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Does Climate Shock Aggravate Household Food Insecurity in Rural Ethiopia? Evidences from Panel Data Estimation

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Abstract
Ethiopian rural households are vulnerable to various climate shocks that affect agricultural production and thereby the household food security. Rural households frequently experience drought which may adversely affect food security and livelihood of rural households in the country. Thus, assessing the past challenges on food security due to climate shocks may have paramount importance in reducing the future vulnerability by providing appropriate measures towards mitigation and adaptation of future climate shocks. Using a longitudinal household dataset drawn from the Ethiopia Rural Household Survey, this study examines the effect of climate shocks on the Ethiopian rural households' food security. By employing a fixed effects econometric analysis technique, climate shock is found to be negatively and significantly associated with food security over time. A negative climate shock variable implies that, households vulnerable to drought tends to be more food insecure than their counterparts. It has also been found that a household food security is hugely determined by the household's resource endowment. Among the variables representing human capital endowments, large family size is found to be negatively associated with household food security. Among the basic physical resource endowments, land and livestock play a vital role in determining the household food security in rural Ethiopia. Moreover, our study identified that, credit use is an important financial capital influencing household food security in the study area. Overall, our principal result is that unfavorable climatic conditions combined with lack of necessary households' resource endowments; adversely affect the rural household food security in Ethiopia. Given the vital role the households resource endowments have in reducing food insecurity, the findings suggest that policies that can contribute to the improvement of households' resource endowments should not be undermined.
Keywords: Climate shock, Drought, Ethiopia, Food security, Resource Endowments

1. Introduction

Identifying the root causes of rural household food insecurity and the struggle to overcome the problem in Ethiopia dates back a long period (Bogale and Shimelis, 2009). The situation still demands a lot of struggle and effort to identify the causes of the problem. In this regard, our study attempts to contribute to the existing literature by answering two research questions. "Does climatic shock have an effect on household food security?" and "Is the households' food security associated with their various resource endowments?"

A food insecurity problem, be it a result of sudden shocks or not, usually requires government's as well as other humanitarian donor organizations' assistances. These assistances may not make a structural change for the deep rooted food insecurity problems unless the fundamental cause of the problem are identified. Thus, empirical assessment of time variant causes of food insecurity has a paramount importance to make better-informed policy decisions.

An event of sudden climate shocks may aggravate the households' food insecurity problem. Therefore, assessing the past challenges on food security due to climate shocks may play a vital role in reducing the future vulnerability of households by providing appropriate early warnings towards mitigation and adaptation of future climate shocks. However, most of previous studies on food security aspects in Ethiopian context did not give an emphasis on identifying the association between climate and food security. Various studies have been conducted so far; however, they are more of region and time specific. Some of the studies gave more emphasis to identifying determinants of food security in a given point of time (cross-sectional). The prominent examples of the cross-sectional studies are; Feleke *et al.* (2005), Hussein and Janekarnkij (2013), Ramakrishna and Demeke (2002), Kassa *et al.* (2002), and Bogale and Shimelis (2009). It is obvious that, evidences from cross sectional data provide information only about current situations at a point in time. Cross sectional data may not give adequate evidence to study forward looking on food security and vulnerability analyses. This fact brought a use of national level longitudinal data to study time-variant food security analysis to our interest.

Direct assessments of the effect of climate shock on food security over years and identifying the time-variant food security determinants remain limited. In fact, there are a few studies; Demeke *et al.* (2011) and Holden and Shiferaw (2004), which emphasized on identifying the association between climate and food security. To this end, our study thought to better address the time variant food insecurity issues and the incoming negative impacts through a unifying conceptual framework. The framework links household's resource endowments with food security and climate shock using Sustainable Livelihood concept. The framework

basically rests on the economics notion that the wealth status of an individual household depends on its resource endowments.

Thus, the major objective this study addresses is to analyze the effect of climate shock on household food security over years. Secondly, it identifies important household resource endowments determining the household food security over years.

Our study has two leading hypotheses which directly follow from our objectives. The primary general hypothesis states that, *"households with better position in their resource endowments are more food secured than their counterparts"*. Our second hypothesis directly drawn from the first hypothesis in a sense that climate shock is one of the natural processes that destroy households' *natural capital endowments.* Thus, the second hypothesis is stated as *"climate shocks have a negative impact on Ethiopian household food security"*. Finally, our study provides useful information to different policymakers in the area of poverty alleviation and food security in the Ethiopian context.

2. Theoretical Framework and Concepts

2.1. Food Security and its indicators

Different scholars commonly conceptualize food security as it is resting on three pillars: availability, access, and utilization (Barrett, 2010). According to Barrett (2002), there are problems on precisely measuring and conceptualizing the incidence of food insecurity. Given an unobservable and complex nature with multi-factorial causality, Barrett (2002) underlined that it is impossible to someone to easily define and precisely measure a broad concept; food security. There are various definitions currently in use, among these the prevailing definition agreed upon at the 1996 World Food Summit: "*food security represents a situation that exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life*" (Barrett, 2010 p. 825). As indicated by (Bickel *et al.*, 2000), food security at a minimum includes the following two conditions. The first one is "*an availability of nutritionally adequate and safe foods*", whereas the second condition is "*an assured ability to acquire acceptable foods in socially acceptable ways"*. Thus, identification of valid and reliable indicators is a key task *prior* to analyzing causal relationship between food security and its potential factors.

Among a bunch of literatures, Haddad *et al.* (1994) tried to find indicators of food security that correctly classify a high proportion of households. Their results from empirical analysis confirmed that, indicators such as; *food expenditure per capita*, *number of unique foods consumed*, *consumption expenditure per capita*, *household income*, and *dependency ratio* are good indicators of household food security. In locating the food and nutrition insecure households, *household size* and total expenditure per capita or household income per capita, do good job. Haddad *et al.* (1994) p. 334, finally concluded that *"the number of unique foods at various levels of aggregation seems a promising indicator"*. In the end, Haddad *et al.* (1994), food expenditure per capita is relatively better indicator since it encompasses the access and availability components of food security.

2.2. Climate Socks

Poor people face various shocks that directly or indirectly affect their livelihoods and food security (Von Braun, 2009). Generally, shock is a broad concept which is defined in different ways in different literatures. For instance, Dercon *et al.* (2005) p. 5, define shocks as *"adverse events that lead to a loss of household income, a reduction in consumption and/or a loss of productive assets"*. Household level shocks can either be *idiosyncratic or covariate. Idiosyncratic* shocks include adverse events that specifically affect particular individual household in the community. Whereas, c*ovariate* shocks include events that simultaneously affect many people in the same geographical location (Von Braun, 2009). Rainfall shock and drought are kinds of *covariate shock* as they affect all households in the village and possibly those nearby. Dercon *et al.* (2005), divided shocks into a number of broad categories; climatic, crime, political, economic, and health related shocks. Among these, climate shocks are severe in developing countries since the majority of the poor depend on agriculture as a source of food and income. The most common climatic shocks could be idiosyncratic; floods, too much rain, climate induced diseases/pests that affect crops and livestock. In some cases, diseases affecting crops or livestock may appear to be a mix of idiosyncratic and covariate shocks.

According to Von Braun (2009), climate shock includes an increase in the incidence of extreme weather events such as droughts and floods which result in a decrease in agricultural yields and hence lower food availability. On top of the obvious examples of climatic shocks, such as drought and flooding, Dercon *et al.* (2005) also mentioned erosion, occurrence of frosts and pestilence affecting crops or livestock as climate shocks.

2.3. Livelihood, Food Security and Shocks

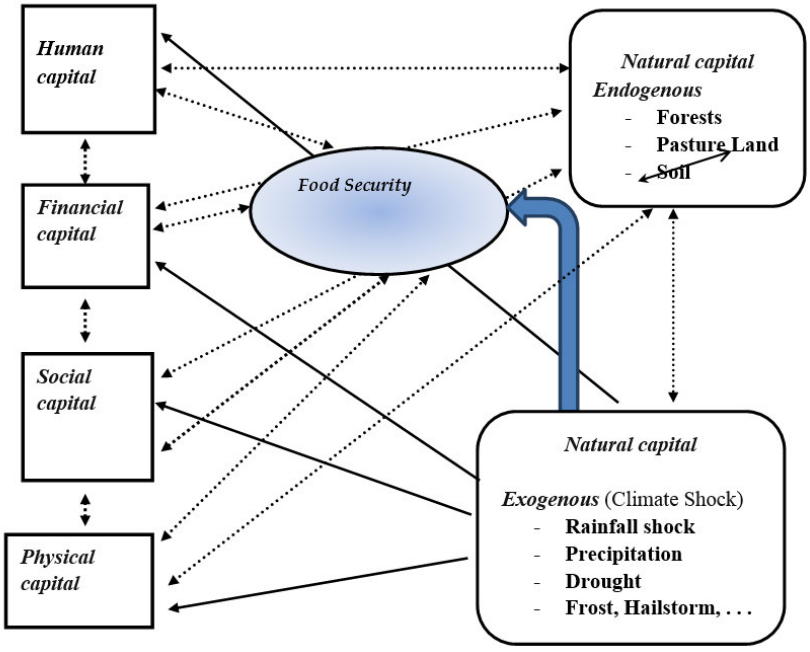
One can hypothesize food security to be mainly influenced by various household's resource endowments based on an economics notion that the wealth status of an individual household depends on its resource endowments.

This is what the general Sustainable Livelihood Framework (SLF) also suggests (DFID, 1999).[1] The framework suggests that, household's resource endowments are the basic "*poverty reducing factors"*. The SLF indicates that the livelihood of a given household or state is mainly dependent on its asset endowments.

There are five broad categories identified by SLF. They are; *human capital*, *social capital*, *physical capital*, *financial capital* and *natural capital* endowments. The SLF is developed to enable information about people's assets to be presented visually using the so called the "*Asset pentagon*" which lies at the core of the vulnerability context. Though the framework may not be considered as an exact representation of the existing reality, it yields important inter-relationships among the various household's assets (DFID, 1999). When peoples are viewed as vulnerable to certain shocks, while having access to various household assets (which play role in poverty reducing), the framework provides a way of thinking towards improving performance in poverty reduction. *"People's livelihoods and the wider availability of assets are fundamentally affected by critical trends as well as by shocks and seasonality – over which they have limited or no control*" (DFID, 1999 *section 2.2*).

Therefore, asset endowments (poverty reducing factors), are assumed to enable households to pursue a sustainable livelihood. Generally, the availability as well as the quality of any of the resource endowment listed above, may directly or indirectly affect the food security of the household. Some shocks which directly affect one of the endowments may also indirectly affect availability or quality of another endowment. *"Clearly financial capital, in terms of access to employment and earnings, is strongly dependent on adequate human capital.....human capital is highly dependent on adequate nutrition, health care, safe environmental conditions, and education"* (Farrington *et al.*, 2002 p. 20).

Similarly, if a household faces a *financial capital* problem (e.g. cash constraint to purchase agricultural inputs), there will be lower agricultural yield. Broadly speaking, some of these resources may also be affected by natural processes (e.g. *Drought*), as a result, there will be low food availability at household level. Therefore, there are potential forward and backward linkages among these resource endowments, occurrence of shocks, and food security. Figure 1 outlines the possible inter-linkages based on the sustainable livelihood contexts. In the figure, the double arrows indicate the two-way inter-linkages, whereas the single arrow indicates the unidirectional relationship between the factors under the particular category.



3. Methods

3.1. Data Source and Sampling

Our data are drawn from the Ethiopia Rural Household Survey (ERHS), a longitudinal household dataset collected in seven survey rounds from 1989-2009. The Data collection was conducted with supervision of Economics Department of Addis Ababa University (AAU), Centre for the Study of African Economies (CSAE), University of Oxford (UK), and the International Food Policy Research Institute (IFPRI), in order to study the response of rural households to food crises in Ethiopia (Dercon and Hoddinott, 2004).

The survey data were collected using a stratified sampling technique on the main agro-ecological zones

[1] DFID: Department for International Development

of the country. 15 rural villages were included from the Amhara, Oromiya, Southern Ethiopian, and Tigray regions of the country. The village sample sizes were chosen to generate an approximate self-weighting sample in terms of farming system (Dercon and Hoddinott, 2004). The peasant associations selected were mainly areas that had suffered from the 1984-1985 famine and other droughts that followed between 1987 and 1989. The panel survey has been conducted for seven rounds (from 1994-2009) giving a total sample of 1477 households.
To allow for even time spacing so as to keep the panel nature of the data, our analysis is performed only on the four rounds which are spaced five years apart. Thus, we utilized the first (1994), the fifth (1999), the sixth (2004), and the seventh (2009), rounds of the survey.

3.2. Econometric Model

Given our theoretical framework specified in section 2 and panel nature of our data, we have two versions of linear regression models prominent candidates for our analysis. They are the Fixed Effects (FE) and the Random Effects (RE) regression models. These models are chosen in most cases since they provide a better control for the influence of missing or unobserved variables (Verbeek, 2008). Moreover, these models are able to account for inter-temporal as well as individual differences among our units of analysis. The simple panel data model suggested by Verbeek (2008) can be specified as:

$$Y_{it} = \alpha_i + \gamma X'_{it} + \beta C_{it} + \varepsilon_{it} \quad \textbf{(1)}$$

Where; Y_{it} is an outcome variable (food security indicator) observed for household i at time t, X_{it} is a k-dimensional vector of other explanatory variables, C_{it} is a climate shock indicator for household i at time t, while β and γ are parameters (coefficients) to be estimated and ε_{it} is the usual disturbance term.

If we treat the α_i as N fixed unknown parameters, the model in equation 1 is referred to as the standard Fixed Effects model. This leads to the Random Effects model, when the individual specific effects α_i are treated as a component of the random term. Therefore; whether to use FE or RE estimator is basically based on whether to treat the individual effects α_i as fixed or random. Whether the efficient random effects estimator should be preferred over the less efficient, but the consistent fixed effects estimator should be tested using a general Hausman test[1].

3.3. Definition of Variables and Hypotheses

As we described in section 2.1, since monthly food expenditure per capita encompasses the access and availability components of food security, we used it as an indicator of food security in the context of rural Ethiopian households. In equation (1), a climate shock variable, C_{it}, for household i at time t is a dummy variable representing whether the household experienced a particular type of climate shock. The variable takes a value of 1, if a household experienced a particular type of climate shock at least once in a given year over a period of 1994-2009, and 0 otherwise. *Prior* to our analysis, we identified the potential climate shock indicators, such as an occurrence drought, an occurrence of flood, and an occurrence of Frost or Hailstorm. Though we proposed to use an aggregation of the three climate shock indicators, the occurrence of flood and the occurrence of Frost/Hailstorm were found to be relevant only for very few households. Since an inclusion of a shock that is only relevant for very few households would not probably give informative results, we excluded them from the analysis. Therefore, this study used, whether a household experienced drought at least once in a given year over a period of 1994-2009 as an indicator of climate shock.

Following our general hypothesis that "households with better position in household's resource endowments are more food secured than their counterparts", we anticipate a negative effect of climate shock on household food security. As climate shock is one of the natural processes that destroy households' natural capital endowments, it is assumed that such shocks worsen the natural capital endowments' position of the households. As factors determining food consumption per capita, this study included variables from a pool of variables identified based on the sustainable livelihood framework context. Under the five broad categories of the household's resource endowments, we included various variables linking food security to human capital, physical capital, natural capital, social and financial capital endowments.

The human capital factors we used include; gender, age (measured in years), and education level of the household head. The gender variable takes a value of 1, if the head of the household is male; and zero otherwise. Education of the household, which was used as a proxy variable for managerial ability of the head, takes a value of one if the farmer is literate and 0; otherwise. Age of the household head measured in years is assumed as a proxy measure of farming experience, which in turn represents a better position in human capital. Though relatively old farmers could have enough experience on farm activities and technology adoption, as the

[1] The general idea of a Hausman test is to check the existence of correlation between the unobserved individual heterogeneity, α_i, and the explanatory variables, x_{it}. "……..two estimators are compared one which is consistent under both the null and alternative hypothesis and one which is consistent (and typically efficient) under the null hypothesis only" (Verbeek, 2008 pp. 351-352)

household head gets older and older, age may have a diminishing effect on managerial ability. To account for this diminishing effect, we used the squared term of age as another explanatory variable.

In smallholders' agriculture family members are the major sources of labor force for agricultural production. This combined with quality education and training may broadly represent human capital endowment. Therefore, we included household size (measured in number of family members) as another proxy for a human capital. Besides participation in labor force, household members are the primary consumers of the agricultural products. For instance, when a family is majorly composed of children and old age people, it may be difficult to see the clear impact of family size. To account for the composition of the household in our analysis, we have included age dependency ratio[1] as another explanatory variable.

Livestock ownership measured in Tropical Livestock Units (TLU)[2], and land measured in hectares, represent physical capital endowments' position of the household. They are expected to be important factors determining household food security in a sense that they are basic inputs for food production. In our regression model, we have also included a membership in savings organization (*Equb*)[3] as social capital endowment. The variable takes a value of 1, if any of the household members is a member of local credit and saving associations and 0; otherwise. Our model also incorporates off-farm employment and use of credit as variables representing Social capital and financial capital endowments, respectively. We entered a dummy variable having a value of 1 if the household earns off-farm income by working on someone else's land or through other employment in the year prior to the survey year, and 0; otherwise. The use of credit represents whether an individual sample household had taken out a loan of at least 20ETB (in cash or in kind) in the past 12 months before the specific survey round. To capture this, we entered a dummy variable that takes a value of 1, if any of the household members has borrowed money for production purpose and 0; otherwise.

Since all aforementioned household resource endowments are basic building blocks for the livelihood of a household, we generally anticipate a positive association of an improvement in the resource endowments with household food security. Moreover, to control for potential effect of inflation trends and any other unobservable time and region specific heterogeneities we introduced a series of dummy variables in our regression. We introduced three year dummies for the four survey rounds and five month dummies for six different months of the interview. We included different interview months as dummies in a sense that there may be sudden shifts in household food consumption due to seasonality. On top of these, we introduced the region dummies to control for unobservable spatial differences in food consumption. Since we used the food consumption expenditure in nominal terms, the dummies are partly intended to capture the effect of potential inflation trends (variation in food prices across regions and times).

4. Results and Discussion

4.1 Descriptive Results

The summary statistics reported in table 1 show the relationship between drought and *per capita food consumption* across different years for our sample households. The summary generally indicates an increasing trend in households' total food consumption over time. The total food consumption increased by about three fold in 2009 compared to that of 1994. Similarly, the average per capita food consumption increased by about fourfold in 2009 compared to 1994. When we consider the entire panel (from 1994-2009), the *mean per capita food consumption* is higher for the sample households who did not experience an extreme drought in a given year. The mean *per capita food consumption* for sample households who experienced extreme drought is 99.80 Ethiopian Birr (ETB), whereas for those who did not experience drought is about 79 ETB. We have also conducted an independent samples t-test to test whether there is a significant difference in the mean scores of *per capita food consumption* between the two groups. The result of independent samples *t-test* (t-value = 4.32 with a p-value of < 0.001), suggests that there is a significant difference between the two groups with respect to the *average per capita food consumption*.

[1] A dependency ratio measures the proportion of economically non-productive (total family members aged between 0 to 14 and > 65) to those who are economically productive (family members aged between 15 and 65).
[2] One TLU is about 250 kg live weight of livestock (Bogale and Shimelis, 2009)
[3] In Ethiopia, Equb is a traditional voluntary saving association in which members form a group and collect a fixed amount of money usually in monthly or weekly basis in such a way that the money will be paid back to members in a lottery basis. The process continues until every member gets his/her total amount of money back.

Table 1: Summary statistics for food consumption and the demographic characteristics of sample households

	1994	1999	2004	2009
Total Food consumption (ETB)[1]				
Number of observations	1476	1447	1363	1355
Mean	268.75	436.40	421.76	850.67
Std. dev.	251.56	389.24	414.80	687.45
Per capita Food consumption (ETB)				
Number of observations	1471	1444	1362	1352
Mean	53.14	88.37	85.34	164.38
Std. dev.	62.28	88.25	93.70	130.10
Mean Household size (Heads)				
Observations	1476	1447	1363	1355
Mean	6	5.78	5.65	5.60
Std. dev.	3.03	2.74	2.52	2.56
Age (Years)				
Observations	1464	1588	163	1513
Mean	46.28	49.10	54.23	52.67
Std. dev.	15.71	15.38	14.71	14.36
Livestock (TLU)[2]				
Observations	1468	1448	1351	1575
Mean	2.43	2.71	2.88	5.10
Std. dev.	3.23	2.75	3.18	5.63
Land (Hectares)				
Observations	1389	1448	1355	1572
Mean	1.34	1.22	1.59	2.05
Std. dev.	1.37	1.11	2.09	3.86

Source: Own computation (2014) from 1994-2009 ERHS dataset

The average age of households' head is slightly increased over the years. The average age increased from 46 to 53 years from 1994 to 2009, respectively (Table 1). As the summary results further indicate, there is an overall increase in land holding from the early rounds to the latter ones. The land holding of the sample households increased from 1.34 hectares in 1994 to 2.05 hectares in 2009. Within the panel, the households' livestock ownership measured in Tropical Livestock Units (TLU) also shows an increasing trend. The result also shows that the livestock resource of the sample household increased almost by twofold in 2009 compared to that of 1994. It increased from 2.43TLU in 1994 to 5.10TLU in 2009.

Among the variables representing social capital and Financial capital endowments, use of credit and off-farm employment show an overall increasing trend across years. In all survey rounds, the proportion of households using credit consistently increases. For instance, the number of sample households getting credit access increased from 47% in 1994 to 62% in 2009. However, it was identified that the pattern in sample households' off-farm participation is mixed. Though there is a slight increase from 1999 to 2009; there is a noticeable drop in 1999 compared to 1994. Number of sample households working off-farm decreased from 35% in 1994 to 27% in 1999, but, in a late survey rounds the trend is reversed and off-farm participation gradually increased to 48% and 49% in 2004 and 2009, respectively. The result of membership in savings groups (*Equb*) indicates that the number of sample households registered as members of social saving groups has a decreasing trend over the years. Number of sample households registered as members in *Equb* decreased from 18% in 1994 to 14% in 2009.

4.1. Econometric Results

4.1.1. Preliminary Tests

In the very beginning of our model estimation, whether the efficient random effects estimator or the less efficient but the consistent fixed effects estimator is appropriate was tested using a general Hausman test. We conducted the test under a null hypothesis (H_0) that, the explanatory variables and the unobserved individual heterogeneity are uncorrelated; i.e. $cov(x_{it}, \alpha_i) = 0$. Our test result (with a p-value of < 0.01) suggests a rejection of the null

[1] *Official exchange rate (in terms of USD) was 5.50, 7.94, 8.64, and 11.78 in year 1994, 199, 2004, and 2009; respectively.*
[2] TLU: Total Livestock Units

hypothesis suggesting that the fixed effects estimator is appropriate. Therefore, this study used the results of fixed effects regression model in subsequent sections.

Prior to estimating the final model we have checked for some of the basic auxiliary assumptions which should be met before estimating a linear regression model. Some of these assumptions are; there should be a constant variance of the error term across the observations (i.e. the variance of the residuals is *homeskedastic or no heteroschedasticity),* there should not be serious correlation among explanatory variables entered into the model (no perfect multicollinearity), and the error terms in the linear regression model should be uncorrelated with the explanatory variables (*exogenous* explanatory variables or "*no endogeneity"*)[1].

Thus, regarding *heteroschedasticity* problem, we used a *Wald* test for *group wise heteroskedasticity in* the fixed effects regression model. The test result suggests a rejection of null hypothesis indicating that the variance of the disturbance term is not constant. In such a case, unless we take the problem into consideration, the model yields parameter estimates with large standard errors (less efficient estimates). Therefore, we used *robust and consistent standard errors* which are corrected for heteroskedasticity in the estimation of the fixed effects model. Multicollinearity is also a serious problem with the identification of variables to be included in a regression model, hence; we conducted a collinearity diagnostics test, for the explanatory variables included in the model. The test result (with a mean Variance Inflation Factor, VIF, of 5.36) indicates that there is no serious multicollinearity problem in our model.

Most importantly, *endogeneity* is one of the most major challenges in econometric analysis. It causes a bias in estimates due to unclear direction of causation when a researcher is intended to identify what determines the observed variation in an outcome of interest. To this end, we assumed strict exogeneity of our major variable of interest (climate shock) since by their nature, climate shocks; such as *drough*t, are kinds of *covariate shock* which affect all households in the village. Thus, we do not expect climate shocks to be endogenous as they are not majorly influenced by individual household's decisions. Moreover, several variables representing the different assets may be endogenous. This may hold for land and livestock. Likewise off-farm employment, credit use and participation in savings groups may depend on climate-change induced food security problems. To address this concern, an instrumental variables estimator implemented using the Generalized Method of Moments (*GMM)*[2]. The IV-GMM estimator is unbiased and consistent with the presence of endogenous regressors. We used the lagged values of each of the aforementioned potential endogenous variables as instruments (*internal instruments)* for the regressors. Our test result (with a test statistic; 2.73 and a p-value of 0.4358), does not suggest rejection of the null hypothesis that the specified endogenous regressors can be treated as exogenous. Generally, the GMM-IV Fixed Effects regression suggests that, there is no endogeneity problem in our regression model.

4.1.2. Parameter Estimates of the Fixed Effects Model

Table 2 summarizes the final results. The F-test for the overall fitness of our fixed effects model (with F-value = 46.38 and a p-value of < 0.01) suggests that all the coefficients of our explanatory variables are jointly different from zero. In other words, the explanatory variables included in the regression model are jointly significant at 1% error probability, implying that our model fits well.

[1] From a textbook context, endogeneity is a quite straightforward concept. The problem exists when the error distribution fails to be independent of the explanatory variables' distribution. Some examples of such situations are; the presence of a lagged dependent variable and autocorrelation in the error term, measurement errors in the regressors, and simultaneity/**endogeneity** of regressors (Verbeek, 2008).

[2] "The optimal General Method of Moments (GMM) estimator is asymptotically no less efficient than two-stage least squares under homoskedasticity, and GMM is generally better under heteroskedasticity" (Wooldridge, 2001 *P. 92*).

Table 2: The estimation results of fixed effects model

Dependent variable	***Per capita food consumption***		
Variables	**Coefficient**	**Robust Std. Error**	**t-ratio**
Climate Shock			
Drought	-13.074**	5.8595	-2.23
Human Capital			
Household Size	-12.490***	1.1415	-10.94
Dependency ratio	-2.009	2.3738	-0.85
Sex	1.966	8.3591	0.24
Age	1.057	1.0031	1.05
Age Squared	-0.0107	0.0096	-1.12
Education	7.889	5.6127	1.41
Physical (Natural) Capital			
Land	4.461**	2.1103	2.11
Livestock	1.934*	1.0096	1.92
Financial Capital			
Off-farm Employment	4.496	3.8775	1.16
Credit Use	7.993**	3.5394	2.26
Social Capital			
Saving Group	5.861	5.0335	1.16
R^2 within	0.4163		
R^2 between	0.2206		
R^2 overall	0.2725		
F(25,1381)	46.38		
$Prob > F$	0.0000		
Observations	3468		

*, **, ***, significant at 10%, 5%, and 1% level of significance, respectively. Time dummies for survey rounds and months of interview are included in the model, but not reported here.

As summarized in Table 2 above we found a negative effect of climate shock on household food security over time. The estimated coefficient corresponding drought suggests a rejection of the null hypothesis that, *drought has no effect on per capita food consumption*. The sign of the coefficient indicates a negative relationship between drought and food consumption per capita. In addition to climate shock indicator, all other hypothesized variables representing households' resource endowments, also have their expected sign. Among the nine variables, which were hypothesized to influence the household food security; *household size, land holding, livestock ownership,* and *use of credit* have statistically significant effect on household food security.

4.3. Key Findings

4.3.1. Climate Shock and Food Security

The result presented in Table 2 implies that, households vulnerable to drought tends to be more food insecure than their counterparts. The result for climate shock is in line with our general hypothesis. The negative effect of climate shock is possibly because, as rural households are vulnerable to extreme weather events; such as drought, agricultural output (crop and livestock production) can be directly affected. As a result, there will be a low level of food available in the household. The effect mainly rests on the effects of climate shocks on the households' Natural capital endowments since drought is one of the extreme natural processes that disrupt the households' natural capital endowments position.

The natural capital endowments, such as rainfall availability directly affect agricultural production thereby the household's food availability. In this regard, the effect of drought rests on rainfall shortage which seriously affects crop production, particularly in areas where agricultural production is primarily rain-fed. Moreover, persistent drought may result in crop yield reduction (crop productivity loss) due to less response to chemical fertilizers and soil nutrient depletion, which in turn hurt the food security status of the households. For instance, serious drought may result in a depletion of the most critical, but volatile nutrients, such as Nitrogen from the soil. When there is a frequent drought, the less fertilizer response of the crops may also lead to an accumulation of some toxic nutrients which may result in yield loss in subsequent cropping seasons.

The finding is consistent with previous studies conducted in Ethiopia. The two prominent studies our finding is in agreement with are; Holden and Shiferaw (2004) and Demeke *et al.* (2011). Similar to our finding,

Holden and Shiferaw (2004); found that, combined with lad degradation and population pressure on land, drought exacerbates food insecurity in the study area. According to their findings, there is an increasing trend in risk of drought on household agricultural production and food security. Similarly, Demeke *et al.* (2011) have shown that climate variability is an important determinant of Ethiopia households food security. Demeke *et al.* (2011), found that, the mean rainfall of main rainy season is positively associated with food security over time.

4.3.2. Household's Resource Endowments and Food Security

The estimation results of the fixed effects model summarized in Table 2 also show that, on top of climate indicator; various variables representing household's resource endowments are important factors determining the household food security. Among these; household size, livestock ownership, land holding, and credit use are factors significantly determining the household food security. This indicates that households' resource endowments matter in explaining household food security in the study area. Our results generally show that, the food security status of a household is determined by various resource endowments. Particularly, we found availability of *physical capital,* such as Land and Livestock hugely determine household food security. The results are consistent with our *prior* expectation and a general hypothesis that, *"households with better position in household's resource endowments are more food secured than their counterparts"*. Our findings are also in line with the sustainable livelihood framework that a household livelihood depends on its own resource endowments.

The negative estimated coefficient corresponding total family size in general suggests that large family size is among the underlying causes of food insecurity in rural Ethiopia. This is probably due to low agricultural yields which fail to meet the increased food demand in the household. The low agricultural yields may be a result of miss management of land combined with lack of access to improved technology in rural Ethiopia.

Another important implication of the negative effect of family size on food security is that, large families put additional pressure on farm income for food and other non-food consumptions, such as; clothing, education, and health; while not ensuring availability of enough family labor for farm operations to be performed in time. In other words, there are a large number of mouths to feed than hands to work which end up with unmatched food demand with the existing food supply in the household, which may finally result in food insecurity. In general, the finding is consistent with the previous findings of Bogale and Shimelis (2009); Feleke *et al.* (2005); and Kidane *et al.* (2005) in Ethiopian context.

In agreement with our hypothesis, among the variables representing the households' physical capital endowments*;* Land holding and Livestock ownership are identified to be important factors reducing household food insecurity.

The result generally suggests that, a better position in land holding improves the food security position of the sample households. This can be due to the fact that, as land holding expands the food production can be increased. This situation in turn leaves the households in a better food security position; provided that all other important production inputs are available. Another justification can be that households with large holding may have a better chance of diversifying crops to be grown thereby increase access to food. Furthermore, given a collateral value of land, larger farmers may get better credit from formal institutions to finance their food production. The result in particular is in agreement with our expectation and previous studies conducted in Ethiopia. Some of these studies are; Kidane *et al.* (2005) and Bogale and Shimelis (2009).

Our result also suggests that, a better position in livestock holding improves the food security position of the households. This is so possibly because, provided that there is enough land, livestock play a vital role as a basic production input in crop production. Moreover, livestock may improve Ethiopian household food security for the reason that income can be obtained from the sale of livestock products such as; milk, butter, etc. The income could be used for the purchase of agricultural inputs and may also augment financing of household consumption expenditures which would otherwise put pressure on the farm income itself. Moreover; in case of short-term liquidity constraint, livestock can be used as collateral to get loans from the informal lenders.

All these direct and indirect roles of livestock combined with other various households' resource endowments; possibly result in an improved food security situation of the households. The finding is consistent with previous food security studies such as; Bogale and Shimelis (2009); Hussein and Janekarnkij (2013); Demeke *et al.* (2011); Feleke *et al.* (2005); and Kassa *et al*. (2002), in Ethiopia.

Credit use is found to be an important financial capital influencing Ethiopian household food security. This may be because; credit plays a vital role in smoothing household's consumption. In other words, credit improves the financial position of a households by relaxing a cash constraint thereby enable them to adopt different livelihood strategies. Moreover, credit can build household's capacity to expand production through the purchased production inputs such as; seeds and fertilizers.

Generally, our finding is in agreement with our prior expectation as well as with the wide consensus that financial credit plays an important role in smoothing consumption and relaxing short-term financial liquidities. The result generally reveals that, credit use representing financial capital endowment, reduces household food insecurity in Ethiopia. The finding is consistent with some previous studies conducted in the

country. Bogale and Shimelis (2009) and Hussein and Janekarnkij (2013), are among them.

5. Conclusion and Policy Implications

Our finding generally suggests that unfavorable climatic condition (drought) adversely affects household food security in rural Ethiopian. On top of this, various households' resource endowments are also found to be important factors determining the household food security. In this regard, our results are also consistent with an economic notion that the wealth status of an individual household depends on its resource endowment. Moreover, this finding is also in agreement with the general Sustainable Livelihood Framework (SLF) which suggests that household's resource endowments are basic building blocks for sustainable livelihood.

However, among households' resource endowments, our study found household size to have a statistically significant negative effect on household food security. This indicates that, the effect of one type of resource endowment may be influenced by the availability of another resource endowment. For instance, the negative impact of large family size in a given household may result from the unmatched food demand with the existing food supply in the household as a result of physical (natural) capital constraint (e.g. Land). Therefore, our findings conclude that; provided that all necessary households resource endowments are not binding, households' resource endowments reduce household's vulnerability to food insecurity.

Based on the results of this study, improving household's food security status requires attention towards mitigating climate shocks. Based on our findings, even though climate shock is not endogenously determined by a single country, appropriate long-run policy interventions at the national level are required to mitigate the future consequences. Efforts towards improving the adaptive mechanisms will also have a positive impact on the household food security in the future. Though these policies may be already in place, given the current existing situation in the country, more effort is needed. Therefore, we recommend that the national government to exert more efforts to keep on provision of early warning with respect to predictable future climate variability based on the past climate trends. Moreover, despite the exogenous nature of climate shocks, the regional governments may also play a role in creating special adaptation mechanisms to climate shocks. In this regard, our study recommends promoting drought resistant crops in the areas where households are frequently affected by drought. We recommend promoting drought-tolerant cross-bread variety of different cereal crops as well as the promotion of some indigenous drought resistant crops (e.g. *Enset*).

Given the vital role the households resource endowments have in reducing food insecurity, policies that can contribute to the improvement of households' resource endowments should not be undermined. The positive effects of Livestock ownership, Land holding, and Credit call for financial strengthening together with awareness creation towards improving livestock production so as to reduce vulnerability to food insecurity. We strongly recommend credit facility which may capacitate the households to avoid distress land and livestock sales in the case of various financial obligations.

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Biography

The corresponding author was born in Sidama Zone (Hawassa) of Southern Regional State, in March 01, 1985. He held his Bachelor's from Hawassa University, Ethiopia, in Agricultural Resource Economics. He then joined Haramaya University, Ethiopia, in 2009 and graduated holding a Master's degree in Agricultural Economics in 2011. He also held another master's degree in Economics from Wageningen University, the Netherlands in 2014.

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