

Vulnerability to Poverty and Its Determinants in Rural Ethiopia*

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Abstract: This study analyzes the vulnerability to poverty of smallholders in rural Ethiopia using a unique panel dataset, the Ethiopian Rural Household Survey which was collected from 15 peasant Associations covering 1359 households for the years 1994, 1999, 2004 and 2009. Three steps feasible generalized least squares and Principal component approaches are employed for this purpose. The results indicate that smallholders in rural Ethiopia in general are subjected to high levels of vulnerability to poverty as measured by a poverty threshold of 1 USD and a vulnerability threshold of 0.5 using the consumption based approach. Both poverty incidence and vulnerability to poverty in rural Ethiopia are substantial but have opposite trends across survey rounds. While vulnerability to poverty increases steadily till 2004 before it moderately declines in the last round, the rate of poverty, on the contrary, declined consistently till the third round but considerably increased in the last round. However, vulnerability to poverty prevailed over poverty incidence in all the survey rounds indicating the need to give more focus on precautionary measures than merely safety net programs.

Keywords: Vulnerability, Multi-dimensional Indices, Panel Data, Ethiopia

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Introduction

With an estimated population of more than 90 million, next only to Nigeria, Ethiopia is a predominantly agrarian nation in Sub-Saharan Africa. Though agriculture is the back bone of the Ethiopian economy, the sector is characterized by backward technologies and low utilization of inputs, which constrained the sector's capability of providing sufficient food and livelihood for the population (Baye, 2017). The current government of Ethiopia has been employing an Agriculture Development Lead Industrialization policy strategy (ADLI) since 1993 (MoFED, 2010). Under the umbrella of ADLI, poverty reduction policies in Ethiopia have focused on strategies to enhance agricultural productivity of the smallholder sector, the mainstay of most of the population, through access to improved extension packages, provision of input and credit supply services, building of infrastructure, mainly rural roads and water supply, and expansion of primary education and health care services (FDRE, 2011). However, studies still contend that ADLI has not brought about the anticipated poverty reduction and sustained economic growth it promised (Mitik, Lemma and Behute, 2010).

By many accounts, Ethiopia is one of the poorest countries in the World (World Bank, 2015). Poverty is profound and widespread in Ethiopia. Measured mainly in terms of food consumption, set at a minimum nutrition requirement of 2,200 calories per adult per day, and including non-food consumption requirements. A 1995/96 estimate showed that 45. 5 percent of the population were below the poverty line. Poverty was prevalent both in rural and urban areas, with coverage of 47 and 33 percent of the respective populations (IMF 2000). In 2005, according to World Bank figures, 38. 9% of Ethiopians lived under the national poverty line, which declined from 44. 2% in 2000 (WB, 2012). However, this trend could have reversed since 2006 due to macroeconomic imbalances and inflationary pressures fanned by rising global commodity prices of food and fuel (Dercon et al., 2011). Though inflationary pressure is not currently a major issue, claims of a substantial reduction in poverty to a rate of 29. 6% in 2010 in official reports by the Ethiopian Government (MoFED, 2012) have been questioned by studies that claim that due to an increase in the number of periodic shocks in the country, millions of households have been dragged into poverty and suffer from food insecurity. They also claim that this has steadily increased the number of people under emergency food aid (Girma, 2013; Rahmato, 2013). Therefore, this study endeavors to bridge this divide by analyzing the

effects of policy and socio-economic factors on rural households' vulnerability to poverty in Ethiopia at national and agro-ecological zone levels. This study uses rich panel data of smallholders in 15 peasant associations spanning over 15 years since 1994.

The article is organized as follows. It starts with a brief review of literature on the concepts and measurements of vulnerability to poverty. It then discusses and outlines the dataset itself, as well as analytical approaches used in this paper, followed by an in-depth discussion detailing the findings of the study. Finally, concise conclusions and implications of the research are provided.

Literature Review

In many countries of the developing world, policy interventions aimed at poverty reduction are often based more on *ex post* poverty incidences rather than *ex ante* poverty measures (Jacob, 2010; Tsehay and Bauer, 2012). A household's current level of deprivation may be a bad guide to its prospects explains the recent emphasis in the poverty literature on vulnerability, a forward-looking poverty concept (World Bank, 2001; Elbers and Gunning, 2003). Poverty studies only reflect welfare of a household or community *ex post*. Lack of panel data sets has partly made the accommodation of *ex ante* measure of poverty for comprehensive policy interventions difficult. However, in recent years, panel data are thriving in such parts of the world such as Socio-economic Surveys, Welfare Monitoring Surveys, Demographic and Health Surveys, which are often made available by international institutions including the World Bank. As a result, besides studies of vulnerability to poverty based on cross-sectional data, growing number of similar studies are undertaken using panel datasets (Echevin, 2011; Morrone et al., 2011).

Methodologically, previous empirical studies in the field have proposed different approaches to assess and estimate vulnerability to poverty. These different approaches to estimating vulnerability to poverty fall into three categories: those that considers vulnerability to poverty as low expected utility called Vulnerability as Expected Utility (VEU) (Ligon and Schechter, 2003); those that consider Vulnerability as Uninsured Exposure to Risk (VER) (Hoddinot and Quisumbing, 2003); and thirdly those that treat vulnerability as a probability of falling into poverty in near future called Vulnerability as Expected Poverty (VEP) (Chaudhuri et al.,

2002; Christiaensen and Subbarao, 2005). These measures have their own advantages and disadvantages. VEU has the benefit of disaggregating vulnerability due to poverty and vulnerability due to uninsured risk. However, it is difficult to calculate and reliant upon difficult-to-acquire panel data (Whitney, 2014). The other alternative measure, i. e., VER is easy to calculate and can attribute welfare loss to either idiosyncratic and covariate risks. However, its serious drawback is that VER cannot serve as a predictive tool (Ibid). The strand of literature on measuring vulnerability as expected poverty is rather a recent phenomenon. VEP is easy to calculate and can be particularly useful in situations where a large portion of the population is just above the poverty line (Hoddinott and Quisumbing, 2003). In developing countries where long years of panel data are scarce or unavailable, VEP is easy to calculate and particularly useful (Azam and Imai, 2009; Jha et al., 2009). Consequently, this study prefers VEP over the other two approaches in analyzing vulnerability of households to poverty in rural Ethiopia.

In terms of the choice of welfare indicator for measuring vulnerability to poverty, a multitude of studies have followed the conventional approach of using income or consumption expenditure as proxy for the living standard of an individual or a household vis-à-vis a certain minimal accepted threshold. Some of the studies along this line include Azam, and Imai, (2009); Dercon, S. et al., (2011) and Hill and Porter, (2017). However, this approach has been criticized as income fails to represent the full amount of available resources households rely upon to cope with the needs of everyday life and to face unexpected shocks; and the fact that that income is only a means and not an end, and cannot account for the multiple dimensions of human well-being (Brandolini et al., 2010). As a result, the measurement of poverty has been broadened over the years to incorporate different aspects of human wellbeing. However, only limited numbers of studies employed multi-dimensional concepts for studying vulnerability (including Liverpool and Nelson, 2010; Dutta and Kumar, 2014; Ambel, et al., 2015; Feeny, and McDonald, 2016). To the best of the researcher's knowledge, empirical evidence is scant internationally and non-existent in Ethiopia when it comes to complementing the outputs of asset-based vulnerability (multi-dimensional) measurements to the standard consumption-based approach. Two studies that do make use of this frame are by Echevin (2011) and Morrone et al. (2011). Using repeated cross-sectional data, the former study showed that expected asset-poverty is a reliable proxy for expected consumption-poverty than is expected income-poverty in Ghana and further cross-country comparisons showed a

clear vulnerability gap between urban and rural areas. The latter used an “assets-based” framework, focusing on the resources that individuals and households can draw upon to reduce vulnerability and strengthen their resilience to a range of different risks in OECD countries.

Using the Ethiopian Rural Household Survey (ERHS), a unique panel dataset, this research aims to complement the consumption-based approach with a comprehensive approach (mainly composed of crucial assets, public utilities, and shocks and coping mechanisms of smallholders) of measuring vulnerability to poverty. In addition to covering the different aspects of vulnerability, this study compares the conventional measurements of vulnerability with that of the multi-dimensional index of vulnerability to accurately evaluate whether reported growth has in fact influenced the vulnerability of the mixed farming smallholders of the country. Moreover, this study investigates the factors determining vulnerability to poverty at national and agro-ecology levels. Thus, this study contributes to literature not only in terms of treating vulnerability to poverty in both uni-dimensional and multi-dimensional approaches but also incorporating in its analysis major agro-ecological and community differences in Ethiopia.

Data Source and Description

This study is based on the Ethiopian Rural Household Survey (ERHS), a unique longitudinal household data set covering households in 15 peasant associations (PAs) of rural Ethiopia. The PAs were selected to better account for diversity in the farming systems of the country. Although only representing 15 communities from the agricultural-based livelihood system, a relatively large sample within each village was taken (Dercon and Krishnan, 1998). Hence, the resulting sample can be considered broadly representative of the households in the different farming systems in the country. Moreover, no other sources allowing a comparison over time exist and the current data set is probably the only one currently available to make any statements about change in Ethiopia.¹ To the best of the researcher’s

¹ According to Dercon and Krishnan, 1998, the survey also gathered extensive information on health and anthropometric outcomes of all persons sampled and a comparison of the health and nutrition outcomes of ERHS have been very similar with the results of the data collected by the Central Statistical Office of Ethiopia as part of the Welfare Monitoring System in the same year, suggesting the resulting sample may be broadly representative of the general situation in

knowledge, no other panel datasets encompassing different agro-ecological systems and breadth of time to analyze the dynamics of rural household poverty and vulnerability in Ethiopia are available to date.

The ERHS panel datasets of the 15 PAs covering 1359 households for the years 1994, 1999, 2004 and 2009 have been therefore specifically used in this study for better comparability and analytical convenience. All PAs have been sampled from the four largest regions of the country except Adele Keke, the only PA from the smallest Harari region. The details of the sampling frame and the actual proportions in the total sample are provided in Table 1 below.

Table 1.
The Sampling frame of the Ethiopian Rural Household Survey (ERHS)
(*N=1359*)

Major Agro-Ecological Zones	Population Share (%)	Sample Share (%)	Number of PAs
Grain Plough Complex: Northern Highlands	21. 2	20. 2%	3
Grain Plough Complex: Central Highlands	27. 7	29. 0	4
Grain Plough: Arsi/Bale	9. 3	14. 3	2
Sorghum Plough/Hoe: Hararghe	9. 9	6. 6	1
Enset ²	31. 9	29. 9	5
Total	100	100	15

(With or Without Coffee/Cereals) Culture.*Source:* Dercon and Hoddinott, 2005.
(Percentages of population share relate to the rural sedentary population; they exclude pastoralists, which is about 10% of total rural population.)

Analytical Approaches

The research methods employed in this study are dealt with in two parts. First, vulnerability to poverty is measured in rural Ethiopia using two approaches: Three Steps Feasible Generalized Least Squares (FGLS) and the Principal Component Analysis (PCA). The former approach is used to estimate a conventional (uni-dimensional) measure of vulnerability to poverty based on the consumption expenditure of households. Three steps

_____ rural Ethiopia. Further discussions are available in Collier et al. 1997.
² Enset is commonly known as “false banana” and is an important root crop that serves as a traditional staple crop in the densely populated south and southwestern parts of Ethiopia.

FGLS is more efficient and advantageous over 2SLS, IV and other models in accounting heteroskedasticity and addressing the problem of endogeneity by exploiting the cross-equation covariations (Theil, 1971 cited in Belsley, 1988; Miller and Startz, 2017). The latter approach is alternatively used to develop a multi-dimensional poverty index at household and peasant association level. The two most widely used techniques for dimension reductions are PCA and Factor Analysis. PCA is applied for reducing directly measured variables while Factor Analysis is used for the measurement of latent /indirectly measured/ variables. On top of its attractive features of low noise sensitivity, lack of redundancy of data, reduced complexity, and decreased requirements for capacity and memory, PCA is preferred over Factor analysis mainly due to the nature of variables used in this study are directly measurable and not latent variables (Sasan K. et al., 2013). Second, determinants of vulnerability to poverty are analyzed at household, agro-ecological zone and national levels by using Fixed Effects IV model. The fixed effects model is preferred over the random effects model for controlling the effects of unobserved heterogeneities existing among households in the panel data overtime as demonstrated by the results of the Hausman model specification test. In addition, the determinants of vulnerability to poverty at national level is examined using Instrumental Generalized Method of Moments (GMM), which is a useful alternative to the fixed effects IV model because it relaxes the constraint imposed by the latter model that the correlation of individual observations within a group is constant (Baum et al., 2003).

Measuring Vulnerability to Poverty

Three Steps FGLS

The major inquisition of the article is to supplement the results of poverty incidences with the ex-ante probability of households being poor using three steps feasible generalized least squares. Linking poverty studies with that of vulnerability to poverty serves as a tool for poverty reduction strategies to attain their goals better. The approach is rooted in the pioneer work of Chaudhuri et al. (2002). Assuming consumption expenditure to follow a log-normal distribution and the consumption of household i in period t is determined by a set of variables X_i .

$$\ln c_i = \beta_0 + \beta_1 X_i + e_i \dots \dots \dots (1)$$

And, the variance of the unexplained part of households' consumption e_i is also assumed to be a function of the same explanatory variables used in model 1 as follows:

$$\sigma_{e_i}^2 = \theta_0 + \theta_1 X_i + \eta_i \dots \dots \dots (2)$$

Then, equations (1) and (2) are estimated using three-step feasible generalized least squares (FGLS) suggested by Amemiya (1977) cited in Chaudhuri et al. (2002). Using consistent and asymptotically efficient estimators $\hat{\beta}$ and $\hat{\theta}$, we get the expected mean and variance of log consumption as:

$$\hat{E}(\ln c_i / X) = \hat{\beta}_0 + \hat{\beta}_1 X_i \dots \dots \dots (3)$$

$$\hat{V}(\ln c_i / X) = \hat{\sigma}_{e_i}^2 = \hat{\theta}_0 + \hat{\theta}_1 X_i \dots \dots \dots (4)$$

Hence, using the estimated expected mean and variance of log consumption in equation (3) and (4) above respectively, the estimated vulnerability to poverty is given as:

$$\hat{v}_i = \hat{P}(\ln c_i < \ln z | X, Z) = \Phi \left(\frac{\ln z - \ln \hat{c}_i}{\sqrt{\hat{\sigma}_i^2}} \right) \dots \dots \dots (5)$$

Where $\Phi(\cdot)$ denotes the cumulative density of the standard normal distribution function. The estimated values of the vulnerability to poverty index, $\hat{v}_i$, ranges from 0 to 1. Finally, the vulnerability status of households is evaluated using the standard vulnerability threshold of 0.5.

Principal Component Analysis (PCA)

Moreover, we used the principal components approach (PCA) to develop a vulnerability to poverty index. Principal component analysis (Pearson, 1901) is a variable reduction procedure and it reduces the observed variables into a smaller number of principal components (artificial variables) that will account for most of the variance in the observed

variables. In developing the index, variables related to the factors that we explicitly considered as factors of vulnerability to poverty are taken to develop the index driven by previous literature in the area as explained in the results and discussions section.

Analyzing Determinants of Vulnerability to Poverty

In addition to finding the vulnerability of smallholders in Ethiopia, this study analyzes the determinants factors of vulnerability to poverty mainly using the fixed effects approach. The vulnerability indices found from the results of the above model are regressed against household characteristics, village characteristics and policy related variables as follows:

$$v_{it} = d'_{it}\sigma + x'_{it}\beta + \alpha_i + u_{it} \dots \dots \dots (9) \quad i = 1, 2, \dots, N$$

$$d_{it} = x'_{it}\delta + z'_{it}\theta + v_{it} \dots \dots \dots (10) \quad t = 1, 2, \dots, T$$

Equation 9 is the original fixed effects model using vulnerability of poverty indices, v_{it} , as a dependent variable against a set of identified endogenous variables, d_{it} , exogenous variables, x_{it} , and unobserved household fixed effects, α_i . In equation 10, we regress the endogenous variables against the rest of the variables in the system in addition to a set of instrumental variables, z_{it} , to estimate their predicted values. The predicted values of the endogenous variables and their lagged forms are used as instruments in equation (9). u_{it} and v_{it} are idiosyncratic error terms in the respective equations. Moreover, Instrumental Generalized Method of Moments is carried out in parallel to compare the robustness of the results.

Results and Discussions

Descriptive Results

Smallholders in Ethiopia are subjected to high levels of poverty incidence and vulnerability. Using the ERHS dataset, the changes in household's welfare in terms of selected data on assets, shocks, coping strategies, social networks, finance, education and participation in development activities are studied. There are improvements in most of these measures, even if some outcomes remain low.

Table 2.

Some Descriptive Statistics from the Sample: 1994 - 2009(N=1359)

Explanatory Variables	1994			2009		
	Mean	SD	MD	Mean	SD	MD
Human Resources						
Age of the Household Head	46.42	16.303	45	52.881	15.05	51
Literacy of the Household Head	0.167	0.373	0	0.465	0.499	0
No. of Literate Adults Per Household	3.151	1.853	3	1.572	1.429	3
Household Size	6.001	3.054	6	4.542	2.293	4
Dependency Ratio	1.051	0.854	1	0.754	0.717	0.6
Days not in Work Due to Illnesses	6.294	15.12	0	9.288	23.884	0
Assets and Utilities						
Size of Cultivated Land (ha)	1.349	1.379	1	1.875	1.784	1.375
Proportion of Fertile Land	62.015	35.214	60	70.298	31.372	77.70
Number of Plots Owned	3.729	3.205	3	5.409	3.018	5
Value of Livestock Asset (Birr)	1756.1	4108.8	850	7693.8	10840.1	3810
Number of Hoe Owned	0.795	1.065	1	5.016	2.409	5
Number of Ploughs Owned	0.925	1.223	1	5.720	3.869	6
Number of Oxen Owned	0.224	0.665	0	0.899	1.144	1
Value of Household Assets (Birr)	434.9	1829.9	92	2694.3	8918.9	1191
Number of Visits by Extension Agents	-	-	-	1.334	2.317	0
Prop. of HHs Getting Safe Water	0.183	0.387	0	0.646	0.478	1
Prop. of HHs Disposing Waste Safely*	0.934	0.248	1	0.795	0.404	1
Prop. of HHs Possessing Toilets*	0.130	0.337	0	0.624	0.485	1
Shocks and Coping Mechanisms³						
Rainfall Shock Severity Index	3.030	1.553	3	2.326	0.548	2
Inputs Shock Severity Index	2.187	0.956	2	0.381	0.713	0
Number of Crops Grown	3.725	2.198	4	4.801	2.394	4
Whether Household Store Cereals	0.627	0.484	1	0.788	0.409	1
Number of Migrants Per Household	0.166	0.746	0	1.136	0.411	1
Social Networks and Finance						
Membership in Saving Groups	0.176	0.381	0	0.140	0.347	0
Participation in Off-farm Activities	0.666	0.666	1	0.499	0.500	0
Credit	0.470	0.499	0	0.620	0.485	1
Transfers (Dummy: 1 if received 0 Not)	0.183	0.387	0	0.542	0.498	1

* Denotes that the estimates of the two variables for 1994 are approximated by the data from the survey round 1995. All the differences between the mean of the variables in 1994 from that of 2009 are statistically significant at 95 percent degrees of freedom. SD and MD denote standard deviation and median respectively. (Source: Calculated from ERHS (1994 and 2009))

³ The rainfall and inputs shock severity indices have been developed from a range of questions forwarded to respondents adopting the approaches of Demeke et al. (2011).

Table 2 shows the summary statistics of the different explanatory variables used for principal component analysis (PCA) and regression analysis for the survey rounds of 1994 and 2009. A lot of effort has gone into incorporating different dimensions of vulnerability to poverty ranging from household characteristics to the different kinds of shocks facing households and their coping mechanisms. Due to the unreliability of the use of mean to compare changes, median has been used alternatively. Using both measures, we realized that sample smallholders have in average enjoyed a rise in their multiple welfare indicators over the period under study. The table indicates that, by and large, there have been considerable improvements on the several indicators of household wealth over the 15 years of the study period, which are the results of the greater focus given by the Ethiopian Government for rural development, supporting findings in the studies of Dercon, et al., (2011) and Ambel, A. et al., (2015). Adult literacy, land fragmentation as measured by number of plots of land cultivated, number of adult days not worked due to illness, safe disposal of waste and participation in off-farm activities have significantly declined over the specified period. The decline in adult literacy is in contrast to the remarkable increment registered in enrollment of schools at age for both boys and girls during the period. The rest of the variables witnessed a substantial change except that extension service visits were briefly interrupted at the beginning of the 1990s due to the fall of the Derg regime in 1991 until the new extension service was launched in 1995 by the current regime.

Measuring Vulnerability to Poverty

Previous studies attach different definitions to vulnerability to poverty. For this paper the working definition of vulnerability is the risk of an individual or a household falling below the poverty line or, for those already below the poverty line, to remain in or to fall further into Poverty (Scaramozzino, 2006; Jha. et al., 2009).

Three Steps Feasible Generalized Least Squares (3 Steps FGLS)

Using 3 steps FGLS, the vulnerability to poverty indices for each household is developed. The indices range from 0 (denoting the least vulnerability) to 1 (indicating highest vulnerability). Using the conventional

vulnerability threshold of 0. 5, the results of the model are reported in Table 3. This study uses the international poverty line of 1 USD per adult equivalent per day (57. 6 Birr/Month) in 1994 Purchasing Power Parity (PPP) Korodegaga village-average constant price, which is found to be the median price among the 15 villages in the sample This study does not use the new international poverty line of 1. 25 per adult/day since its poverty measures are based on real consumption expenditures in 1994 PPP prices and hence the use of 1 \$ poverty line (which is set based on the 1993 PPP prices) is more appropriate than that of the 1. 25 \$ threshold, which is set based on the 2005 PPP prices. However, comparison of the poverty estimates of this study with other similar studies using the new international poverty line should be done with care as the poverty line adopted for this work is slightly lower and could undermine the poverty estimates. Table 3 shows that both poverty incidence and vulnerability to poverty in rural Ethiopia are dominant but have opposite trends across the survey rounds. While vulnerability to poverty increases steadily till 2004 before it moderately declines in the last round, the rate of poverty, on the contrary, declined consistently till the third round but considerably increased in the last round. However, vulnerability to poverty prevailed over poverty incidence in all of the survey rounds consistent to theoretical expositions and supports empirical works such as Dercon and Krishnan (2008) and Liverpool and Nelson (2010).

Table 3.
Proportion of Vulnerable Households to Poverty in 15 PAs of Rural Ethiopia (N=1359)

Measures	1994	1999	2004	2009
Vulnerability to Poverty	0. 61	0. 70	0. 79	0. 71
Poverty Rate (Head Count Index)	0. 46	0. 36	0. 28	0. 35

Source: Calculated from ERHS (1994-2009).

Looking at the extent of vulnerability to poverty by agro-ecological zones, the experiences of agro-ecological zones have been different across the panel years. In average, we find that Enset culture, northern and Arsi-Bale highlands have a relatively high risk of being poor in the future but less in Central and Eastern highlands. Except in the Enset culture, which maintained relatively stable levels of vulnerability, the latter two highly vulnerable agro-ecological zones experienced huge fluctuations of

vulnerability across the panel years. The proportion of households found to be more vulnerable in central highlands started from one of the lowest level and witnessed a steady decline thereafter while the corresponding figure for Hararghe was even the lowest in 1994 before it experienced its peak in 1999 and successively declined in the remaining survey rounds.

Table 4.

Proportion of Vulnerable Households to Poverty by Zones(1994-2009)

Vulnerability to Poverty	1994	1999	2004	2009
Arsi-Bale	0. 53	0. 11	0. 22	0. 10
Northern Highlands	0. 35	0. 19	0. 19	0. 59
Central Highlands	0. 27	0. 20	0. 08	0. 07
'Enset' Culture	0. 61	0. 64	0. 45	0. 51
Hararghe	0. 10	0. 26	0. 24	0. 10

Source: Calculated from ERHS (1994-2009).

Principal Component Analysis (PCA)

PCA does not provide an easy way to generate a best-fit model to develop an index. The approach requires trial and error and continual scrutiny of variables to determine which combination yields the most logical results (Henry, C. et al., 2003). The primary strategy is to systematically screen the list of variables that could be used in the model without compromising the explanatory power of the index. Accordingly, after successive trial and error, we eventually selected nine variables for developing the index based on their strong correlation with our bench mark vulnerability to poverty indicator, real monthly consumption expenditure per adult equivalent, and a compromise to capture different dimensions of vulnerability to poverty as shown in Table 5.

The PCA has been conducted at PA and household levels. In both cases, nine factors are finally selected to develop the vulnerability of Poverty index. All of the factors coefficients are well above 0. 300 to be screened following Burt-Banks formula. The values of the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy are 0. 80 and 0. 832 at the PA and household levels respectively, indicating that both models are commendable. The results of the PCA at the household level indicate that the first factor explained 39. 40 percent of the total variation in the

data; the second factor explains only about 12. 04 percent of the variance. The results of the PCA at the PA level is even more robust with the first and second factors explaining 54. 45 and 16. 99 percent of the total variations in the data respectively. The first component loading coefficients, which are the most critical outputs for determining the composition of the vulnerability to poverty index, for both levels of analysis are shown in Table 5.

Table 5.
Component Matrix of the PCA Analysis for the Combined 1994 and 2009 Data

Factors at Household Level	First Component	Factors at PA Level	First Component
Number of Ploughs Owned	0. 801	Median Number of Ploughs Owned	-0. 857
Size of Cultivated land (ha)	0. 622	Median size of land cultivated (ha)	-0. 616
Livestock Asset Excluding Oxen (Birr)	0. 752	Median Livestock Asset Excluding Oxen (Birr)	-0. 860
Whether Household Store (1 Yes, 0 No)	0. 548	Proportion of HHs Storing No Cereals	0. 537
Number of Oxen Owned Per Household	0. 831	Proportion of HHs with no Ox(en)	0. 858
Dependency Ratio	-0. 230	Share of Non-Working Population	0. 658
Whether Head is Literate (1 Yes, 0 No)	0. 577	Proportion of Illiterate HH heads	0. 915
Input Shock Severity Index	-0. 652	Average Input Shock Severity Index	0. 647
Rainfall Shock Severiety Index	-0. 388	Average Rainfall Shock Severity	0. 578

Source: Calculated from ERHS (1994 and 2009)

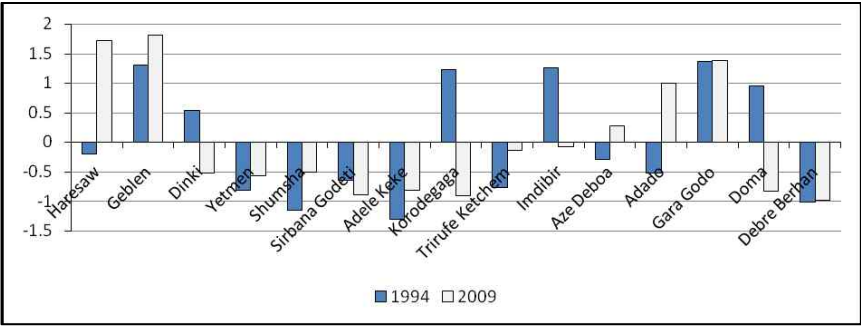
The component matrix above shows the loadings in the first component, which explains the highest variation in the data compared to the successive component loadings. All the factor coefficients have the expected sign consistent to previous literature. However, it is important to note at this juncture that due to the differences in the forms of the factors comparing the two levels of analyses (for *example, number of oxen owned*

vs proportion of households with no oxen), the factors of the household level PCA in the first component are associated with less vulnerability while the factors at PA level to high vulnerability. Hence, comparison of the indices between the two levels of analyses should be made with caution. Though the results of both levels of analysis are acceptable, the PCA analysis at the PA level performs better compared to the household level analysis, as shown in Table 5, both individually and jointly. Henceforth, our analyses, comparisons and interpretations will be entirely based on the results of the PCA at PA level. According to the results of Table 5, median number of ploughs owned, median value of livestock owned excluding oxen, proportion of households possessing no oxen and percentage of household heads being illiterate have the highest component loadings.

A correlation analysis was done for each year to examine to what extent our index is associated with some of the factors commonly known to indicate vulnerability to poverty such as average real consumption expenditure per adult equivalent, mean value of food consumption per month, mean value of household assets owned, among others. The results show that our index is highly and significantly correlated with the variables in the expected directions. For example, the Pearson correlations with average real consumption expenditure per adult equivalent are -0.83 and -0.81 for the years 1994 and 2009 respectively, indicating the validity of our index in measuring the relative vulnerability to poverty status of smallholders at PA level.

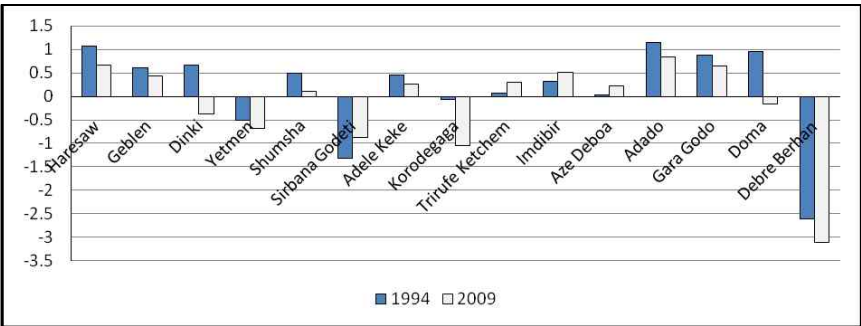
To make the vulnerability to poverty indices of the consumption based approach (three Steps FGLS) conform to the indices of the PCA; we first standardized the indices of the three Steps FGLS so that comparison and contrast is made possible. After standardization the outcomes have been aggregated at PA and Agro-ecological zone levels and are compared in the figures 2, 3 and 4 (A and B) below. Higher values represent more vulnerable PAs and lower values denote less vulnerability to Poverty for both years. In both approaches, most of the PAs in Northern Highlands and Enset Culture have relatively higher vulnerability to Poverty indices while those in central highlands, Hararghe and Arsi-Bale have lower indices in both 1994 and 2009. Among the PAs, Haresaw, Geblen, Yetmen, Shumsheha, Trirufe Ketchem, Aze Deboa, Adado and Gara Godo have become more vulnerable in 2009 compared to their status before 15 years ago based on the consumption based approach while most of the villages except Trirufe ketchem, Imdibir and Aze Deboa have experienced a decline

in vulnerability to poverty over the same period of time. One notable difference here is Adele Keke (the only PA in Hararghe) has relatively the least vulnerability indices (comparable to Debre Berhan) in the three steps FGLS but found to be even more vulnerable than that of PAs in Arsi-Bale based on the PCA method.



Source: Calculated from ERHS (1994 and 2009)

Figure 1.
Vulnerability Indices of PAs using 3 steps FGLS (1994 and 2009)

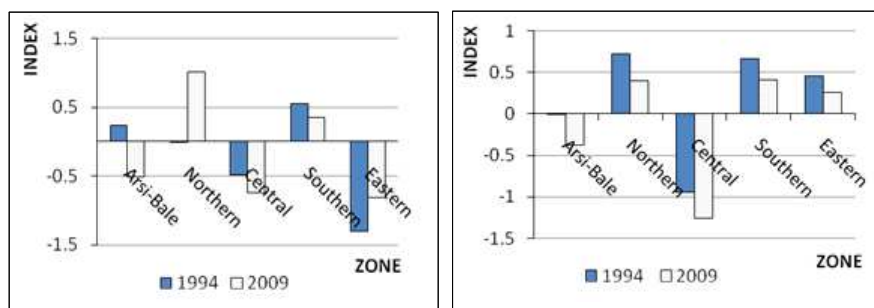


Source: Calculated from ERHS (1994 and 2009)

Figure 2.
Vulnerability to Poverty Indices of PAs using PCA (1994 and 2009)

Though Northern highland and South or ‘Enset Culture’ are clearly shown to be the two regions with the highest concentration of more vulnerable households in both approaches, notable differences have especially been observed at the other end. Hararghe is rated to be the least vulnerable based on the 3 steps FGLS while Central Highlands are the least according to the PCA approach. Over the entire study period, all zones

have similarly exhibited a noticeable decline in vulnerability to poverty according to the PCA approach. However, the results for Northern and Eastern agro-ecological zones showed a clear rise of households' vulnerability to poverty based on the consumption based approach. For the rest of the zones, both approaches have shown a decline in vulnerability to poverty similarly.



A) Based on 3 steps FGLS

Source: Calculated from ERHS (1994 and 2009)

Figure 4.

Vulnerability to Poverty at Agro-Ecological Level (1994 and 2009)

The PCA approach further supports the descriptive results, which showed the improvement of households' welfare in many of the indicators of wellbeing. However, the consumption based approach has undermined the overall improvements of households' welfare in the study period indicating the limitation of the consumption based approach in accounting for over all changes in wellbeing of households and in line with previous studies such as Ambel et al. (2015), which documented a rapid reduction of the proportion of population under multiple deprivation than in some of the dimension depreciation including monetary measures. Thus, complementing consumption based approaches with the more comprehensive method of measuring vulnerability to poverty becomes indispensable in framing development progress in Ethiopia.

Determinants of Vulnerability to Poverty

The causes for vulnerability of households to poverty have been assessed mainly using a Fixed Effects Instrumental Variable (FE-IV) regression model after a Hausman specification test showed that error terms

are correlated with the regressors and Hausman-Wu test of endogeneity confirmed the presence of endogenous variables. Besides, Instrumental Generalized Method of Moments (IV-GMM) was carried out against the same set of regressors and compared with the results of the FEIV model. Five variables in the system namely off-farm, whether households store cereals, transfers, participation in off-farm activities and number of adult days not in work are found endogenous and their predicted (after regressing them against the rest of the variables in the system) and lagged values are used as instruments.⁴ However, caution should be made in interpreting the results as positive (negative) coefficients mean increasing (decreasing) vulnerability in the three steps FGLS approach while the opposite is true for the PCA approach at the household level. Results are reported in table 6.

The overall significances as measured by Wald chi-square in both regression models of both approaches are robust. Most of the regressors have similar association with the dependent variables in all four regression models. The most valuable assets of mixed farming smallholders in rural Ethiopia namely land and livestock assets are found to be negatively associated with vulnerability to poverty regardless of the models estimated. The remaining discussions on Table 6 are based on the results of the FEIV model estimation of the consumption based approach as it is found to be more robust than the result of the IV-GMM. Besides, the asset-based vulnerability indices tend to be embedded in the variables used for constructing the index and might complicate our estimations and interpretations.

All the remaining significant variables show expected patterns except for age and age squared of the household heads. Against expectations, households headed by younger individuals are associated with higher vulnerability, while their counterparts (embodied in the age-squared variable) are less likely to be vulnerable to poverty. These results appear to reflect the often-ignored reality in rural parts of the country that younger adults (usually new couples in the context of rural Ethiopia) face challenges of having limited command of vital resources of farming such as land, oxen and other social assets, which increase their likelihood of falling into poverty. This result is consistent with Fedkadu (2013); however, contradicts the results of Tola et al. (2016) and Hill and Porter (2017).

⁴ See the results of Hansen J tests of over identification in Appendix part Table 1.

Table 6.
Determinants of Vulnerability to Poverty in Rural Ethiopia Using Two Approaches (1994 – 2009)

Vulnerability Index	3 Steps FGLS Approach		PCA Approach	
	FE-IV	IV-GMM	FE-IV	IV-GMM
Sex of the household head	0.041 (0.078)	0.031 (0.033)	0.249 (0.086)***	0.146 (0.045)***
Age of the household head	0.016 (0.005)***	0.005 (0.005)	0.010 (0.013)	-0.007 (0.010)
Age Squared of the household head	-1.47e-04 (4.77e-05)***	-3.94e-05 (4.51e-05)	-9.95e-05 (1.22e-04)	6.92e-05 (9.86e-05)
Lag of the vulnerability index	0.447 (0.028)***	0.314 (0.039)***	0.046 (0.037)	0.042 (0.027)
Credit (Dummy)	0.001 (0.017)	-0.003 (0.023)	-0.070 (0.044)	-0.030 (0.043)
Membership in Local Savings Group (Dummy: Yes=1)	-0.070 (0.021)***	-0.037 (0.031)	-0.076 (0.052)	0.064 (0.054)
Participation in off farm activities (Dummy)	-0.068 (0.017)***	-0.065 (0.023)***	0.105 (0.044)**	-0.006 (0.045)
Literacy of the household head	-0.023 (0.020)	-0.043 (0.025)*	0.274 (0.047)***	0.314 (0.051)***
Size of Cultivated land (ha)	-0.017 (0.007)**	-0.018 (0.009)**	0.168 (0.021)***	0.196 (0.017)***
Value of Livestock owned (Birr)	-8.45e-6 (4.6e-6)*	-2.6e-5 (9.45e-6)***	1.07e-4 (9.4e-6)***	1.55e-4 (1.0e-5)***
Days not in work due to illness	-5.5e-04 (3.34e-04)	-1.61e-05 (5.29e-04)	3.4e-04 (0.001)	-0.011 (0.007)
No. of Agents visit in the main harvest season	-0.002 (0.001)**	-0.007 (0.003)***	0.001 (0.003)	0.003 (0.027)
Number of crops grown in the year	-0.052 (0.006)***	-0.022 (0.006)***	0.009 (0.014)	0.020 (0.013)
Number of plots owned by the household	0.019 (0.004)***	0.015 (0.01)	0.005 (0.009)	-0.038 (0.018)**
If remittance received (Dummy)	0.007 (0.018)	0.061 (0.024)***	0.059 (0.042)	-0.065 (0.042)
Dependency ratio	0.062 (0.015)***	0.033 (0.028)	0.025 (0.032)	-0.015 (0.034)
hsize	0.039 (0.0045)***	0.061 (0.008)***	0.014 (0.010)	0.022 (0.012)*
If households stored cereals (Dummy)	-0.019 (0.019)	-0.040 (0.027)	0.420 (0.053)***	0.599 (0.048)***
Constant	-0.327 (0.142)**	-0.129 (0.148)	-1.426 (0.351)***	-0.965 (0.303)***
Observations	1359	541	856	545
Wald chi2(18) F(18, N-19)	40.65	387.38	38.62	1784.39
Prob > chi2	0.000	0.000	0.000	0.000
R-squared/ centered R-squared	0.417	0.401	0.550	0.775

NB: Figures in brackets are robust standard errors. Source: Calculated from ERHS (1994 and 2009)

Lag of vulnerability to poverty is positively and significantly associated with vulnerability to poverty indicating that the degree of vulnerability of households in the preceding survey rounds is highly interwoven with the succeeding rounds. Whilst saving groups, off-farm participation and crop diversification tends to reduce vulnerability to poverty, land fragmentation, household size and dependency appears to exacerbate vulnerability to poverty all by one percent level of significance and supports previous studies in the field (Moser, 1998; Albert et al., 2007; Imai et al., 2009; Demeke et al., 2011). Land fragmentation appears to reveal that the influence of external (supply side) factors outweighs the

demand side (beneficial levels of land fragmentation needed by smallholders) and in line with Bentley (1987). Moreover, agricultural extension service (represented by the number of visits by extension agents in the previous main harvesting season) has a negative association with vulnerability to poverty at 5 percent level of significance showing the meaningful impact of government's agricultural extension services expansion all over the country giving at most priority in its policy agenda and supports previous studies such as Hasan et al. (2013), which evidently proved the impact of participation in extension programs in reducing household vulnerability in Uganda and Kipurgat. and Tuigong, (2015), which showed a positive impact of extension services to agricultural production and food security in Kenya.

Table 7.

Determinants of Vulnerability to Poverty Using Dynamic Fixed Effects Instrumental (1994-2009)

Vulnerability Index	Enset Culture	Central Highlands	Northern Highlands	Arsi-Bale
Sex of the household head	-0.063 (0.050)	0.122 (0.080)	-0.177 (0.107)	-0.108 (0.090)
Age of the household head	0.003 (0.005)	-0.004 (0.010)	-0.003 (0.013)	0.009 (0.011)
Age Squared of the household head	-2.6E-05 (4.8E-05)	1.5E-05 (9.5E-05)	-7.8E-05 (1.2E-04)	-1.1E-04 (1.0E-05)
Lag of the vulnerability index	0.479 (0.066)***	0.406 (0.058)***	0.466 (0.064)***	0.516 (0.078)***
Credit (Dummy: Yes=1)	0.013 (0.021)	-0.030 (0.034)	-0.022 (0.036)	0.027 (0.042)
Membership in Local Savings Group (Dummy: Yes=1)	-0.044 (0.026)*	-0.210 (0.044)***	0.007 (0.075)	0.060 (0.085)
Participation in off farm activities (Dummy: Yes=1)	-0.054 (0.020)***	-0.001 (0.033)	-0.105 (0.048)**	-0.432 (0.104)***
Literacy of the household head	-0.035 (0.028)	-0.089 (0.037)**	-0.004 (0.062)	0.002 (0.043)
Size of Cultivated land (ha)	-0.028 (0.012)**	-0.020 (0.013)	0.030 (0.033)	0.005 (0.015)
Value of Livestock owned (Birr)	-1.1E-05 (1.2E-05)	-4.8E-06 (6.6E-06)	-1.3E-05 (1.3E-05)	-1.3E-05 (9.8E-06)
Days not in work due to illness	-4.4E-05 (3.9E-05)	0.001 (0.001)	0.001 (0.001)	-0.001 (0.001)
Number of Agents visit in the main harvesting season	-0.011 (0.003)***	-3.7E-04 (0.003)	-0.041 (0.014)***	0.007 (0.007)
Number of crops grown in the year	-0.037 (0.007)***	-0.057 (0.011)***	-0.047 (0.014)***	0.020 (0.020)
Number of plots owned	0.010 (0.005)	0.006 (0.007)	3.17E-04 (0.010)	0.001 (0.012)
If remittance received (Dummy: Yes=1)	-0.029 (0.021)	-0.025 (0.038)	-0.074 (0.038)***	0.029 (0.045)
Dependency ratio	0.021 (0.018)	0.007 (0.033)	0.037 (0.029)	-0.039 (0.048)
hhsize	0.018 (0.007)***	0.045 (0.007)***	0.086 (0.017)***	0.035 (0.013)***
If households stored cereals (Dummy: Yes=1)	-0.013 (0.019)	-0.011 (0.064)	-0.135 (0.074)**	-0.058 (0.049)
Constant	1.418 (0.151)***	0.963 (0.257)***	1.390 (0.365)***	1.160 (0.274)***
Observations	656	575	378	334
Wald chi2(32)	25954.32	3416.34	5426.36	4571.51
Prob > chi2	0.0000	0.0000	0.0000	0.0000

Source: Calculated from ERHS (1994 and 2009)

Beyond the national level analysis, the determinants of vulnerability to poverty are estimated at agro-ecological zone levels using the FE IV model. The results are shown in table below. The FE IV estimations have been robust for the four agro-ecological zones except for Hararghe highland, which contains only one PA. Hence, the results are reported only for the four agro-ecological zones.

Both lag of vulnerability to poverty and household size have the same association with the dependent variable both at national level and across all the agro-ecological zones. The significance of the remaining regressors are limited to only some of the agro-ecological zones. Members of local saving institutions are found to have significantly less vulnerability to poverty compared to non-members though limited to the Enset culture and North Highlands. Participation in off-farm activities have similar impacts in all the zones except in central highlands. The vulnerability reducing impact of both literacy of the household head and size of cultivated land has been only significant in central highlands and Enset culture respectively, reflecting the low productivity of agricultural lands due to the deterioration of agricultural lands in quality. It also suggests a lack of complementary inputs to enhance productivity and the slow progress in expanding adult literacy programs.

Moreover, the number of visits by extension agents appears to be negatively and significantly associated with households' vulnerability to poverty only in the Enset culture (Southern Highlands) and Northern highlands at 1 percent level of significance, while it has no meaningful impact on other agro-ecological zones. This implies that extension services provided by government are not really helping smallholders in the rest of the zones to insulate households from falling into poverty. Similarly, number of crops grown also significantly reduces the risk of households to poverty in all zones except in Arsi-Bale highlands. Finally, dummy variables for transfers received and whether households store cereals are both found to significantly reduce households' vulnerability to poverty only limited to the Northern highlands of Ethiopia. All the remaining regressors are negatively correlated except that they are not consistently relevant in all of the agro-ecological zones.

Conclusion

Finally, this study is strategically positioned to help bridge the

literature gap in the field of Ethiopian poverty studies and vulnerabilities studies in terms of datasets and measurements applied. First, it serves to bridge the empirical evidence gap of studies based on cross-sectional and/or short panel rounds of older and recent datasets in rural poverty and vulnerability analyses in Ethiopia. Second, this study's utility increases in its unique approach in comparing conventional and multidimensional vulnerability estimates in Ethiopia, encouraging further research to be done that centers more nuanced approaches in understanding the nature of poverty in Ethiopia.

Overall, this study shows that vulnerability to poverty is pervasive among rural households in Ethiopia. The estimation results show that both poverty incidence and vulnerability to poverty in rural Ethiopia are substantial but have opposite trends across the survey rounds. However, vulnerability to poverty prevailed over poverty incidence in all survey rounds.

In both consumption-based and asset-based approaches, most of the PAs in Northern Highlands and Enset Culture have relatively higher vulnerability to Poverty indices while those in central highlands, Hararghe and Arsi-Bale have lower indices in both 1994 and 2009. At the agro-ecological level, the experience has been somewhat different for the consumption-based approach compared to that of the Asset-based approach. Except the Northern and Eastern highlands, the rest of the zones exhibited a decline in vulnerability of poverty using the consumption-based approach. However, following the asset based measure of vulnerability, we learnt that all the agro-ecological zones have indeed experienced a decline in the vulnerability to poverty indices reflecting that consumption based approaches would undermine the existing welfare improvements of rural households and their complimentary use is indeed commendable.

The study of determinants also furnishes important insights about the major factors causing vulnerability of households to poverty in rural Ethiopia. On the one hand, households headed by more experienced persons, having more cultivated land, more livestock assets, participating in extension service, saving groups and off-farm activities; and with higher number of crops cultivated are less vulnerable to poverty than their counterparts. On the other hand, households with more number of plots of land, family size and dependency ratio are more vulnerable poverty than those that have relatively less of them. The results of the regression estimation confirm that the efforts of the Ethiopian Government in

providing extension services and helping smallholders to diversify crops cultivated has produced positive results. However, there is still a need to work on family planning and refrain from policies that might result in more land fragmentation as this move might exacerbate vulnerability of households to poverty. Analysis of the determinants of vulnerability to poverty at agro-ecological zone levels has also given interesting contrasts in terms of the commonality and differences of significant covariates, which must be given due attention to address the problems of vulnerability to poverty in each of the agro-ecological zones adequately. Therefore, poverty reduction strategies should be crafted with care considering the realities on the ground as ‘one size fits all’ strategies and interventions might not come up with the desired results. It is also imperative to look at agro-ecological and community differences to make poverty reduction efforts impact *ex ante* poverty meaningfully.

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Appendix

Table 1.

Hansen J Statistic: Over-Identification Test of All Instruments

Sample Coverage	Chi-sq	P-value
3 Steps FGLS		
FE-IV	4. 190	0. 5225
IV-GMM	4. 0131	0. 5475
PCA		
FE-IV	7. 317	0. 0625
IV-GMM	3. 24494	0. 3554

Note: The null hypothesis is that instruments are not correlated with error terms. The null is accepted in all equations and that all instruments are found to be valid at 95 percent level of confidence. (Source: Estimated from ERHS (1994 - 2009))

Table 2.

Bivariate Correlation Matrix with Benchmark Indicator

Variables used in the PCA Analysis		Real monthly food consumption per adult equivalent
Number of Food Groups Consumed in 7 days	Pearson Correlation	0. 438***
	Sig. (2-tailed)	0. 000
	N	2299
Number of Oxen Owned	Pearson Correlation	0. 213**
	Sig. (2-tailed)	0. 000
	N	2297
Number of Ploughs Owned	Pearson Correlation	0. 227**
	Sig. (2-tailed)	0. 000
	N	2304
Size of Cultivated Land	Pearson Correlation	0. 211**
	Sig. (2-tailed)	0. 000
	N	2238
Value of Livestock Asset	Pearson Correlation	0. 257**
	Sig. (2-tailed)	0. 000
	N	2304
Whether Households Store Cereals	Pearson Correlation	0. 229**
	Sig. (2-tailed)	0. 000
	N	2297

*** Correlation is significant at the 0. 01 level (2-tailed). (Source: Estimated from ERHS (1994 - 2009))

Table 3.
Goodness-of-fit of the Model

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0. 796
Bartlett's Test of Sphericity	Approx. Chi-Square	3383. 253
	df	15
	Sig.	0. 000

Source: Estimated from ERHS (1994 - 2009).

Table 4.
First Component Loading Matrix

Factors used for PCA	First Component
Number of Food Groups Consumed in 7 Days	0. 550
Number of Oxen Owned	0. 809
Number of Ploughs Owned	0. 652
Size of Cultivated Land	0. 700
Value of Livestock Asset	0. 808
Whether Households Store Cereals	0. 540

Source: Estimated from ERHS (1994-2009).