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ANALYSIS OF HOUSEHOLDS' VULNERABILITY TO FOOD INSECURITY AND ITS INFLUENCING FACTORS IN EAST HARARGHE, ETHIOPIA

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Abstract

Food insecurity studies in many developing countries, including Ethiopia, mainly target current food insecurity, thus lack of information to policy makers with *ex-ante* looking information. An understanding of household vulnerability and future food insecurity is critically important when designing policies and strategies to improve the food security status of farming households as well as reduce vulnerability to food insecurity. This paper analyzes vulnerability to food insecurity of farming households by adopting vulnerability as expected poverty approach. The study is based on cross-section data collected from 408 households in East Hararghe, Ethiopia, selected using a multi-stage sampling procedure. The Feasible General Least Squares regression results indicate that the age of the household head, family size, access to irrigation, adoption of soil and water conservation, size of cultivated land, and received credit were all significant in determining vulnerability to food insecurity. Based on the intensity of their vulnerability, households were grouped as chronic food insecure (24.27 percent), transient food insecure (11.77 percent), highly vulnerable-food secure (18.38 percent), and low vulnerable-food secure (45.59 percent). Moreover, the study indicated that 54.01 percent of households are vulnerable to food insecurity, which is by higher than the current incidence (national or study areas) of food insecurity (36.02 percent). Therefore, any food insecurity policy and program intervention to reduce food insecurity should also be based on the households' future access to food in addition to their current access.

Keywords: Vulnerability as expected poverty; Vulnerability to food insecurity; Food insecurity; Ethiopia

1. Introduction

Despite double digit economic growth in Ethiopia since 2005, Ethiopia ranks 174 out of 188 countries in the 2015 UN Human Development Index and 104 out of 119 in the Global Hunger Index classified as 'serious' (IFPRI, 2017). The rate of rural poverty is also high, with 30.4 percent of rural households living below the poverty line. IFPRI (2015) reports that, prevalence of stunting and wasting in children younger than five is 40.4 and 8.7 percent, respectively. This suggests that food insecurity is a serious problem and many households are vulnerable to it.

Although efforts made at reducing prevalence poverty and vulnerability to food insecurity (VFI),[1] both chronic and transitory food insecurity persist at the household level and millions of people are still vulnerable due to different shocks and stresses (FAO, 2015; FAO, 2016; FAO, 2010; Bogale and Shimelis, 2009). Studies indicate that poverty and vulnerability in Ethiopia remains very high (IFPRI, 2015; FAO, 2016; Dercon & Christiaensen, 2011; Fentaw et al., 2013; Dercon et al. 2012; Kumar & Quisumbing, 2012). On average, 32 percent and 40 percent of the Ethiopia's population are undernourished and consume less than the recommended daily calories, respectively (IFPRI, 2015). Moreover, the FAO (2016) situation report indicates that more than 10.2 million people needed food assistance in 2016, more than the size at any other time since 2006.

The prevalence food insecurity and related vulnerability is generally high in rural parts of Ethiopia, where 84 percent of the population live (CSA, 2007), with rain-fed subsistence farming dominating agricultural production. The level of vulnerability and food insecurity mainly depends on the performance of agriculture (Demeke et al., 2011; Collier et al., 2008; Di Falco et al., 2011). Therefore, household vulnerability and food security largely depends on a combination of both natural and man-made factors, including rainfall patterns, land degradation, population density, climate change, low levels of rural investment, volatile input and grain prices, drought, pest hazard, frost, and flooding (Gelaw and Sileshi, 2013; WFP, 2011; Dercon and Christiaensen, 2007; Dercon and Krishnan, 1998). In addition, access to different resources and institutional factors, such as access to land and labor, infrastructure, technologies, credit, and geographic suitability also affect the level of vulnerability and food

[1] Between the time when the current government (the Ethiopian People's Revolutionary Democratic Front (EPRDF)) came to power in 1991 and 2003, most Ethiopian food security policies were based on relief and emergency. Thereafter, the Food Security Program was implemented in selected chronically food insecure districts.

insecurity though the channels of agricultural production and rural income (Bevan, 2000 and Dercon and Krishnan 1998).

Furthermore, empirical findings (Dercon and Christiaensen, 2007; Dercon and Krishnan, 1998; Capaldo et al. 2010) also show that food security status in many developing countries, like Ethiopia, fluctuates from time to time or is unstable. According to Capaldo et al. (2010) and Dercon and Krishnan (2000), due to households' proneness to shocks and other risks, such as flood, land degradation, and extreme climate conditions and capacity to recover and respond, many households access to adequate food vary over time. Thus, this suggesting that the concept of food insecurity is best thought of in a dynamic context rather than static nature (Capaldo et al., 2010). It is no surprise that the dynamic nature of food insecurity persist in rural population of Ethiopia as their livelihood derives from agriculture that is rainfall dependent and highly erratic.

Analyzing the VFI is very important for identifying food insecure households in the near future, along with further disaggregates food insecurity status household rather than food secure and food insecure. Further disaggregation of food insecurity status is vital when designing and implementing food security policies and strategies for different groups.

This, in turn, implies that food security policies and programs should be based equally on the assessment of households' current conditions as well as on the expectations of their future access to food (Capaldo et al. 2010). In addition, although the emphasis is on analyses of dynamic nature food insecurity for better and effective policy action, most past studies focus on vulnerability to poverty, not food insecurity (Scaramozzino, 2006; Chaudhuri, 2003). However, despite this, most food security strategy and program studies conducted in Ethiopia target the identification of the current situation of food security with respect to who is food insecure and why. They did not go beyond and attempt to determine who will be VFI.

Therefore, this study analyzes the VFI of households and its influencing factors using vulnerability as expected poverty (VEP) approach. Then, implications for effective policy intervention that will enhance food security and reduce the VFI in the study areas are drawn.

2. The concepts of vulnerability and literature review

In the broad academic literature, vulnerability is a term with a variety of discipline specific implications. The disaster management literature generally associates vulnerability with natural hazards (Alwang et al. 2001), while both human geography and human ecology relate vulnerability to environmental change (Adger, 2006). Food insecurity and poverty literature, as well as social risk management literature, defined vulnerability in terms of future negative effect on welfare (Mansuri and Healy 2001; Dercon 2001; Holzmann and Jørgensen 2000; World Bank 2000). Others define vulnerability in terms of the level risk and the capacity to recover and respond. Thus, not only does vulnerability imply a measure of risk associated with physical, social, and economic aspects, it is also describes the ability to cope different risk and shocks. (Chambers, 1989; Proag, 2014). Accordingly, there are two components to vulnerability: the external side referring to the structural elements that determine sensitivity and risk to exposure (Moser, 1998; McCarthy et al., 2001; Chambers, 1989), while internal side concerns the ability of households to respond and cope with stressors and the actions required to overcome them (Bohle, 2001; Hart 2009; Chambers, 1989).

In the framework of social risk management, vulnerability to poverty was first applied in early 2000s and, thereafter, increasing awareness vulnerability in the context of food insecurity (Scaramozzino, 2006; Bogale, 2012; Sharaunga et al., 2015*;* Ozughalu, 2016). In context of food insecurity, vulnerability is defined to household's probability to fall, or stay, below food poverty line within a given period time (Capaldo et al. 2010; Løvendal *et al.,* 2004; Løvendal and Knowles, 2005).

Vulnerability analysis has two main advantages. First, it is explicitly dynamic; vulnerability analysis does not just focus on the current status, but it is also forward-looking (ex-ante). Secondly, it is also emphasis on given shock or set of shocks and the coping strategies that household and communities can adopt in order to reduce the probability of being food insecure (Bogale, 2012; Mutabazi et al., Ozughalu., 2016; Scaramozzino, 2006).

The main difference between food insecurity and VFI analysis is that the former summarizes food insecurity as a deficiency of a given household or society at a particular point in time, thus a static measure of welfare that categorizes households as either "food secure" or "food insecure". On the other hand, the later takes into account the different shocks and risks, such

as climate change, land degradation, drought, erratic rainfall, and environmental degradation, that may affect households and society in the future, determining if consumption will move below a given threshold level. Further vulnerability analysis will sort households into four food security statuses: "chronically food insecure," "transitory food insecure," "permanently food secure," and "transitory food secure" (Scaramozzino, 2006; Bogale, 2012).

According to FAO (2002), Løvendal and Knowles (2005), Ligon and Schechter (2004), just as there is no unique indicator of food security, there is also no single method to analysis VFI. However, there are three principal methods to assessing VFI: vulnerability as expected poverty (VEP), vulnerability as low expected utility (VEU), and vulnerability as uninsured exposure to risk (VER) (Deressa et al. 2009; Hoddinott and Quisumbing 2003; Scaramozzino, 2006).

VEP focuses on the probability that a given shock or set of shocks will move the well-being of individuals or households below the benchmark (such as below the food poverty line) in the near future (Chaudhuri et. al. 2002; Christiaensen and Subbarao 2001; Pritchett et. al. 2000; Chaudhuri 2003; Bogale, 2012). Following VEP, VEU focuses on the change of utility derived from a certainty equivalent level of consumption (a benchmark) to the household's own expected utility (Ligon and Schechter 2003; Hoddinott and Quisumbing 2003). Lastly, VER is measure the extent to which a given shock or set of shock imposes a welfare loss due to the absence of effective and efficient risk management tools. In addition, this approach is *ex post* assessment and no attempt to construct an overall measure of vulnerability (Hoogeveen et. al. 2004). In the estimation, all three approaches are based on expected mean and variance of a household's consumption or income. While VEP can be implemented using both cross-sectional and panel data, VEU and VER require lengthy panel data. Therefore, due to the lack of appropriate panel data, the present study analyzes the VFI of households and examine those factors that are associated with the vulnerability of households to food insecurity by adopting the VEP approach.

Studies (for example, Demeke *et al.,* 2001; Bogale, 2012; Proag, 2014; Ellis, 2003; Gelawu and Sileshi, 2012; Sen, 1981; World Bank, 2000; Sharaunga *et al.,* 2015; Chaudhuri *et al.*, 2002; Chaudhuri, 2003, Mutabazi *et al.,*2015; Ogundari, 2017; Belachew, 2012; Demeke *et al.,* 2011; Bayudan-Dacuycuy and Lim, 2015; Ogundari, 2014) analyze vulnerability to poverty and food insecurity and its determinants using a variety of econometric tools.

Sen (1981) finds food insecurity and related vulnerability is associated with entitlement theory, which focuses on the current and expected availability of factors of production for given households, based on their own production, assets, and reciprocal arrangements. In addition, access to production resources at the household level and the available adaptation strategies for given risk are the most important factors for escaping poverty and food insecurity in the near future (Proag, 2014; Ellis 2003). According to Sharaunga et al. (2015), women's empowerment, in particular, economic and physical capital empowerment, is vital for reducing the probability of a household falling victim to food insecurity.

Mutabazi *et al.,* (2015), using three-stage Feasible General Least Squares (FGLS) to assess the vulnerability of smallholder farmers in the context of changing climate, finds that farmers who perceived climate change are less likely to be vulnerable to poverty. According to Demeke et al. (2011), rainfall pattern is an important factor determined households' food security status over time. Jenkins et al. (2003), Finnie and Sweetman (2003), and Devicienti (2002), also measure vulnerability using income patterns and sources. Households with stable incomes are less likely to be vulnerable to external shocks. According to Alwang et al. (2001), vulnerability to poverty can be determined based on the frequency of households transitioning in and out of the poverty state over a given period of time. Households are considered vulnerable if they were poor in all of the sample years. On the contrary, households below poverty just a few times are considered as transient poverty.

Chaudhuri et al. (2002) and Chaudhuri (2003) adopt vulnerability as expected poverty to analyze VFI using cross-sectional data from Indonesia. They conclude that true poverty cost of risk is higher than the observed outcome and there is also difference between current poverty head count and vulnerability across different population characteristics. However, Ogundari (2014) finds that the association between food insecurity and VFI is significant.

Gelaw and Sileshi (2013) study the impacts of grain price hikes on poverty in rural Ethiopia based on panel data. Their result shows that price hikes of grain have significant effects on households transitioning in and out of poverty. Kimani-Murage et al. (2014) also find that prices of staple foods, like maize flour, and the unemployment situation are factors affecting VFI in the urban slums of Kenya. Others studies, including Bogale (2012), Mutabazi et al. (2015), Ogundari (2017), Azeem et al. (2017), and Bayudan-Dacuycuy, and Lim (2015) also identify important factors significantly associated to vulnerability to poverty and food

insecurity. The factors include gender, income, household size, household source of food (purchased or own), geographical location, conflict, receiving remittances, educational level, economically stability, and riskiness of occupations.

3. Research Methodology

3.1. Description of the study area

The study is conducted in East Hararghe, Ethiopia from in August and September, 2017. East Hararghe is located between 7°32᾽- 9°44᾽ North latitude and 41°10᾽- 43°16᾽ East longitudes. The zone is characterized by three agro-ecological zones: the semi-arid (62.2 percent), the semi-temperate (26.4 percent), and the temperate tropical highlands (11.4 percent). This wide range of agro-ecological zones allows the area to produce a variety of products, including cereal crops like sorghum, maize, wheat, and teff; vegetables like potatos, onions, shallots, and cabbage; as well as perennial crops like coffee and *Khat* (*Catha adulis*). Livestock keeping is also an integral activity of farmers in the study areas. Among the cereal crops, sorghum and maize are the dominant crops, in terms of both the size of the land allocated and the number of households producing it. For example, 134,708.26 ha and 49,979.80 ha of land are covered by sorghum and maize, respectively, with an average productivity of 19.69 qt/ha and 26.67 qt/ha in 2015/16 production season, respectively, which is much lower that national average production (sorghum = 23.31qt/ha and maize = 33.87qt/ha).

East Hararge is highly vulnerable to regular droughts and to serious degradation of land and other natural resources. Thus, the central and regional governments, along with other development partners, have implemented policies and programs designed to reverse this situation. For instance, within the framework of the federal government's food security strategy, a food security program has been implemented since 2003 in selected chronically food insecure districts. The main goal of this program is to improve the food security status of chronically and transitory food insecure peoples through resettlement programs, productive safety net programs, household asset building programs and complimentary community investment, including public works projects like soil and water conservation (SWC) practices, road construction, and natural resource rehabilitation. However, food insecurity and VFI still persist.

3.2. Sampling technique and data collection

The empirical analysis in this study is based on cross-sectional data from 408 households in East Hararge, Ethiopia. A multi-stage sampling procedure was used to select districts, *kebeles*,[2] and sample households. In the first stage, three districts (Deder, Gorogutu, and Haramaya) were selected purposively to capture the agro-ecological, economic, and social diversities of the zone. In the second stage, three representative *kebeles*, from each district, were randomly selected. In the third stage, a representative sample of 408 households (157 households from Deder, 124 households from Gorogutu, and 127 households from Haramaya district) were randomly selected using proportionate probability sampling based on the size of each district and *kebele*.

For the household survey, data was collected by enumerators from the sample households using a semi structured interview. Before performing household survey, the semi structured questionnaire was pretested. The survey collected information on the households' socio-economic and institutional characteristics, SWC, different shocks and coping strategies, food consumption and expenditure, geographic and weather variables, access to education and social infrastructure, as well as available relevant food security programs and activities.

3.3. Econometric modeling strategy

Food security and vulnerability analysis measurement primarily requires a method of discriminating the food secure from the food insecure or the highly vulnerable from the low vulnerable. To determine the food security status of household, we used the amount of money required to achieve the daily minimum dietary requirement. The government of Ethiopia set the minimum acceptable level of per capita calorie intake per day to 2200 (MoFED 2002). Thus, a household is considered to be food insecure if the amount of money it spends on food is not sufficient to purchase a basic diet that is nutritionally adequate.

Basically, there are two types of approaches to distinguish the determinants of household level food insecurity. The first represents the food security status of households through discrete choice models (Logit, Probit, Multinomial, and Order models) where the dependent variable is a dummy that takes a value of zero or one depending on whether or not a household is food

[2] *It is usually a named peasant association and is the lowest administrative unit in the country.*

insecure, or low, boundary, and acceptable food security status (Kimani-Murage *et al.*, 2014; Magaña-Lemus *et al.,*2016*,* Agidew and Singh, 2018; Motbainor *et al.,* 2016; Ogundari, 2017). However, this approach does not take consideration the extent of food insecurity. Bogale, (2012); Mutabazi *et al.*, (2015); Ogundari, (2017) and World Bank (2002) express the degree of households' food security based on food consumption expenditure as an indicator of wellbeing and define food insecurity in terms of the household's Per Capita Food Consumption Expenditure (PCFCE) level. Thus, we use PCFCE as a measure of household welfare and the food insecurity status of households

To analyze household VFI, the study adopts an econometric model proposed by Christiaensen and Subbarao (2004) and Chaudhuri et al. (2002). The model follows the vulnerability as expected poverty (VEP) approach, using PCFCE as a measure of household welfare. It also accounts for household risk exposure and coping strategies that may lead a household to fall below a given minimum level, for example, food poverty line. The vulnerability of the household during the current period is expressed as:

$$V_{ht} = P\ (\mathrm{c}_{\mathrm{it+1}} < z) \qquad (1)$$

Where the vulnerability of a household (V_{it}) during the current period depends on the probability that the future household food consumption expenditure (C_{it+1}) will be less than the threshold level (Z). Thus, estimating vulnerability involves determining the probability distribution of future consumption. Assuming that the probability distribution is log normal, then estimating the mean and variances of future consumption effectively determines this distribution.

VEP approach estimates are always a function of the expected mean and variance of household PCFCE. The expected mean of PCFCE is determined by household and community characteristics, while the variance (also known as volatility) in household consumption captures the idiosyncratic shocks that contribute to the difference in PCFCE levels for households that have the similar characteristics (Gunther and Harttgen 2009; Bogale 2012; Echevin 2013).

Following Chaudhuri et al. (2002), Gaiha and Imai (2008), and Günther and Harttgen (2009), we estimate empirically a variant of VEP from the food consumption expenditure function as:

$$ln\, c_i = x_i\beta + \varepsilon_i \quad (2)$$

Where $ln\, c_i$ represents the log of PCFCE for the i[th] household, x_i represents a household and farm characteristics, as selected based on a review of relevant literature, β is a vector of parameters, and ε_i is a disturbance term with mean zero and heteroscedastic, and not homoscedastic in which the usual regression techniques may yield estimates that are inefficient but not bias in the main parameters of interest. This implies that variances of the error term vary across households depending on x_i.

Then, the squared residuals from equation (2) are regressed on household characteristics (x_i) to generate estimates for the expected variances, specified as:

$$\sigma^2\, \varepsilon_i = x_i\theta + \tau_i \quad (3)$$

Where θ represents the vector of parameters and τ represent the error term for the equation (3) estimation.

As proposed by Amemiya (1977), Christiaensen and Subbarao (2005), Chaudhuri (2000), and Chaudhuri et al. (2002), the estimates of β and θ can be obtained using three-step FGLS. This starts by estimating equation (2) using Ordinary Least Squares (OLS). Thereafter, equation (3) is estimated, using the squared of error term from the estimation of equation (2) as dependent variables. To obtain asymptotically efficient estimates of θ, we re-estimate equation (3) by OLS using predations of equation (2) and after weighted each residual by $x_i\theta$ (Chaudhuri et al. 2002). On the other hand, according to Bogale (2012), Chaudhuri et al. (2002), Mutabazi et al. (2015), to get asymptotically efficient estimates of β, re-estimate equation (2) after using efficient θ to weigh it and weighted least squares.

$$\frac{\hat{\varepsilon}^2_{OLS,i}}{x_h\hat{\theta}_{OLS}} = \left(\frac{x_h}{x_h\hat{\theta}_{OLS}}\right)\theta + \frac{\tau_i}{x_h\hat{\theta}_{OLS}} \quad (4)$$

The standard deviation of the variance can then be obtained by the following equation:

$$\hat{\sigma}_{\varepsilon,i} = \sqrt{x_i\hat{\theta}_{FGLS}} \quad (5)$$

Finally, to estimateβ, equation (2) is transformed as follows:

$$\frac{lnc_i}{\hat{\sigma}_{\varepsilon,i}} = \left(\frac{x_i}{\hat{\sigma}_{\varepsilon,i}}\right)\beta + \frac{\varepsilon_i}{\hat{\sigma}_{\varepsilon,i}} \quad (6)$$

Using the estimated β and θ, we are able to directly estimate the expected log PCFCE and the variance of log PCFCE for each household as follows, respectively.

$$\mathrm{E}\left[\ln \mathrm{c_i}/x_\mathrm{i}\right] = x_\mathrm{i}\,\hat{\beta} \quad (7)$$

$$\mathrm{V}\left[\ln \mathrm{c_i}/x_\mathrm{i}\right] = x_\mathrm{i}\hat{\theta} \quad (8)$$

Accordingly, assuming that consumption is log-normally distributed, each household's VFI at time t + 1 is expressed as:

$$\widehat{\mathrm{V}} = \widehat{\mathrm{P}}(\ln \mathrm{c_i} < \ln \mathrm{z}/x_\mathrm{i}) = \emptyset\left(\frac{\mathrm{lnZ} - \mathrm{ln}x_i\hat{\theta}}{\sqrt{x_i\hat{\beta}}}\right) \quad (6)$$

Where Φ is the cumulative density of the standard normal distribution; $x_i\hat{\theta}$ and $x_i\hat{\beta}$ are the expected household food consumption expenditure and the standard error of the regression, Z is threshold level, and V is probability that each household VFI, ranging between zero and one. Chaudhuri et al. (2002), justify a threshold measure that is used to define vulnerable households as those with an estimated vulnerability coefficient above or equal to 0.5. Thus, we classify households as vulnerable if $\widehat{\mathrm{V}}$ is above or equal to 0.5 and, otherwise, non-vulnerable.

As specified earlier, to determine the current food security status of each household, the study uses the household expenditure on food to achieve the daily minimum dietary requirement (food poverty line). Thus, the study adopts household dietary intake as its measure for determining the food poverty line. According to Bogale (2012), to determine the food poverty line (threshold), we first pick a 'basket' of the food items typically consumed by the poor. Then, we determine the quantity of the 'basket,' which is the given bundle that meets the predetermined minimum per capital calorie requirement; i.e. 2,200 kcal per day (MoFED, 2002). Finally, using local prices, both the cost of basket is estimated and the value of the food poverty line is determined. Accordingly, the food poverty line was found to be Birr[3] 2637.86 per annum. In other words, Birr 2637.86 is amount of money needed to purchase enough food

[3] Birr is Ethiopia currency (1USD=23.32Birr).

to meet the basic daily food-energy requirements per adult equivalent, per year. Based on the CSA (2017) country and regional level consumer price indices report the Consumer Price Index (CPI) of the survey area (Oromia regional state) was 171.4 percent (December 2011 = 100). Thus, the food poverty line is deflated in order to take into account the effect of inflation. Therefore, the adjusted food poverty line is Birr 1539 per adult equivalent, per year, at the end of 2011 constant price.

4. Results and discussion

4.1. Descriptive Statistics

Based on the review of relevant literature (Demeke et al. 2001; Bogale, 2012; Bogale et al.2005; Mutabazi, 2015; Pritchett et al.2000; Christiaensen L & Boisvert RN, 2000; Deressa, 2009), we include a range of household and farm characteristics as independent variables in the vulnerability analysis at household level. Accordingly, the summary of descriptive statistics are given in Table 1.

The average age of household heads is 40.19 years. However, the majority of family members are younger than 15 or older than 64 years, meaning that the dependency ratio is very high (averaging 1.29, with a standard deviation of 0.96). Family size, expressed as adult-equivalent, averages 4.82 with a standard deviation of 1.65. However, there are households with as many as 10.85 adult-equivalents. A large total adult equivalency may imply insufficiency in terms of food consumption because large households tend to consume more than small households. This is usually true if the dependency ratio of the household is large (Bogale, 2012; Mulabazi, 2015). The gender dimension shows that households are mainly headed by men, with only 13 percent out of the 408 sampled households being headed women. Although education can equip and enhance access to information and technology, thereby contributing to greater understanding of new technology that can help them reduce food insecurity and vulnerability, 40.69 percent of household heads have never attend formal education. On average, household heads have completed 3.65 years of formal education.

Table 1. Variables specification and summary statistics of household characteristics

Variable	Viable label	Mean	Std. Dev.
lnFCE	Natural log of consumption expenditure per adult equivalent	8.00	0.40
Sex	Dummy of sex of household sex (1=male)	0.87	0.34
Age	Age of the household head in years	40.19	12.73
Education	Level of education in numbers of years	3.65	3.67
Adult equivalent	Size of household in adult equivalent	4.89	1.65
Dependence ratio	Dependence ratio	1.29	.96
Annual income	Total annual income in birr	16878.67	13263.07
Off-farm Activity	Dummy for participation to off farm activity (Yes=1)	0.46	0.50
Use of fertilizer	Dummy for use to fertilizer (Yes=1)	0.54	0.50
Use of improved seed	Dummy for use to improved seed (Yes=1)	0.51	0.50
Use of irrigation	Dummy for use to irrigation (Yes=1)	0.35	0.48
Cultivated land	Total cultivated land holding	0.29	0.17
Adoption of SWC	Dummy for use to SWC (Yes=1)	0.49	0.50
Total Assets	Total assets in birr	24627.73	48081.69
Livestock TLU	Livestock owned (Tropical Livestock Unit)	1.78	1.90
Crop diversification	Number of crop growth	2.46	0.70
Coping strategy index	Coping strategy index	16.46	4.93
Number of Sick	Number of sick person in 1 year	0.36	0.66
Received credit	Dummy for receiving credit (Yes=1)	0.13	0.34
Contact with DA	Number of contacts with extension agent, per month	2.28	2.08

Source: Computed from the survey data

Household asset holdings and productivity enhancing inputs, including area of cultivated land, livestock holdings, use of fertilizers, improved seed and irrigation, as well as adoption of SWC are also considered important factors in analyzing VFI. These factors are critical agricultural inputs that enhance productivity per unit of cultivated area. On average the respondents have 0.29 hectares of land and 1.78 TLU of livestock. Furthermore, 54, 51, 35, and 49 percent of households used fertilizer, improved seed, irrigation, as well as SWC, respectively. Concerning the institutional variables, about 13 percent of the respondents have received credit from formal credit institutions. On average, each respondent contacts extension agents about 2.28 times a month. Crop diversification insures that farmers do not depend solely on the production and price of a single crop. Descriptive statistics indicate that, on average, households grew 2.48 crops during the last production season. Moreover, 46 percent of households participated in off

and non-farm activities. Cash generated from off/non-farm activities backs up the farmers' income and enable them to smooth their food consumption. Finally, the number of household members (on average= 0.36) who were sick over the past 12 months at the time of survey was also included in the model as an idiosyncratic shock.

4.2. Empirical result

In this section, the analyses of household vulnerability to food poverty and its influencing factors are presented in Table 2. Three-step FGLS was employed to predict the probability of falling below the minimum food consumption expenditure and determine those factors affecting expected food consumption expenditure or VFI. The model had good overall fit and most variables performed as expected [$F(19, 388)=8.12$, $P<0.001$]. To test for multicolinearity, the study employs Variance Inflation Factor (VIF) and Contingency Coefficient for continuous variables and dummy variables, respectively. Results suggest that no serious multicolinearity (mean VIF=1.46) problem is present.

The results reveal that out of the 19 explanatory variables considered in the econometric model, 6 variables significantly determine the expected food consumption expenditure. Household head age and family size, expressed by adult equivalents, negatively and significantly influences the future food consumption expenditure, while using improved seed, total cultivated land, adopting of SWC, and access to credit all positively and significantly influence future food consumption expenditure.

Family size, expressed as adult equivalents, is significantly and negatively associated with the expected food consumption expenditure at the 1 percent probability level. This means that an increase in household size increases the level of VFI for households in the study areas. The possible explanation is that family size can determine expected food consumption expenditure by directly reducing the share of each member in the total household consumption when marginal productivity of household members and contribution of household income is less than the food consumption expenditure. If family size increases by one AE, the expected food consumption expenditure tends to fall by 10.70 percent. This result is in line with both Ogundari (2017) and Capaldo et al. (2010).

Cultivated land is one of the important determinants of VFI. It influences expected food consumption expenditure positively and significantly, at less than 10 percent probability level.

This implies that future food consumption expenditure is likely to increase if the amount of land cultivated increases. As land is the basic farming input for farm households, it is a binding resource. Accordingly, it is directly associated with the ability of households to produce crops for consumption and for sale, thereby, positively contributing to future food consumption expenditures. As the model results show, for every hectare increase in cultivated land, the expected food consumption expenditure is likely to increase by 24.33 percent. Schröder-Butterfill and Marianti, (2006) also indicate that cultivated land is positively related to household food security.

Improved seed is used to increase agricultural production per unit area, thus contributing toward alleviating VFI. In the present study, improved seed usage is found to positively and significantly affect expected food consumption expenditure. The variable is significant at less than 1 percent probability level. For a discrete change in a dummy variable from 0 to 1, future food consumption expenditure increases by 12.92 percent. This may be because the use of improved seed potentially contributes to an increase in household production and reduces downward fluctuation of its production because it not only resists pests and diseases, but it also is resilient in adverse conditions, which in turn reduces VFI. This is consistent with Jaleta et al., (2018), who find that access to improved seed is significantly associated with household food consumption in Ethiopia.

Other factors affecting expected PCFCE positively include the adoption of SWC. The variable is significant at less than 1 percent probability level. Using SWC on a farm tends to reduce soil erosion, while maintaining the fertility status and moisture content of the farm land, thus increasing farm production and producing a quickly maturing crop. In addition, SWC may also reduce the adverse consequences of flooding and of land degradation. Therefore, adopting SWC reduces VFI. The model results indicate that adopting SWC practices boosts expected food consumption expenditure by 9.96 percent. The result is consistent with Bogale (2012), who find a positive influence of adopting SWC on household food consumption expenditure in Ethiopia.

The model results also reveals that household head age is positively and significantly associated with expected PCFCE at the less than 10 percent probability level. The findings show that for a one year increase in the age of the household head, expected PCFCE tends to fall by 0.28 percent. We argue that older household heads in rural areas are in disadvantaged when it comes

to undertaking the hard physical labor required for agriculture, meaning that, at some point in time, each additional year of age is associated with a reduction in productivity and, consequently, household income; thus implying an inverse-U shaped relationship between age and productivity. Therefore, the families of young household heads are less likely to be VFI than families of older household heads; a result that mirrors the results of Agidew and Singh, (2005).

Access to credit from formal institutions is another important institutional factor influencing expected food consumption expenditure positively and significantly (at 10 percent probability level). The results indicate that expected food consumption expenditure increases by 9.39 percent if households have access to formal credit services. This implies that households receiving credit are less likely to be VFI than other households. This is because access to credit service is a vital element for households to make timely purchases of agricultural inputs, like fertilizer, pesticides, herbicides, and improved seeds, that enhance farm productivity and increase future food consumption expenditure. This is also consistent with Iftikhar and Mahmood, (2017).

Table 2. Three-step Feasible Generalized Least Squares result for determinant of VFI (N=408)

Variables	Log food consumption expenditure			Variance of food consumption expenditure		
	Coef.	Robust Std. Err.	t	Coef.	Robust Std. Err.	t
Sex	-0.01671	0.06513	-0.26	-0.07286	0.041547	-1.75*
Age	-0.00276	0.001575	-1.75*	0.000516	0.000721	0.72
Education	-0.00084	0.005267	-0.16	-0.00059	0.00238	-0.25
Adult equivalent	-0.10703	0.013987	-7.65***	0.001788	0.006142	0.29
Dependence ratio	0.000193	0.000182	1.06	1.98E-05	8.57E-05	0.23
Annual income	1.94E-07	2.20E-06	0.09	1.06E-08	9.14E-07	0.01
Off-farm Activity	-0.0032	0.038652	-0.08	-0.00192	0.01893	-0.1
Use of fertilizer	0.004633	0.0446	0.1	-0.00413	0.017621	-0.23
Use of improved seed	0.12923	0.044757	2.89***	0.025503	0.019947	1.28
Use of irrigation	0.057287	0.037366	1.53	-0.02456	0.017612	-1.39
Cultivated land	0.243252	0.134057	1.81*	-0.01209	0.071363	-0.17
Adoption of SWC	0.099622	0.038057	2.62***	0.021715	0.019241	1.13
Total Asset	3.43E-07	3.64E-07	0.94	2.65E-07	1.81E-07	1.46
Livestock TLU	0.014592	0.011647	1.25	-0.00593	0.005751	-1.03
Crop diversification	0.007827	0.023725	0.33	-0.01368	0.011163	-1.23
Coping strategy index	-0.00275	0.004054	-0.68	0.000739	0.001842	0.4
Number of Sick	0.038339	0.027557	1.39	-0.00565	0.01421	-0.4
Received credit	0.093882	0.056577	1.66*	0.01992	0.02823	0.71
Contact with DA	0.00029	0.009152	0.03	0.00047	0.00388	0.12
_cons	8.384155	0.122067	68.68***	0.162107	0.060399	2.68***
F(19, 388)=8.12				F(19, 388)=1.51		
Prob > F=0				Prob > F=0.0769		
R-squared=0.3041				R-squared=0.0437		
Root MSE=0.33456				Root MSE=0.1633		

***, ** and * significant at the 1, 5 and 10 percent probability levels, respectively

Source: Computed from the survey data

Vulnerability to food insecurity is estimated using vulnerability as expected poverty. The method is always a function of the expected mean and variance of household consumption. In this study, the *ex-ante* probability distribution of each household falling victim to food insecurity is estimated using expected mean and variance of household consumption (Gonçalves and Machado, 2015).

After estimating the probability of a household falling into future food insecurity, the VFI status of the household is determined using a 0.5 vulnerability score as the threshold level (Pritchett et al. 2000). Accordingly, when the vulnerability score is less than 0.5, the household is considered low VFI, while a score greater than or equal to 0.5 means the household is highly vulnerable to food insecurity. The current food insecurity status of households is determined using food poverty line. Therefore, if the household PCFCE is less than the threshold level, it is considered food insecure; otherwise it is food secure. Combining vulnerability status with current food insecurity status of household, we extend the analysis into several food insecurity and vulnerability categories, as shown in Table 3.

Table 3. Vulnerability and food security status of households

		Food security status						
		Secure		Insecure		χ2-value	Total	
		No.	Percent	No.	Percent		No.	Percent
Vulnerability status	Low-vulnerable	186	45.588	48	11.765		234	57.353
	High vulnerable	75	18.382	99	24.265	57.317***	174	42.647
Total		261	63.971	147	36.029		408	100.00

***, ** and * significant at the 1, 5 and 10 percent probability levels, respectively

Source: Computed from the survey data

The results indicate that 45.588 percent (186 out of 408) of the sample households enjoy stable food security levels. These households are currently food secure and have a low probability of being food insecure in the near future (less VFI). On the other hand, 99 households, accounting for 24.265 percent of the sample, are food insecure for an extended period of time and are considered as chronic food insecure. These households have a PCFCE that is below the threshold level and have a probability of being food insecure that is greater than 0.5, thus being highly VFI.

This means that these households have little chance of avoiding food insecurity in the near future. Thus, households may need direct food assistance and access to productive resources that will enable them to improve their productive capacity and to escape food insecurity in the near future.

Forty eight households, accounting for 11.765 percent of the sample, are considered as transient food insecurity, which means that even if these households have a current PCFCE that is less than the food poverty line, they are less likely to fall into food insecurity in the near future and may be able to escape food insecurity. Moreover, about 18.382 percent (75 out of 408) sample households are categorized as transient food security, meaning that the households may face a sudden drop in their ability to access of adequate and sufficient food to maintain a good nutritional status in the near future. Those households are currently access to adequate food but highly VFI. This implies that these households have a high probability of becoming food insecure in the future. Thus, about 30 percent (11.765+18.382) of the sampled rural households have an unstable food insecurity status. This indicates that households frequently move into and out of the state of food insecurity.

For policy purposes, vulnerable groups consist of households that are currently food secure but high likely to VFI, currently food insecure but less likely to be VFI and chronically food insecure. Therefore, policy makers need to take into account all the vulnerable groups, as they account for 54.422 percent of the sample; more than the 36.029 percent that makes up currently food insecure households.

5. Conclusions

Access to adequate and sufficient food in many developing countries, like Ethiopia, is unstable. This means that many households food insecurity status vary over time and dynamic nature. This, in turn, implies that food security policies should be based equally on the assessment of households' current conditions as well as on the expectations of their future access to food. Therefore, we analyze the vulnerability of faming households to food insecurity in East Hararghe using the VEP approach. The results indicate that 147 households (36.03 percent of sample) and 174 households (about 42.64 percent sample) are current and future food insecure, respectively. Combining the current and future food insecurity status of households, we find that 36.029 percent are chronic food insecure, 11.765 percent are transient food insecure, 18.382 percent are transient food insecure, and 45.588 percent are stable food secure. Furthermore, we find that the age of

household head, family size, cultivated land, received to credit, access to improved seed, and the adoption of SWC practices are all significantly associated with VFI. The results suggest that assessment of households' current and expected food security status are important for food security and related policies and programs formation. Governments and other concerned bodies should both support the establishment and strengthening of local institutions, including agricultural extension and formal credit services, as well as promote the use of production enhancing inputs, like improved seed, and implementation of SWC practices.

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