)**	(0.122)	(0.093)*
September	0.153	0.075	0.158	-0.007	0.065	0.376
	(0.045)**	(0.051)	(0.064)*	(0.078)	(0.100)	(0.094)**
October	-0.250	-0.243	-0.200	-0.453	-0.096	-0.322
	(0.050)**	(0.054)**	(0.073)**	(0.077)**	(0.110)	(0.125)*
November	-0.277	-0.268	-0.483	-0.227	-0.087	-0.300
	(0.048)**	(0.055)**	(0.082)**	(0.078)**	(0.114)	(0.097)**
December	-0.445	-0.461	-0.854	-0.635	0.154	-0.401
	(0.055)**	(0.063)**	(0.089)**	(0.102)**	(0.117)	(0.109)**
February	-0.508	-0.580	-0.857	-0.589	-0.291	-0.307
	(0.053)**	(0.063)**	(0.083)**	(0.088)**	(0.132)*	(0.093)**
March	-0.194	-0.152	-0.442	-0.240	0.215	-0.315
	(0.049)**	(0.055)**	(0.076)**	(0.082)**	(0.108)*	(0.101)**
April	0.077	0.081	0.097	0.094	0.062	0.066
	(0.045)+	(0.054)	(0.069)	(0.093)	(0.109)	(0.079)
May	-0.350	-0.359	-0.460	-0.422	-0.198	-0.321
	(0.046)**	(0.053)**	(0.071)**	(0.087)**	(0.101)+	(0.091)**
Constant	11.803	10.108	7.345	9.235	8.769	15.792
	(2.006)**	(2.402)**	(5.548)	(6.516)	(5.086)+	(3.726)**
F- test for months	35.67	27.60	39.08	12.14	6.60	11.68
p value	0.000	0.000	0.000	0.000	0.000	0.000
F statistic	51.3	30.7	28.0	16.2	10.0	13.3
Adjusted R-squared	0.31	0.26	0.41	0.37	0.21	0.23
Observations	2,806	2,083	727	654	703	724

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

Note: Robust standard errors in brackets; the regressions were controlled for household total income and its squared, age, sex and education level of household head; household composition and income quintile.

Table 8: OLS coefficient estimates; Log per capita calorie consumption

	Full sample	All but Azedebo	D/Birhan	Yetmen	Eteya	Azedebo
Jun.-Aug.	-0.015	0.015	-0.006	-0.022	0.064	-0.102
	(0.033)	(0.037)	(0.051)	(0.059)	(0.066)	(0.071)
Sep.-Nov.	0.168	0.167	0.347	0.154	-0.006	0.169
	(0.036)**	(0.038)**	(0.054)**	(0.052)**	(0.075)	(0.079)*
Mar.-May	0.133	0.177	0.205	0.213	0.114	0.004
	(0.035)**	(0.039)**	(0.064)**	(0.064)**	(0.066)+	(0.072)
Constant	12.919	11.752	4.513	15.093	9.577	16.125
	(2.302)**	(2.759)**	(6.793)	(7.701)+	(6.861)	(4.165)**
F test for months	16.90	12.14	33.14	7.30	1.26	6.10
p value	0.000	0.000	0.000	0.001	0.285	0.003
F statistic	44.1	25.0	15.6	14.9	14.1	10.5
Adjusted R-squared	0.43	0.37	0.44	0.50	0.35	0.28
Observations	960	714	248	220	246	246

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

Note: Robust standard errors in brackets

The regression results are also controlled for per capita income and its squared, per capita livestock ownership (in TLU), head sex and education level, household composition (age groups) as well as expenditure quintiles (Table A4). Most of them, however, found to be statistically insignificant; except for per capita livestock ownership for full sample and for households in D/Brihan and Azedebo. Age composition is significant in most of the cases. As we have indicated in the descriptive section, per capita calorie consumption is significantly greater than for households in the highest quintile (5^{th} quintile).

The Working-Leser model, equation (2), is estimated for six food grouping (cereals, pulses, root crops, fruits & vegetables, animal products and "other food staffs") (Table 9 and 10). The budget shares in total expenditure is used as dependent variables and regressed against log total food expenditure and it squared, age of household head and its squared, sex of head and family size as well as villages and monthly dummies. The Wald test display existence of seasonality in consumption for cereals, pulses, root crops, animal products and "other foods" in Table 9 but only for cereals and pulses for seasonal dummies (Table 10). The Adjusted R^2 values are 0.66, 0.74, 0.84, 0.78 and 0.47, respectively, in the former group (Table 9). Note that food budget share in the month of January (reference) is lower than other months except in the month of September and April that coincides with Holiday festivals. Table A5 and A6 present the full regression results. Log per capita consumption has positive and significant impact for each food group. Log total cultivated land has positive impact on the share of cereal consumption but negatively influence other food groups. More lands are allocated for cereal production as its share mount in the total household budget. Age and sex of head

have significant impact only in a full sample while age-composition has mixed results. As expected the share of food in the total expenditure for households in the higher expenditure quintile is lower than other quintiles.

Table 9: OLS estimates seasonality effect by food groups

	Cereal	Pulses	Root crops	Fruits & vegetables	Animal products	Other foods
June	0.012	0.008	0.009	0.001	-0.000	0.008
	(0.011)	(0.004)*	(0.007)	(0.001)	(0.002)	(0.006)
July	0.040	0.013	0.025	0.001	0.001	0.015
	(0.012)**	(0.004)**	(0.006)**	(0.001)	(0.002)	(0.007)*
August	0.058	0.017	0.028	-0.000	0.003	0.027
	(0.012)**	(0.004)**	(0.007)**	(0.001)	(0.002)	(0.007)**
September	-0.026	-0.011	0.006	0.001	-0.002	-0.020
	(0.012)*	(0.003)**	(0.007)	(0.001)	(0.002)	(0.007)**
October	0.022	0.003	0.031	0.002	0.003	0.039
	(0.012)+	(0.004)	(0.006)**	(0.001)+	(0.002)	(0.008)**
November	0.045	0.009	0.012	0.002	0.001	0.052
	(0.012)**	(0.004)*	(0.006)*	(0.001)+	(0.002)	(0.008)**
December	0.063	0.019	0.025	0.003	0.002	0.063
	(0.013)**	(0.004)**	(0.006)**	(0.002)+	(0.002)	(0.007)**
February	0.068	0.018	0.021	0.002	0.003	0.056
	(0.013)**	(0.004)**	(0.006)**	(0.001)*	(0.002)	(0.007)**
March	0.011	0.006	0.010	0.000	-0.001	0.048
	(0.012)	(0.004)+	(0.006)+	(0.001)	(0.002)	(0.008)**
April	-0.023	-0.006	0.007	0.001	-0.004	-0.007
	(0.012)*	(0.004)	(0.006)	(0.001)	(0.003)	(0.007)
May	0.031	0.015	0.035	0.002	0.003	0.034
	(0.012)**	(0.004)**	(0.006)**	(0.001)*	(0.003)	(0.007)**
Constant	-0.116	-0.020	-0.064	-0.004	-0.001	-0.097
	(0.032)**	(0.009)*	(0.017)**	(0.002)+	(0.004)	(0.020)**
F test for months	11.81	17.18	6.11	2.23	3.78	25.84
p value	0.000	0.000	0.000	0.014	0.000	0.000
F statistic	379.8	276.0	229.8	23.1	82.0	113.7
Adjusted R-squared	0.66	0.74	0.84	0.81	0.78	0.47
Observations	2,960	2,935	2,959	2,964	2,964	2,939

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

Table 10: OLS estimates; seasonality effect by food groups

	Cereal	Pulses	Root crops	Fruits& vegetables	Animal products	Other foods
Jun.-Aug.	0.008	0.003	0.003	-0.002	0.001	-0.013
	(0.011)	(0.003)	(0.006)	(0.001)	(0.001)	(0.004)**
Sep.-Nov.	-0.033	-0.014	0.004	-0.001	-0.003	-0.019
	(0.011)**	(0.002)**	(0.006)	(0.001)	(0.001)*	(0.005)**
Mar.-May	-0.030	-0.005	0.008	-0.001	-0.001	-0.008
	(0.010)**	(0.003)*	(0.005)	(0.001)	(0.002)	(0.005)+
Constant	-0.158	-0.004	-0.042	-0.004	-0.011	-0.071
	(0.059)**	(0.012)	(0.027)	(0.004)	(0.006)+	(0.021)**
F test for months	10.04	21.24	0.45	0.33	3.13	2.31
p value	0.000	0.000	0.637	0.719	0.044	0.100
F statistic	70.6	245.0	192.3	27.2	215.3	86.8
Adjusted R-squared	0.63	0.81	0.87	0.88	0.90	0.60
Observations	988	969	988	988	982	973

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

Table 11 presents instrumental variables regression results from 2SLS, LIML and GMM estimators for impact of market participation on household consumption. The results are controlled for assets (livestock ownership), share of off-farm income, household demographics as well as village dummies. The Wald chi-square test signifies with adjusted R^2 of about 0.42. Test of endogeneity and over identification restrictions, reported at the bottom of Table 11, shows that there is no endogeneity and over identification problem in the instrumental variables. The results have confirmed that household market participation, as measured by share of income from output sales; significantly improve household consumption by about 50 percent in GMM estimators to 59 percent in LIML estimators. In all estimators, share of income from off-farm activities are positively and significantly increase household consumption. Among household demographics, only family sizes (household compositions) are found to have negative and significant impact on household consumption. The consumption level of households in D/Brihan, Yetmen and Eteya are found to be higher than households in Azedebo (reference villages).

Table 11: Per capita calorie consumption: Instrumental-variables regression

	2SLS	LIML	GMM
Share of income from crop output sales	0.583	0.593	0.508
	(0.232)*	(0.266)*	(0.223)*
Log(livestock owned (in TLU))	0.538	0.537	0.517
	(0.093)**	(0.082)**	(0.082)**
Share of off-farm earning	0.349	0.351	0.319
	(0.110)**	(0.133)**	(0.106)**
Age of household head	0.011	0.011	0.011
	(0.011)	(0.009)	(0.010)
Household head age squared	-0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)
Sex of household head	-0.081	-0.081	-0.109
	(0.063)	(0.059)	(0.053)*
Education of head (1=Primary)	0.050	0.050	0.051
	(0.046)	(0.047)	(0.043)
Education of head (1=Secondary)	0.017	0.016	0.025
	(0.044)	(0.056)	(0.042)
Family member aged 0-6 years	-0.108	-0.108	-0.106
	(0.017)**	(0.019)**	(0.015)**
Family member aged 7-15 years	-0.042	-0.042	-0.045
	(0.016)**	(0.017)*	(0.016)**
Family member aged 16-60 years	-0.063	-0.064	-0.064
	(0.011)**	(0.012)**	(0.011)**
Family member aged 61 and above years	0.021	0.021	0.024
	(0.036)	(0.041)	(0.034)
Village dummy(1=D/Brihan)	0.207	0.208	0.211
	(0.084)*	(0.078)**	(0.078)**
Village dummy (1=Yetmen)	0.117	0.117	0.139
	(0.079)	(0.062)+	(0.070)*
Village dummy(1=Eteya)	0.253	0.251	0.271
	(0.058)**	(0.069)**	(0.055)**
Constant	13.248	13.246	13.306
	(0.288)**	(0.215)**	(0.240)**
Wald Chi2	458.1**	265.6**	496.2**
Adjusted R-squared	0.49	0.49	0.50
Observations	246	246	246
Instrumental-variables test			
Test of endogeneity			
Robust score *chi2(1)*	0.72(p=0.39)		
Robust regression *F(1, 229)*	0.67(p=0.41)		
GMM C statistics *chi2(1)*			0.5(p=0.48)
Test of over identification restrictions			
Score *chi2(5)*	3.13(p=0.68)		
Anderson-Rubin *chi2(5)*		2.6(p=0.76)	
Basmann *F(5, 225)*		0.48(p=0.78)	
Hansen's J *chi2(5)*			3.13(p=0.68)

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

5 Conclusions

In this study seasonality food consumption seasonality and household market participation in the effort to improve household consumption are examined using a Yearlong Monitoring Ethiopian Rural Household Survey (YLMERHS) conducted at every fortnight for a period between April 2000 and June 2001. Using simple OLS as well as Working-Leser model, we found that food consumption seasonality is profound in rural areas of Ethiopia. More importantly, food consumption, as measured by calorie intake, rises not only during harvest season where the stock is relative high but also in the months of lean season that coincide with Holidays. In the month of September, for instance, households colorfully celebrate two National Holidays: the Ethiopia New Year (*Enkutatash*) and the Founding of True Cross (*Meskel)* festivals; Easter Sunday is celebrated in the month of April. During these festivals animals are slaughtered to lavishly feed not only own family members but also visitors and relatives outside of the family. Moreover, using instrumental-variables regression, as to control for endogeniety of the share of income from crop output sales, we also found that household market participation improves household consumption. Household consumption is also positively and significantly influenced by productive assets ownership (livestock) and income from off-farm activities. As expected, family size negatively influence the level of household consumption.

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Table A2: Percentage share of total income from different sources

	D/Brihan	Yetmen	Eteya	Azedebo	All sample
Crop output	69.22	85.30	82.25	29.13	66.40
Livestock/product sales	17.66	1.14	3.63	20.82	10.85
Wage & self-employment	1.95	3.69	4.29	13.31	5.82
Transfers	9.56	9.86	9.83	36.73	16.52

Table A3: Proportions of households reported output sales (in %)

	D/Brihan	Yetmen	Eteya	Azedebo	All sample
Teff		90.2		21.0	27.5
Wheat	3.2	39.3	100.0	1.6	36.0
Others	38.7	44.3	88.7	85.5	64.4
Total	40.3	95.1	100.0	88.7	81.0

Table A3: Food budget share by seasons and villages (in %)

	D/Birhan				Eteya			
	Jun.-Aug.	Sep.-Nov.	Dec.-Feb.	Mar.-May	Jun.-Aug.	Sep.-Nov.	Dec.-Feb.	Mar.-May
Food share	59.6	64.7	46.6	59.4	48.8	54.0	24.3	23.3
Cereals	54.8	54.7	56.9	53.8	51.4	58.6	50.9	47.8
Teff	19.0	23.2	3.9	13.7	19.2	12.7	11.5	22.0
Barley	44.6	37.3	67.0	57.7	12.8	23.7	20.4	15.1
Wheat	20.8	25.1	25.3	20.2	49.3	51.9	44.6	45.0
Maize	8.4	6.6	1.2	3.0	8.2	6.1	8.9	8.5
Sorghum	6.7	7.2	2.4	4.5	10.5	5.7	11.2	9.2
Other cereals	0.6	0.7	0.1	0.9	0.0	0.0	0.1	0.2
Pluses	22.9	27.9	18.1	17.1	16.8	15.6	18.4	15.9
Horse bean	86.1	82.2	81.8	82.0	76.4	78.9	80.2	81.1
Other pluses	13.9	17.8	18.2	18.0	23.6	16.3	16.6	18.9
Root crops	1.8	1.5	5.5	2.3	8.6	3.5	4.5	4.7
Enset	3.2	1.6	9.3	10.5	1.8	0.0	1.1	0.2
Potato	54.8	46.8	45.5	41.1	85.3	56.5	81.1	91.8
Fruits & vegetables	1.4	1.5	0.9	0.9	1.5	0.7	2.1	2.0
Animal products	8.0	1.2	7.3	15.1	9.4	7.2	8.1	14.7
other foods	11.1	13.2	11.4	10.8	12.3	11.1	14.4	14.8
Coffee	24.3	24.0	26.6	26.2	30.1	29.2	25.0	27.6
Sugar	18.7	16.8	16.1	14.9	18.9	19.2	14.6	14.1
Cooking oil	18.6	20.0	18.3	16.1	22.7	23.5	17.8	18.0
Others	38.4	39.1	39.1	42.8	28.3	28.0	39.3	40.3

Table A3: Food budget share by seasons and villages (cont'd)

	Yetmen				Azedebo			
	Jun.-Aug.	Sep.-Nov.	Dec.-Feb.	Mar.-May	Jun.-Aug.	Sep.-Nov.	Dec.-Feb.	Mar.-May
Food share	75.8	65.4	66.2	56.6	76.7	53.1	60.9	50.4
Cereals	62.6	60.7	58.4	61.5	38.9	42.9	33.7	31.9
Teff	55.4	39.6	50.0	53.4	3.6	3.8	18.8	20.2
Barley	1.0	1.6	0.6	0.7	0.0	1.2	1.5	1.8
Wheat	14.4	13.0	9.2	15.1	11.4	8.0	21.0	16.0
Maize	15.9	30.1	26.3	19.2	83.5	85.9	53.7	61.4
Sorghum	0.1	0.6	1.0	0.2	1.6	1.1	0.2	0.4
Other cereals	8.3	10.2	9.6	9.8	0.0	0.0	0.0	0.2
Pluses	7.7	8.4	8.9	13.9	14.6	3.0	7.7	9.8
Horse bean	4.0	11.3	22.0	9.3	6.0	62.6	48.6	32.4
Other pluses	27.1	31.3	25.5	38.2	82.7	24.5	40.1	62.8
Root crops	2.3	1.6	2.9	3.4	30.1	41.6	32.8	31.5
Enset	0.0	0.0	0.0	0.0	76.0	90.0	73.1	62.5
Potato	50.8	59.0	86.9	91.8	24.0	8.4	18.8	35.9
Fruits & vegetables	0.0	1.2	5.1	0.0	0.7	0.3	0.8	0.8
Animal products	10.6	10.3	8.0	9.0	0.2	0.4	1.0	0.6
other foods	13.6	14.6	15.1	12.2	15.5	11.7	22.4	25.4
Coffee	28.6	28.7	25.5	30.1	4.0	3.2	13.7	3.8
Sugar	6.1	4.6	3.3	6.1	0.0	0.3	0.4	0.6
Cooking oil	18.5	16.9	14.5	16.3	5.7	5.4	4.6	8.3
Others	43.6	46.5	53.4	42.5	90.3	91.1	74.8	87.2

Source: Authors' computation from survey data

Table A4: OLS coefficient estimates; Log per capita daily calorie consumption

	All	All but Azedebo	D/Birhan	Yetmen	Eteya	Azedebo
Log (per capita income)	-0.089	-0.228	0.205	0.042	-0.540	0.235
	(0.099)	(0.140)	(1.296)	(0.245)	(0.371)	(0.268)
Log (per capita income squared)	0.014	0.028	-0.001	-0.002	0.050	-0.027
	(0.009)	(0.012)*	(0.100)	(0.024)	(0.031)	(0.029)
Log (per capita livestock owned (in TLU)	0.196	0.128	0.190	0.003	0.241	0.631
	(0.053)**	(0.056)*	(0.110)+	(0.103)	(0.147)	(0.234)**
Log (age of household head (in years)	0.037	1.137	1.629	1.031	2.465	-2.850
	(1.057)	(1.262)	(1.848)	(3.544)	(2.519)	(2.031)
Log (age of household head squared (in years)	-0.012	-0.161	-0.203	-0.100	-0.354	0.384
	(0.141)	(0.167)	(0.241)	(0.477)	(0.339)	(0.272)
Sex of household head; 1 if male	-0.068	-0.009	-0.026	0.090	-0.114	-0.216
	(0.038)+	(0.044)	(0.065)	(0.138)	(0.079)	(0.077)**
Education of head; 1 if literate	-0.009	-0.042	-0.120	0.170	-0.100	0.091
	(0.027)	(0.031)	(0.040)**	(0.074)*	(0.068)	(0.062)
Family member aged 0-6 years	-0.077	-0.064	-0.072	0.007	-0.093	-0.085
	(0.010)**	(0.013)**	(0.026)**	(0.025)	(0.022)**	(0.020)**
Family member aged 7-15 years	-0.033	-0.031	-0.028	-0.035	-0.032	-0.021
	(0.010)**	(0.012)**	(0.024)	(0.023)	(0.019)+	(0.021)
Family member aged 16-60 years	-0.040	-0.041	-0.037	-0.070	-0.039	-0.058
	(0.007)**	(0.008)**	(0.020)+	(0.025)**	(0.012)**	(0.016)**
Family member aged 61 and above years	-0.000	0.008	-0.021	-0.081	0.022	-0.033
	(0.025)	(0.027)	(0.036)	(0.102)	(0.047)	(0.056)
June	-0.177	-0.187	-0.528	-0.282	0.241	-0.149
	(0.043)**	(0.050)**	(0.066)**	(0.065)**	(0.100)*	(0.083)+
July	-0.300	-0.242	-0.383	-0.204	-0.140	-0.476
	(0.053)**	(0.060)**	(0.088)**	(0.092)*	(0.124)	(0.106)**
August	-0.429	-0.511	-0.698	-0.667	-0.184	-0.195
	(0.052)**	(0.062)**	(0.087)**	(0.098)**	(0.122)	(0.093)*
September	0.153	0.075	0.158	-0.007	0.065	0.376
	(0.045)**	(0.051)	(0.064)*	(0.078)	(0.100)	(0.094)**
October	-0.250	-0.243	-0.200	-0.453	-0.096	-0.322
	(0.050)**	(0.054)**	(0.073)**	(0.077)**	(0.110)	(0.125)*
November	-0.277	-0.268	-0.483	-0.227	-0.087	-0.300
	(0.048)**	(0.055)**	(0.082)**	(0.078)**	(0.114)	(0.097)**
December	-0.445	-0.461	-0.854	-0.635	0.154	-0.401
	(0.055)**	(0.063)**	(0.089)**	(0.102)**	(0.117)	(0.109)**
February	-0.508	-0.580	-0.857	-0.589	-0.291	-0.307
	(0.053)**	(0.063)**	(0.083)**	(0.088)**	(0.132)*	(0.093)**
March	-0.194	-0.152	-0.442	-0.240	0.215	-0.315
	(0.049)**	(0.055)**	(0.076)**	(0.082)**	(0.108)*	(0.101)**
April	0.077	0.081	0.097	0.094	0.062	0.066
	(0.045)+	(0.054)	(0.069)	(0.093)	(0.109)	(0.079)
May	-0.350	-0.359	-0.460	-0.422	-0.198	-0.321
	(0.046)**	(0.053)**	(0.071)**	(0.087)**	(0.101)+	(0.091)**
Constant	11.803	10.108	7.345	9.235	8.769	15.792
	(2.006)**	(2.402)**	(5.548)	(6.516)	(5.086)+	(3.726)**
F test for months	35.67	27.60	39.08	12.14	6.60	11.68
p value	0.000	0.000	0.000	0.000	0.000	0.000
F statistic	51.3	30.7	28.0	16.2	10.0	13.3
Adjusted R-squared	0.31	0.26	0.41	0.37	0.21	0.23
Observations	2,806	2,083	727	654	703	724

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

Table A5: OLS estimates; seasonality effect by food groups

	Cereal	Pulses	Root crops	Fruits& vegetables	Animal products	Other foods
Log pc consumption	0.329	0.073	0.103	0.021	0.038	0.115
	(0.008)**	(0.003)**	(0.008)**	(0.012)+	(0.005)**	(0.010)**
Log pc consumption squared	-0.032	0.002	0.026	0.031	0.013	-0.000
	(0.002)**	(0.001)	(0.003)**	(0.008)**	(0.003)**	(0.003)
Log total cultivated land size	0.023	-0.010	-0.035	-0.002	-0.002	-0.032
	(0.008)**	(0.002)**	(0.004)**	(0.001)**	(0.001)*	(0.005)**
Age of household head	-0.002	-0.001	0.001	0.000	-0.000	0.000
	(0.001)+	(0.000)	(0.001)	(0.000)	(0.000)	(0.001)
Age of household head squared	0.000	0.000	-0.000	-0.000	0.000	-0.000
	(0.000)*	(0.000)+	(0.000)	(0.000)	(0.000)	(0.000)
Sex of household head	0.028	0.001	0.010	0.001	0.002	-0.000
	(0.008)**	(0.002)	(0.004)*	(0.001)	(0.001)+	(0.005)
Head education dummy; 1 if literate	-0.046	0.005	0.007	-0.001	-0.002	0.011
	(0.007)**	(0.002)*	(0.003)*	(0.001)	(0.001)*	(0.004)**
Number of families aged <= 6	0.019	0.002	0.002	0.000	0.001	0.005
	(0.003)**	(0.001)**	(0.001)	(0.000)*	(0.000)**	(0.002)**
Number of families aged 7-15	-0.002	0.002	0.005	0.001	-0.001	0.005
	(0.002)	(0.001)**	(0.001)**	(0.000)*	(0.000)+	(0.002)**
Number of families aged 16-60	-0.003	0.002	0.006	0.000	0.000	0.009
	(0.002)*	(0.000)**	(0.001)**	(0.000)	(0.000)	(0.001)**
Number of families aged 61 and above	-0.037	-0.001	0.013	0.000	-0.002	0.012
	(0.008)**	(0.002)	(0.004)**	(0.001)	(0.001)+	(0.004)**
June	0.012	0.008	0.009	0.001	-0.000	0.008
	(0.011)	(0.004)*	(0.007)	(0.001)	(0.002)	(0.006)
July	0.040	0.013	0.025	0.001	0.001	0.015
	(0.012)**	(0.004)**	(0.006)**	(0.001)	(0.002)	(0.007)*
August	0.058	0.017	0.028	-0.000	0.003	0.027
	(0.012)**	(0.004)**	(0.007)**	(0.001)	(0.002)	(0.007)**
September	-0.026	-0.011	0.006	0.001	-0.002	-0.020
	(0.012)*	(0.003)**	(0.007)	(0.001)	(0.002)	(0.007)**
October	0.022	0.003	0.031	0.002	0.003	0.039
	(0.012)+	(0.004)	(0.006)**	(0.001)+	(0.002)	(0.008)**
November	0.045	0.009	0.012	0.002	0.001	0.052
	(0.012)**	(0.004)*	(0.006)*	(0.001)+	(0.002)	(0.008)**
December	0.063	0.019	0.025	0.003	0.002	0.063
	(0.013)**	(0.004)**	(0.006)**	(0.002)+	(0.002)	(0.007)**
February	0.068	0.018	0.021	0.002	0.003	0.056
	(0.013)**	(0.004)**	(0.006)**	(0.001)*	(0.002)	(0.007)**
March	0.011	0.006	0.010	0.000	-0.001	0.048
	(0.012)	(0.004)+	(0.006)+	(0.001)	(0.002)	(0.008)**
April	-0.023	-0.006	0.007	0.001	-0.004	-0.007
	(0.012)*	(0.004)	(0.006)	(0.001)	(0.003)	(0.007)
May	0.031	0.015	0.035	0.002	0.003	0.034
	(0.012)**	(0.004)**	(0.006)**	(0.001)*	(0.003)	(0.007)**
Constant	-0.116	-0.020	-0.064	-0.004	-0.001	-0.097
	(0.032)**	(0.009)*	(0.017)**	(0.002)+	(0.004)	(0.020)**
F test for months	11.81	17.18	6.11	2.23	3.78	25.84
p value	0.000	0.000	0.000	0.014	0.000	0.000
F statistic	379.8	276.0	229.8	23.1	82.0	113.7
Adjusted R-squared	0.66	0.74	0.84	0.81	0.78	0.47
Observations	2,960	2,935	2,959	2,964	2,964	2,939

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

Table A6: OLS estimates; seasonality effect by food groups

	Cereal	Pulses	Root crops	Fruits& vegetables	Animal products	Other foods
Log pc consumption	0.299	0.054	0.042	0.027	0.034	0.092
	(0.023)**	(0.004)**	(0.012)**	(0.007)**	(0.003)**	(0.017)**
Log pc consumption squared	-0.020	0.010	0.044	0.027	0.014	0.007
	(0.004)**	(0.001)**	(0.005)**	(0.004)**	(0.002)**	(0.006)
Log total cultivated land size	0.016	-0.013	-0.041	-0.003	-0.005	-0.022
	(0.011)	(0.003)**	(0.006)**	(0.001)+	(0.002)**	(0.005)**
Age of household head	-0.003	-0.001	0.000	0.000	0.000	-0.001
	(0.002)+	(0.001)*	(0.001)	(0.000)	(0.000)	(0.001)
Age of household head squared	0.000	0.000	-0.000	-0.000	-0.000	0.000
	(0.000)*	(0.000)**	(0.000)	(0.000)	(0.000)	(0.000)
Sex of household head	0.018	0.002	0.012	0.001	0.002	-0.001
	(0.012)	(0.003)	(0.007)+	(0.001)	(0.001)+	(0.005)
Head education dummy; 1 if literate	-0.038	0.001	0.011	-0.001	-0.000	0.010
	(0.010)**	(0.003)	(0.005)*	(0.001)	(0.001)	(0.004)*
Number of families aged <= 6	0.021	0.004	0.002	0.001	0.003	0.007
	(0.004)**	(0.001)**	(0.002)	(0.000)*	(0.001)**	(0.002)**
Number of families aged 7-15	0.002	0.002	0.006	0.001	-0.001	0.005
	(0.003)	(0.001)**	(0.002)**	(0.001)	(0.000)	(0.002)**
Number of families aged 16-60	0.001	0.003	0.007	0.000	0.000	0.008
	(0.002)	(0.001)**	(0.001)**	(0.000)	(0.000)	(0.001)**
Number of families aged 61 and above	-0.031	-0.005	0.016	0.002	-0.000	0.010
	(0.010)**	(0.003)+	(0.007)*	(0.001)	(0.001)	(0.005)*
Jun.-Aug.	0.008	0.003	0.003	-0.002	0.001	-0.013
	(0.011)	(0.003)	(0.006)	(0.001)	(0.001)	(0.004)**
Sep.-Nov.	-0.033	-0.014	0.004	-0.001	-0.003	-0.019
	(0.011)**	(0.002)**	(0.006)	(0.001)	(0.001)*	(0.005)**
Mar.-May	-0.030	-0.005	0.008	-0.001	-0.001	-0.008
	(0.010)**	(0.003)*	(0.005)	(0.001)	(0.002)	(0.005)+
Constant	-0.158	-0.004	-0.042	-0.004	-0.011	-0.071
	(0.059)**	(0.012)	(0.027)	(0.004)	(0.006)+	(0.021)**
Test for months	10.04	21.24	0.45	0.33	3.13	2.31
p value	0.000	0.000	0.637	0.719	0.044	0.100
F statistic	70.6	245.0	192.3	27.2	215.3	86.8
Adjusted R-squared	0.63	0.81	0.87	0.88	0.90	0.60
Observations	988	969	988	988	982	973

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

Paper V

Emerging Cash Transfers and Beneficiaries Preference: The case of Productive Safety net programme in Ethiopia

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Abstract

An estimate of 8.8 million individuals in rural Ethiopia suffers from chronic food insecurity and many more from transitory food insecurity. Productive Safety Net Programme (PSNP) has been implemented in attempting for long-term solution through protecting asset depletion at household levels and asset creation at community levels. The programme offers nationwide opportunity to begin a transition from providing in-kind (especially food) relief to giving cash to beneficiaries. The rationale for cash transfer was that cash would better enable beneficiary households to diversify income sources and build asset levels, and that increased cash supply in rural communities would stimulate the rural economy benefiting everyone, including the destitute. However, less than 20 percent of beneficiaries prefer "cash only" transfer comparing with "in-kind only" or combination of "in-kind and cash" transfer. Using multinomial probit regression the paper has shown that, among others, escalating prices of food crops, higher local wage rate, receiving free food aid in most recent years, low levels of food consumption, distress assets sale and distance from local markets are major factors influencing their transfer choice. As current prices of major food crops escalating, fixed amount of cash transfer, Birr 5 per day per person, is insufficient to purchase basic food requirements. Moreover, local wage rate varies among regions and significantly higher than cash transfer. The paper argues that transfer adjustment conditional to a local wage rates is crucial if we are dreaming for long-term impacts of the programme.

Keywords: cash; transfer choice; chronic food insecurity; productive safety net program

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1 Introduction

Ethiopia has had long standing capacity in emergency response, which has protected vulnerable populations against the most severe symptoms of crises in the short term. Food insecure households have received food aid on an annual basis for most of the past years. Yet, an estimate of over 8 million individuals in rural areas suffers from chronic[61] food insecurity and many more from transitory food insecurity. The government of Ethiopia (GoE), with the collaboration of a group of donors, has embarked in a large effort aimed at finding a more development-oriented solution to chronic food insecurity.

A new Food Security Programme (FSP), Productive Safety Net Programme (PSNP)[62], has been put in place since 2005 with objective to graduate chronically food insecure individuals in five years through assets protection mechanisms at household levels and building community assets to contribute to address root causes of food insecurity. The Productive Safety Net Program (PSNP) has protected the consumption needs of groups that had tended to show up on food aid rolls every year, and prevented the loss of household assets of those groups over the medium term (Sharp et al. 2006, Devereux and Sabates-Wheeler 2006). Moreover, PSNP has provided an opportunity to begin a transition from providing in-kind (especially food) relief to giving cash to programme beneficiaries. The rationale for cash transfer was that cash would better enable beneficiary households to diversity income sources and build asset levels, and that

[61] According to Ethiopian Food Security Programme (FSP) context chronically food insecure households are households who report food insecurity for three or more months of the year at least in the last three consecutive years.

[62] Resettlement and Other Food Security Programme (OFSP) are another Food Security Packages implemented by Government of Ethiopia with collaboration of donors aimed at reducing food insecurity faced by vulnerable households.

increased cash supply in rural communities would stimulate the rural economy benefiting everyone, including the destitute (see also GFDRE, 2004; Adams and Emebet, 2005; Emebet, 2006 and Gilligan et al., 2007).

PSNP has two components: (i) labour intensive public works and (ii) direct supports. While chronically food insecure households who can contribute labour participate in public works component, labor poor households such as disabled, ill, elders, etc., received direct supports. The programme intends to serve a dual purpose through its both components. One is to help bridge the income gap of chronically food-insecure households, and the second is to engage chronically food insecure households in community based asset-building such as rehabilitation of natural resources including land, water and vegetation in exchange for the income they earn. Although PSNP beneficiaries have to substantially complement with Other Food Security Program (OFSP) such as improved credit, fertilizer, improved seed etc., which would enhance asset creation and income generation, there is a little evidence that the beneficiaries are also receiving benefits from OFSP except in Tigray and to lesser extent in Amhara (see Gilligan et al., 2007).

PSNP Programme Implementation Manual (PIM) stated that beneficiary households (both in public works or direct supports components) have to be those who failed to meet food requirements at least for three months of the year in the last three years and/or who subjected to productive assets sale because of shocks. Among others the paper then tries to enumerate: (i) whether selection of beneficiaries are as anticipated

in the PIM.[63], (ii) whether transfers could bridge consumption gaps at least to the level of better off non-beneficiary households in the local community and (iii) whether beneficiaries prefer "cash only" than in-kind (food) payment as cash is assumed to be more flexible to diversify income sources and build asset. If not what is (are) the major factor(s) influencing their decision?

The long-term impacts of the programme i.e., protecting distress assets sale at household levels and creating assets at community level is not yet explored in the paper as it is too early to judge the results. Nevertheless, it is important to mention here that long-term impacts are more indispensable for asset formulation both at household and community level. Long term-impacts of food-for-work programmes, for instance, have mixed effects. In 1990s, it built road with multiplier effects in the low land of Ethiopia (Braun et al., 1999) and crowd-in private investment in soil conservation and improve the welfare of people in the longer term in Tigray region (Holden et al., 2006). In contrast, survival rate of trees planted were low, maintenance of contour bunds was inadequate, and productivity gains often appear minimal for the program implemented in 1980s (see Von Braun et al., 1992).

Cash transfer is not completely a new happening in Ethiopia. NGOs, such as Save the Children UK (SC-UK), World Vision, the Ethiopian Orthodox Church, CARE-Ethiopia, Feed the Hungry International (FHI) and the Relief Society of Tigray (REST) have engaged in cash transfer since 2001. These organizations are now working as a PSNP implementing partners and have their own cash-based livelihood development programme. Impact evaluation of SC-UK cash transfer project under Meket Livelihoods Development Project (MLDP) has shown that assisted households suited to areas

[63] The detail discussions how beneficiaries are selected, who participate in selection process and other important information are given in Gilligan et al., 2007.

integrated into market-oriented infrastructure and institution were able to take advantage of cash transfer to build and exploit productive assets (Adams and Emebet, 2005 and Emebet, 2006). However, for similar project of SC-UK in more remote areas from integrated market such as Sekota district, use of in-kind transfer appears more appropriate (Emebet, 2006). The rest of the paper is organized first to address the conceptual issues intended to capture the central themes followed by description of the key variables, determinants of selection and beneficiaries transfer choice. Finally, policy implications are drawn.

2 Data and methodology

The paper is based on the Ethiopian food security baseline survey data collected between June and September 2006 by Central Statistical Agency (CSA) in collaboration with donors. The survey was developed with technical support from the International Food Policy Research Institute (IFPRI). The data are collected based on sample survey of four regional states of Amhara, Oromiya, Tigray and SNNP and covers a total of 3,688 households[64], both Food Security Programme (FSP) and non-FSP beneficiaries, located in 148 communities. The ultimate sampling units and households were selected from each community using random sampling techniques (see detail discussions in Gilligan et al., 2007). Data were collected using structured questionnaire. For the purpose of this paper, at minimal, the most relevant information required to undertake the analysis included those factors that measure or indicate the chance of being in PSNP and their transfer choice that include shocks (both idiosyncratic and covariate), distress assets sale, household levels of food consumption, livestock ownership, etc.

[64] Although the survey was intended to cover 3,700 households, only 3688 households were covered.

Following PSNP community identification, the survey purposively included 60 percent of beneficiary households whose members, at least one, participated in public works, direct supports or both. Sections, in the survey questionnaire, designed to report public works and direct supports used to identify beneficiary and non-beneficiary households. In the public works section beneficiary individuals were requested to report number of days worked and amount paid under PSNP. Similarly, beneficiary individuals under direct supports also were requested to report amount received in cash or its in-kind equivalent. The study then supposes beneficiaries are only those who report public works and amount paid or who received direct supports. Finally, household status was identified through aggregating individual data in a mode that a household is beneficiary of the programme if at least one of its members being in public works or direct supports components.

"Given a choice what proportion of your payment would you like to receive in cash and/or in-kind" is articulated to capture perception of beneficiaries to PSNP operation. The responses were measured using a discrete choice, namely in "cash only", "in-kind only", 50% in cash and 50% in-kind, 75% in-kind and 25% in cash or vice versa. Nevertheless, only 12 and 6 percent of cases reported 75% in cash and 25% in-kind; and 25% in cash and 75% in-kind, respectively (see annex I). Thus, all combinations of cash and in-kind preferences are merged and treated as single category of "*combination of cash and in-kind transfer*". Consequently, the paper uses "*cash only", "in-kind only"* and *combinations of in cash and in-kind* preferences as three discrete choices. Although there are 2,224 programme beneficiary households in the sample, only 2,007(90%) report their transfer choice. Therefore, the discussion of transfer choice is conducted for households who reported their preferences.

As we have discrete variables for both selection (i.e., 1 if at least one member of household is programme beneficiary and 0 otherwise) and beneficiaries transfer choice (i.e., 0 if in-kind only, 1 if in cash only and 2 if both in-kind and cash), the study applies simple probit regression model for selection and multinomial probit regression model for transfer choice. The independent variables are constructed as follows: Households were requested to report the most important shocks that affect their welfare status in the last five years. At the same time they also appealed to rank the three most important shocks that acutely affect their status in the last three years. Households were also asked to rank whether the shocks were compulsory to reduce income and/or to sale assets to cover food requirements at least for three months of the year in the last three years. As a maters of fact distress assets sale is considered if households subjected to productive assets sale to cover food requirements at least for two years. Besides, construction of receiving free food aid variables is straightforward. Households were asked to report whether they received free food aid between June 2004/05 and June 2005/06, June 2003/04 and June 2004/05; and June 2001/02 and June 2002/03. All the above explanatory variables are dichotomy variables recode to 1 if shocks, impacts of shocks, distress assets sale and received free food aid in most recent years are reported and to 0 otherwise, respectively.

Computing food consumption per capita was a bit difficult for various reasons. Firstly, the problem arises due to inappropriate local unit conversions to kilogram. While conducting a survey weekly consumption of households were measured in local unit, but there was also a column to report its equivalent in kilogram; nevertheless, either due to misinterpretation of local unit conversion to kilogram or data entry problem

etc., figures for most of the reported equivalent is found to be inconsistent. We first fix known local unit to kilogram and where it was difficult to reconcile, we prefer to adapt nearby areas local unit conversion factors collected by the Ethiopian Rural Household Survey (ERHS). The second major problem arises from reported amount of consumption in a week. Whilst it was very big that couldn't seem to be consumed in a week for some households, it was very low that was not even enough for a day for some other households. We used robust statistics and made an adjustment in both cases. Missing unit prices of some crops consumed is the third major problem in constructing food consumption. As value of consumption is used, rather than quantity, it is inevitable to construct unit prices of items consumed. However, it was missed for some crops and hence urged us to look for other alternatives such as replacing by woredas, zones or regional unit prices. Accordingly, if the missing was found at *woreda* level, we preferred to use *woredas* crop unit prices and if not we used zones or regional unit prices until the missing is replaced.

3 Descriptive statistics

The major criterion to be PSNP beneficiary is short of food requirements of households at least for three months of the last three years mainly because of shocks. Therefore, it is important to explore the nature of shocks influencing those households' welfare status. The survey was designed to rank shocks as first, second and third most important. In this scrutiny, drought is the single most important shock influencing welfare status of households in the first, second and third ranks. Although they account for less than 5 percent, death, flood, illness, frost and pests or diseases affecting crops/storage follows drought in the first rank. Drought is followed by pests/disease affecting crops/storage, frost, flood, lack of access to inputs, pests/diseases affecting

livestock, erosion and illness in the second rank. The same shocks followed drought in the third rank and accounted for 2 to 5 percent (Table 1).

Table 1: Percent of households reporting shock problems (ranking)

	1st	2nd	3rd
Major shocks		(percent)	
Drought	55.04	14.45	8.54
Too much rain or flood	3.15	6.48	2.74
Erosion	1.08	4.26	2.77
Frosts or hailstorm	2.87	7.24	4.96
Pests or diseases affecting crops/storage	2.33	8.22	4.88
Pests or diseases affecting livestock	1.36	4.75	3.61
Lack of access to inputs	1.65	5.61	5.78
Large increase in input prices	0.52	2.20	2.96
Large decrease in output prices/lack of output demand	0.19	0.24	0.54
Death of husband/wife/other person	3.25	1.90	0.92
Illness of husband/wife/other person	3.04	3.34	2.44
Others such as theft of livestock/crops, divorce etc.,	0.95	0.57	1.08

Source: own computation from survey questions

The impact of shocks on welfare status was also ranked in a related fashion. These shocks are expected to cause reduction in income and consumption as well as loss of productive assets or their combinations. Table 2 reveals that reduction in income and consumption account for the largest share in the first rank followed by combination of reduction in income and consumption, reduction in income and consumption as well as loss of productive assets. Loses of productive assets, assets and income; and asset and consumption account for about 12 to 13 percent in the first rank. While reduction in income, consumption and combination of income and consumption remain significant figure for more than a quarter of households in the second rank, the proportion of households reporting loss of asset and income; and asset and consumption slightly increased to 17 and 18 percent, respectively. The percentage of household reporting these impacts ranges 13 to 21 percent in the third rank except for loss of productive

assets (4.47%). In general, shocks largely influence reduction in income and consumption as almost half of households are reporting (see Table 2, 1st rank column).

Table 2: Effects of shocks on household welfare (percentage)

	1st	2nd	3rd
Effects of shocks		(percent)	
Loss of productive assets	11.50	4.15	4.47
Loss of household income	46.72	24.02	13.99
Reduction in household consumption	52.47	38.20	16.46
Asset & income loss	11.88	16.81	13.34
Asset loss & reduced consumption	12.66	17.08	14.64
Income loss & reduced consumption	29.96	26.63	20.63
Asset, income loss & reduced consumption	17.73	12.64	21.07
Other effects not listed	2.87	1.84	2.82

Source: own computation from survey questions

As stated earlier, PSNP mainly aim to protect assets sale at household levels and creating assets at community levels on a way of maintaining food security leading to gradual graduation in about five years. Introducing new activities such as road construction, soil conservation, tree planting, building of new wells and schools as well as maintenance of the existing one were the major events performed as reported by local community and regional bureaus (see Table 3). Whilst the highest proportion of public works reported on soil conservation in three of four regions: Tigray, Amhara and Oromiya, road construction account for the largest share in SNNP. Soil conservation is followed by building new schools in Tigray and road construction in Amhara and Oromiya. Soil conservation is the second new activity in SNNP followed by building of new schools. Roads, soil conservation sites and schools are among maintenance work in public works programme. Roads maintenance, for instance, account for 24, 25, 32 and 33 percent in SNNP, Amhara, Oromiya and Tigray,

respectively (see Table 3). However, most of these activities were not yet completed (see Gilligan et al., 2007).

Table 3: Types of assets constructed as part of PSNP Public Works, by region

	Tigray	Amhara	Oromiya	SNNP
	(percent)			
New activities or construction				
Road construction	39	47	53	74
Soil conservation	81	53	66	50
Tree planting	28	22	34	24
Construction of new wells	22	14	24	26
Construction of health clinics	3	14	11	21
Construction of irrigation works	8	8	8	3
Building new schools	64	36	26	37
Maintenance work				
Roads	33	25	32	24
Soil conservation sites	33	22	0	5
Trees and tree nurseries	0	11	8	11
Wells	0	11	11	8
Health clinics	6	0	3	0
Irrigation works	0	11	3	0
Schools	14	0	21	11
Any construction	97	83	95	89
Any maintenance	58	47	55	45
Mean number of public works activities	3.3	2.8	3.0	2.9

Source: Gilligan. D et al., 2007 (Ethiopian food security program: report on 2006 base survey).

Although examining the long-term impacts of newly constructed/maintained assets under PSNP is beyond the scope of this paper, it is promising to compile an assessment how it helps beneficiaries to bridge at least food gaps of beneficiary households. In order to make such comparison, it would be good if we have consumption data before and after program implementation. However, constructing of consumption figures prior to PSNP implementation was not possible as the survey was conducted after program implementation. In order to undergo comparison the study then depend on PSNP working manual which specify that beneficiaries should be chronically food insecure households who failed to meet food requirement at least for three months of the year in the last three years. Following the working manual this study then assumes that (i) non-beneficiary households are able to meet food requirement for all months of

the year at least in the last three years and (ii) the amount of transfer (either in cash or its in-kind equivalent) would cover food requirements of beneficiaries at least for three months of the year.

Table 4 presents the pattern of consumption levels across households for food per capita consumption deciles and PSNP status. The levels of per capita consumption for the lowest three deciles i.e. deciles 1 to 3 (both beneficiary and non-beneficiary) were very low ranging from 3 to 10 Birr per week, which is less than universal standard consumption per capita (i.e. $1 dollar per day). Albeit it is below standard, non-beneficiaries consumption per capita is significantly greater than beneficiaries in 2nd and 3rd deciles. Whilst non-beneficiaries consumption per capita is significantly greater than its counterparts in 4th, 5th and 6th deciles, there is no significant difference in the remaining highest deciles (i.e., 7th to 10th deciles). Beneficiaries' consumption per capita is higher than non-beneficiaries only in the 1st deciles although the difference is not significant. In general, as we can see from Table 4, PSNP transfer more likely improves the welfare status of beneficiaries in the highest consumption deciles as compared to the lowest deciles. In fact, had it not been PSNP intervention in the areas, food insecurity problem could have been more worsening.

Table 4: Weekly food per capita consumption by deciles and PSNP status

Food consumption deciles	PSNP Beneficiary								Non-beneficiary		t-value (p-value)
	Rec'd PW		Rec'd DS		Rec'd PW & DS		All beneficiary				
	Mean	Median	Mean	Median	Mean	Median	Mean	Median	Mean	Median	
1st deciles	3.35 (1.52)	3.64	3.97 (1.44)	4.08	3.02 (1.82)	3.26	3.42 (1.55)	3.65	3.23 (1.64)	3.40	1.13 (0.2572)
2nd deciles	6.90 (0.73)	6.98	7.83 (0.86)	7.90	6.80 (0.88)	6.70	7.03 (0.83)	7.01	7.22 (0.82)	7.22	2.185** (0.0298)
3rd deciles	9.35 (0.67)	9.30	10.59 (0.83)	10.47	9.97 (1.10)	9.96	9.57 (0.86)	9.51	10.09 (0.90)	10.05	5.43*** (0.000)
4th deciles	11.99 (0.85)	12.00	13.51 (0.96)	13.61	13.20 (0.77)	13.33	12.30 (1.04)	12.35	12.93 (0.80)	13.02	6.06*** (0.000)
5th deciles	14.72 (0.84)	14.75	18.17 (1.41)	18.23	15.53 (0.68)	15.42	15.28 (1.53)	15.06	15.65 (0.90)	15.54	2.61*** (0.009)
6th deciles	17.95 (1.12)	17.85	21.76 (1.32)	21.47	18.55 (0.91)	18.53	18.56 (1.77)	18.33	18.97 (1.10)	18.91	2.43** (0.015)
7th deciles	22.48 (1.54)	22.22	28.52 (2.54)	28.30	21.66 (0.99)	21.70	23.30 (2.75)	22.63	23.41 (1.79)	23.15	0.38 (0.698)
8th deciles	29.65 (2.50)	29.60	40.67 (4.12)	41.63	27.06 (2.80)	27.35	31.08 (4.91)	30.08	31.79 (3.14)	31.63	1.56 (0.122)
9th deciles	44.93 (7.40)	43.17	56.90 (7.45)	54.85	39.30 (5.07)	39.13	46.27 (8.60)	44.25	47.66 (8.05)	44.91	1.54 (0.124)
10th deciles^	311.31 (677.01)	112.05	412.24 (681.29)	135.61	200.88 (314.22)	74.32	318.02 (657.60)	112.05	575.35 (2809.67)	109.66	1.097 (0.194)

Note: Figures in parenthesis are standard deviations. Unexpectedly we have larger value for the 10th deciles.
Source: Own computation from survey questions

Cash transfer is broadly assumed as giving more flexible opportunities to beneficiaries i.e., cash gives beneficiary households the opportunity to make their own decisions about what they need and enables them to buy what is appropriate for them. Moreover, cash transfers have also been found to result in a more diverse dietary intake, improvements in child-caring practices and increased uptake of social services (Duffield et al., 2005; Aklu and Hailekiros, 2005; and Acacia Consultants, 2005 as cited in Emebet, 2006). Although beneficiaries under PSNP have received cash (80%) or its in-kind equivalent (20%) base on availability of grain market in the neighborhoods, less than 4 percent of beneficiaries in Tigray, 12 percent in Amhara, 18 percent in Oromiya and 33 percent in SNNP prefer to have payment in cash only (see Table 5). They prefer to have either in-kind or combination of in-kind and cash transfer. Households prefer to have in-kind only account for 51 percent in Tigray, 48 percent in Amhara, 34 percent in Oromiya and 14 percent in SNNP. The figures for combinations of in-kind and cash transfer are 45 percent in Tigray,

40 percent in Amhara, 49 percent in Oromiya and 51 percent in SNNP. Comparison by PSNP status has shown that only few percent of households who received both Public Work (PW) and Direct Support (DS) prefer to receive cash transfer than either in-kind or combination of in-kind and cash transfer in three of the four regions. In SNNP, where cash transfer is much closer to local wage rates (see Table 6), 40 percent of households who received both public work and direct support prefer to have cash payment than either in-kind or combinations of cash and in-kind transfer. Households received direct support in Tigray and Oromiya and households received public work support in Amhara and SNNP stood in the 2nd ranks of having cash transfer payments preference.

Table 5: Percentage of household reporting preference transfers

	Rec'd PW	Rec'd DS	Rec'd PW & DS	Total
	(Percent)			
Tigray				
All food (in-kind)	49.28	55.13	64.52	51.32
Cash only	4.35	3.85	0	3.96
Combinations of food and cash	46.38	41.03	35.48	44.71
Amhara				
All food	46.15	51.67	66.67	47.53
Cash only	12.12	16.67	5.56	12.43
Combinations of food and cash	41.72	31.67	27.78	40.04
Oromiya				
All food (in-kind)	30.84	35.59	48.57	33.57
Cash only	19.39	18.64	5.71	17.59
Combinations of food and cash	49.77	45.76	45.71	48.83
SNNP				
All food (in-kind)	13.62	20.29	6.67	14.14
Cash only	33.42	44.93	40	35.45
Combinations of food and cash	52.96	34.78	53.33	50.41

Source: Own computation from survey questions

Why beneficiaries generally preferred to have in-kind or combinations of in-kind and cash payment while cash preference take for granted more flexible opportunities? There are many reasons but comparing local wages rate with the amount of cash transfer (i.e. 5 Birr per person per day) seems more plausible. Table 6 compares average local wages rate against PSNP cash payment. The amount of cash transfer is fairly lower than average local wages rate (either male or female adult or child wages rate) in three of four regions (see Table 6). In SNNP region local wages rate is relatively closer to PSNP per day per person cash transfer. In this region significant number of household prefer to have cash payment as indicated in Table 5 above. In other regions such as Tigray and Oromiya, however, local wage rates are almost twice of PSNP cash transfer. Such significant difference, in addition to current escalating prices of food crops, discourages households' cash payment preference even if they know that cash transfer more benefiting them. As prices are escalating, the amount of transfer can't purchase basic needs, i.e., food. In fact, there was an instance in Amhara

regions where households totally refused to accept cash for PSNP public works (see FAO/WFP, 2006). Such very low cash payment is also peculiar as compared to other countries who has practiced cash transfer for social security purpose i.e. other countries experiences have shown that amount of cash transfer is lower but closer to the local wage rate. Meanwhile, PSNP is one of the largest programmes implemented in Ethiopia that has never been practiced in other developing countries.

Table 6: Comparison of local wage rates with PSNP cash transfer (5 Birr per person per day)

	Male adult wage			Female adult wage			Child wage		
	Mean	t-value	p-value	Mean	t-value	p-value	Mean	t-value	p-value
Tigray	11.38			8.75			9.05		
	(2.63)	14.62	0.000	(3.10)	7.04	0.000	(3.64)	6.50	0.00
Amhara	8.15			7.11			6.41		
	(2.77)	6.62	0.000	(2.37)	5.21	0.000	(1.57)	5.20	0.00
Oromiya	10.31			9.93			10.82		
	(4.00)	7.13	0.000	(3.27)	8.10	0.000	(5.52)	5.67	0.00
SNNP	6.45			5.65			2.79		
	(3.15)	2.78	0.000	(2.70)	2.28	0.014	(1.66)	-8.02	0.00

Note: Figures in parenthesis are standard deviations
Source: Own computation from community questionnaire

4 Empirical Results

4.1 Determinants of households being member PSNP beneficiary

Considering that assets protection at household levels and assets creation at community levels will feature as an overriding development objectives in PSNP plan, it is necessary to evaluate criteria of targeting and nature of beneficiaries. The criteria used for beneficiary selection, governmental organizations (i.e., regional and local government) and civic societies involved in the process of selection were broadly discussed in Gilligan et al., 2007. This paper tries to quantify some of these criteria using probit regression. Results from the probit model of a household being in PSNP (a dichotomous variable with a value 1 when household is beneficiary and 0 otherwise) is

extracted and presented in Table 7.[65]. Receiving free food aid in most recent year (i.e. between June 2004/05 and June 2005/06) and reported drought that affect welfare status in the last five years have a statistically significant, positive impact on the probability of a household being in PSNP. Calvo and Dercon (2005) indicated that once covariate shocks such as drought affects households status recovery within short period is difficult as its effects persist over a long time span unless proper interventions are taken.

Furthermore, distress assets sale for food in the last 2 years, receiving free food aid between June 2001/02 and June 2004/05, lack of access to inputs and death of any household members would increase the probability of being in PSNP. An increase in the chance of being in PSNP while reporting drought shock, receiving free food aid in most recent years, distress assets sale, lack of access to inputs or death of any family members verify wisdom between criteria setting and targeting beneficiaries. Though we anticipated that illness of household members would most likely increase the chance of being selected as beneficiaries, the result came up with unexpected sign; however, the coefficient is not statistically significant. Wealth status of rural household usually measured by owning at least a pair of oxen as it is the most crucial factors of production, next to ownership of arable land. In this respect, household owning at least a pair of oxen should be excluded from being in PSNP. The regression result supports this hypothesis that it is unlikely for households possessing at least a pair of oxen in year 2003/04 or 2005/06 to be included in PSNP. Moreover, both Public Works participants and Direct Support beneficiaries had significantly lower mean asset

[65] Marginal effect is reported. See annex II for odds ratio

holdings than non-beneficiaries in all four regions prior to the implementation of the PSNP (see Gilligan, et al., 2007).

Household demographics such as household size, age of household head and sex of household head influences the probability of selection. As the size of household increase the chances of being in a program also increase. This can be due to increase in consumption with increase in household size or due to availability of potential labour supply that is important for public works. Similar argument could apply for age of household head. Since younger household head is more active than older household head, the probability of younger household head being in the public works program is high. Female-headed households are less likely in PSNP, as compared to their counterparts, probably due to triple burden of household chores, child care and agriculture works that would take their valuable time. The regression analysis is controlled for age of household head square, mean age of household members, and family size square to capture the second order effect of age, the age composition in the household and the idea of scale economies at the household level, respectively.

Table 7: Determinants of household being PSNP beneficiary (estimated using probit model)

Explanatory variables	Marginal effects	t statistics (absolute value)
Received free food aid between June 2004/05 and June 2005/06	0.227	9.75***
Received free food aid between June 2002/03 and June 2004/05	0.041	1.51
Received free food aid between June 2001/02 and June 2002/03	0.042	1.75*
Drought that affect household status in the last five years	0.078	2.99***
Distress assets sale for food in the last 2 years	0.021	1.05
Lack of access to input	0.049	2.20**
Household own at least a pair of oxen in 2005/06	-0.152	5.51***
Household own at least a pair of oxen in 2004/05	-0.075	2.94***
Death of husband/wife/other persons	0.024	0.75
Illness of husband/wife/other persons	-0.009	0.31
Age of household head	0.007	2.01**
Age of household head square	-0.000	2.48**
Mean age of household member	0.001	0.72
Household size	0.059	2.73***
Household size square	-0.004	2.28**
Sex of household head: 1 if male	0.020	0.78
Literacy of household head: 1 if literate	-0.028	1.26
Tigray region	0.108	3.94***
Amhara region	0.140	5.07***
Oromiya regions	0.082	3.18***
R^2	0.3986	
Sample size	2,808	

Notes: Standard errors are robust to locality cluster effects; * significant at 10%; ** significant at 5%; *** significant at 1%.

5 Factors influencing beneficiary choices (in-kind and cash payment)

In the descriptive section we have seen that majority of beneficiaries' choose to have in-kind or combinations of in-kind and cash payment than cash only, although cash transfers have promising advantages. Using multinomial probit regression, this section further explores why beneficiaries are less likely willing to have cash payment as compared to other alternatives. Table 8 presents the regression results where in-kind payment is used as base outcome. We have seen in descriptive section that local wage

rate is significantly greater than PSNP per day per person cash transfer. The regression result further substantiated the finding that households are more likely to choose in-kind payment than cash or their combinations as local wage rates increase whilst PSNP cash transfer remains constant. Furthermore, the current escalating prices of food crops (major cereal crops), particularly wheat price, significantly influence their decision to have in-kind transfers than cash only or combinations of cash and in-kind transfer. The plausibility of the finding is further enhanced as those households who judge the PSNP transfer as "*helpful but not sufficient*" more likely prefer in-kind payment than cash or combinations of cash and in-kind.

Household consumption per capita is also a factor influencing their decision. A household is more likely to prefer in-kind payment than cash or their combinations whenever per capita level of consumption is low, below certain limits (i.e., possibly minimum requirements). Households then intend to have in cash payment preference i.e. after fulfilling the basic food requirement they prefer cash payments, as cash is more flexible to reallocate to their own needs. Furthermore, if households had received free food aid in most recent years, they choose in-kind transfer more likely than cash or combinations of cash and in-kind. In addition to the lower amount of cash they have paid from PSNP cash transfer, as we discussed above, this may also be due to wrong anticipation that if it were in-kind it would also be free of any work requirement. Using the same comparison, household who received free food aid between June 2001/02 and June 2004/05 prefer in-kind payment than in cash or combinations. Obviously, household who faced distress assets sales for food in the last two years prefer in-kind transfer than other alternatives. Moreover, as distance from the local market increase, households tend to prefer in-kind transfer than combination of in-kind and cash.

Households who have access to information on how PSNP has implemented to combat food insecurity that leads to gradual graduation significantly prefer payment in cash or combinations of cash and in-kind than in-kind only. Thus, it is important to create awareness on how PSNP assists households to graduation. Gilligan et al., 2007 indicated that apart from SNNP there was a considerable fraction of PSNP beneficiaries who could not identify any function of the Community Food Security Task Forces (CFSTF). Awareness of the existence of CFSTFs, was generally high amongst public works beneficiaries but lower amongst recipients of direct support (see Gilligan et al., 2007). While probability of preferring in-kind transfer increase as head born in the kebele, male households head does more prefer cash payment than its counterparts. The results were controlled for different tests to determine whether it is robust and sensible.

Table 8: Determinants of PSNP beneficiary choices (a multinomial probit model using in-kind only as a base category for comparison)

	Cash only		Both cash and food	
Explanatory variables	Estimated coefficient	t-statistics (absolute value)	Estimated coefficient	t-statistics (absolute value)
Log food expenditure per capita	-0.266	1.77*	-0.209	1.77*
Log food expenditure square per capita	0.001	0.05	0.016	0.96
Log of adult wage	-0.689	5.65***	-0.214	1.95*
Log of Wheat price per kg	-0.986	4.33***	-0.803	4.29***
Log of Maize price per kg	-0.345	1.75*	-0.056	0.34
Log of Teff price per kg	-0.526	2.34**	0.044	0.23
Log of Barely price per kg	-0.266	1.71*	-0.245	1.97**
Received free food aid between June 2004/05 and June 2005/06	-0.606	4.17***	-0.120	1.03
Received free food aid between June 2002/03 and June 2004/05	-0.149	0.91	-0.096	0.72
Received free food aid between June 2001/02 and June 2002/03	-0.400	2.69***	-0.186	1.55
Have information how current transfer is allocated	0.443	3.91***	0.402	4.27***
Distress assets sales for food in the last 2 years	-0.219	1.87*	-0.222	2.28**
Current transfer is helpfully but not sufficient	-0.277	2.44**	-0.299	3.18***
Log distance from nearest market in km	-0.025	0.34	-0.140	2.41**
Household head born in PA	-0.392	2.57**	-0.423	3.34***
Age of household head	-0.009	0.41	-0.019	1.02
Age of household head square	0.000	0.52	0.000	0.75
Sex of household head:1 if male	0.359	2.40**	0.158	1.28
Household size	-0.117	1.12	-0.038	0.44
Household size square	0.011	1.31	0.004	0.55
Constant	4.183	5.90***	2.851	4.79***
Wald chi2(40)	359.24			
Prob > chi2	0.000			
Sample size	1722			

Notes: Standard errors are robust to locality cluster effects; * significant at 10%; ** significant at 5%; *** significant at 1%; regional dummies are also included but not reported.

6 Conclusion and recommendation

Using Food security baseline survey 2006 data the paper explores issues related to beneficiary selection and their transfer preferences. As outlined in PIM, the probability of being in PSNP is high if the household faced food insecurity at least for three months of the year in the last three years. Households who report drought as the most sensitive shock affecting their welfare status in the last five years and who received free food aid in the most recent years have high probability of being beneficiaries. Households who reported distress assets sale in the last two years are more likely being in PSNP. Moreover, as owning at least a pair of oxen indicates better wealth status for household in the rural areas; households reporting owning at least a pair of oxen are less likely being to be in PSNP.

Productive Safety Net Programme (PSNP) is implemented attempting for long-term solution through protecting asset depletion at household levels and asset creation at community levels. The programme offers nationwide opportunity to begin a transition from providing in-kind (especially food) relief to giving cash to programme beneficiaries. The rationale for cash transfer was that cash would better enable beneficiary households to diversity income sources and build asset levels, and that increased cash supply in rural communities would stimulate the rural economy benefiting everyone, including the destitute. However, less than 20 percent of beneficiaries' choice was cash transfer as compared to in-kind or combinations of cash and in-kind transfer. Using multinomial probit regression the paper has shown that escalating prices of major food crops, higher local wage rate, receiving free food aid in the most recent years, lower per capita food consumption, distress asset sales, distance

from local markets, access to information on how PSNP assists chronically food insecure households to graduation and family size are among the major factors influencing their decision.

Considerably lower amount of PSNP cash transfer (compared to local wage rate) discourages beneficiaries to prefer cash transfer compared to in-kind or combinations of in-kind and cash transfers. In some areas such as Amhara and Tigray, for instance, the local wage rate is twice of PSNP cash transfer. In SNNP, more than quarter of households (33% of all beneficiaries and 44% of public work beneficiaries) prefer to have to cash transfer only as PSNP cash transfer is closer to their local wage rate. Thus, the paper recommends region-wise local wage rates conditional cash transfer is more influential than having fixed and equal amount of transfer for all regions (i.e., Birr 5 per day per person). Conditional amendment on the amount of cash transfer closer to local wage rate is more important for gradual graduation.

Using consumption per capita deciles the paper found out that beneficiaries consumption per capita in the highest deciles are almost proportional to non-beneficiaries although consumption per capita of non-beneficiaries are significantly higher than beneficiaries in the lower deciles. As free food aid have been practicing for a longer period of time in most beneficiaries' community, beneficiaries are also more likely to have in-kind transfer only. This may be due to their belief that if it were in-kind it is also free of any work requirement. Thus, it is important to create awareness how PSNP is operational to lead to graduation.

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Annex I: What portion of your payment would you like to receive in-kind, cash or combinations

	Tigray	Amhara	Oromiya	SNNP	Total
			(percent)		
Cash only	4.03	12.63	18.85	34.67	17.54
75% cash and 25% food	9.71	14.36	8.95	14.6	11.84
50% cash and 50% food	21.98	25.43	35.14	34.12	29.33
25% cash and 75% food	13.74	1.73	5.27	2.74	5.79
All food	50.55	45.85	31.79	13.87	35.51
Total	100	100	100	100	100

Annex II: Determinants of household being PSNP beneficiary (estimated using probit model)

Explanatory variables	Estimated coefficients	t statistics (absolute value)
Received free food aid between June 2004/05 and June 2005/06	0.641	9.69***
Received free food aid between June 2002/03 and June 2004/05	0.113	1.50
Received free food aid between June 2001/02 and June 2002/03	0.116	1.75*
Drought that affect household status in the last three years	0.208	3.02***
Distress assets sales for food in the last 2 years	0.056	1.05
Lack of access to input	0.137	2.16**
Household own at least a pair of oxen in 2005/06	-0.402	5.37***
Household own at least a pair of oxen in 2004/05	-0.202	2.86***
Death of husband/wife/other persons	0.067	0.76
Illness of husband/wife/other persons	-0.023	0.31
Age of household head	0.020	2.07**
Age of household head square	-0.000	2.56**
Mean age of household member	0.003	0.71
Household size	0.161	2.67***
Household size square	-0.010	2.18**
Sex of household head: 1 if male	0.055	0.79
Literacy of household head: 1 if literate	-0.077	1.27
Tigray Region	0.108	(3.94)***
Amhara Region	0.140	(5.07)***
Oromiya Region	0.082	(3.18)***
R^2	0.3986	
Sample size	2,808	

Notes: Standard errors are robust to locality cluster effects; * significant at 10%; ** significant at 5%; *** significant at 1%.