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Rural Household Vulnerability to Multidimensional Poverty in Ethiopia's Degu'a Tembien District, Tigray

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This paper investigates household vulnerability to multidimensional poverty in Degu'a Tembien District. Cross-sectional data were collected randomly from 420 households from six rural villages. Vulnerability to multidimensional poverty was estimated using three-step FGLS. Finding shows that, on the one hand, households with greater social capital, financial capital and number of plots tend to be less vulnerable owing to their lower rates of expected multidimensional deprivation. On the other hand, households with better physical capital are found highly vulnerable with lower volatility of expected multidimensional deprivations. The analysis also shows that female-headed households are more vulnerable to future poverty than male-headed households. Household's who experienced drought, hailed rainfall and pest attack shocks were associated with increased vulnerability. Results also show that households that rely on savings, sale of livestock and formal borrowing of money following a shock were found to be less vulnerable to multidimensional poverty. Overall, 80 percent of households were vulnerable to multidimensional poverty and the probability of experiencing multidimensional poverty in the near future exceeds the current incidence of household multidimensional poverty. This implies the need to focus on reducing household vulnerability through social protection interventions rather than reducing observed multidimensional poverty.

Keywords: Vulnerability, Multidimensional poverty, Shock, Deprivation, Incidence

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INTRODUCTION

Poverty can be conceptualized as "deprivation in wellbeing" (Haughton and Khandker, 2009, p.1). The United Nations has announced a strategy to end all modes of such deprivations by 2030 (UNDP, 2018). Within this context, several national governments and various development organizations are making efforts to attain this goal. However, a significant number of people are continuing to live in chronic poverty (FAO, 2015; United Nations, 2015) and the road to reducing poverty remains challenging.

One major obstacle is that the poor are highly exposed to risk and have inadequate risk management capacities (Holzmann and Jorgensen, 2001). Households are exposed to a range of risks originating from different sources. Natural shocks, social stress, economic problems and physical illness are some of the stresses or risks that pose threats to households' material and subjective wellbeing. Such shocks and stresses also affect individuals, communities and regions in unexpected ways, aggravating poverty and vulnerability. Whether a household will be

in danger of becoming poor in the future is influenced by the household's current asset capacity, its exposure to shocks, and ability to efficiently manage shocks (Feeny and Mcdonald, 2016). Studies indicate that risks, shocks and vulnerabilities have a significant role in increasing household poverty as the poor are adversely affected by uninsured shocks and have less capabilities or assets to cope and recover from these shocks. Due to these risks, people who are currently out of poverty may fall into poverty in the near future and people in poverty may also remain in poverty over time. Poverty is a stochastic phenomenon where the currently poor households may or may not be poor in the near future and the current non-poor households may become poor due to unexpected events (Chaudhuri, 2003; Ozughulu, 2014). Therefore, although analyzing current poverty rate is an important indicator of households' wellbeing, it does not give a sufficiently clear indication of future poverty.

Accordingly, it is extremely important to assess vulnerability when designing pro-poor poverty reduction policies to enable the identification of those who may fall into poverty. The importance of a vulnerability analysis-approach has obtained corresponding attention in the international arena. This approach focuses on the various shocks which push households into poverty and constrain improvement towards the minimum acceptable necessities of sustained wellbeing.

Such an exploration of household vulnerability from multidimensional wellbeing perspectives is valuable for *ex-ante* poverty prevention schemes that strengthen the resilience capacities of households. Calvo and Dercon (2005) indicated that one of the major reasons to focus on vulnerability to poverty is that addressing the existing rate of poverty and the extent of the risk of poverty measured in advance is extremely helpful and provides powerful information for poverty alleviation efforts. Empirical findings indicate that poverty prevention is the most effective way of avoiding poverty rather than reversing it once it has occurred (Chaudhuri et al., 2000). The static approach to household wellbeing does not assess a household's risk of future poverty and it also does not help us to explore the sources and forms of risks that households face when designing appropriate safety net programs or policy interventions to improve wellbeing (Chaudhuri, 2003).

Analysis of vulnerability includes investigating not only shocks, but also resilience in coping or recovering from the adverse effects of shocks. Households who are exposed to shocks have been found to employ a mix of sequenced *ex-ante* risk management strategies and *ex-post* coping mechanisms to mitigate and cope with the impact of the unexpected events and to maintain livelihoods (Alwang et al., 2001; Dercon, 2002). Many authors (Dercon, 2001; Chaudhuri et al., 2002; Chaudhuri, 2003 and Azam and Imai, 2009) emphasize that the incorporation of household shock coping responses in the analysis of household vulnerability to poverty is important to design proper social safety net programs.

In Ethiopia, vulnerability to shocks relates to a large extent to the large rural population who are dependent on rain-fed agriculture for their livelihood. According to Mahoo et al. (2013, p.23), this vulnerability is getting worse:

> crop production in Ethiopia is affected by failure of rains or occurrence of successive dry spells during the growing season. Food shortages resulting from adverse weather conditions are not new in Ethiopia. However, food shortages have increased in severity, with frequent shortages in recent years.

This vulnerability to weather variations is acute in the study region (Tigray), where agriculture supports more than 80 percent of the population in terms of employment and means of livelihood. The agricultural systems of the region are subsistence, rain-fed and dominated by smallholders with average landholding of less than one hectare per household, who have been adopting low agricultural external inputs and undertake mixed farming with farm technologies totally reliant on animal draught (Tagel and Van der Veen, 2013). Dependence on traditional economic systems also makes the region susceptible to weather/climate induced shock, and these have substantial influence on households' poverty status. Almost every year, the region faces natural shocks causing harvest failure, which in turn impedes socioeconomic development (Tagel and Van der Veen, 2013). In particular, the study region has been suffering from recurrent drought, with severe events occurring in 1982, 1983, 1985, 1987, 1988, 1989, 1991, 1999, 2000 and 2009 (Tagel et al., 2011, p.314). Tigray was the most severely affected region during the well-known 1983-1984 famine (Webb et al., 1992). Tagel and Van der Veen (2013) also

marked that crop failure as a result of droughts, and rainfall variability has been the major causes of famine and food shortages in Tigray.

This study is significant in terms of generating understandings of vulnerability components, as it provides household multidimensional poverty and vulnerability estimates that can be aggregated at a District level. At the national level, the Tigray region's comparative vulnerability is generally recognized in many studies. Vulnerability to consumption poverty in Ethiopia is relatively well studied (see Abrham and Bauer, 2012; Dereje, 2013; Birhan and Tesfahun, 2017). However, an exploration of vulnerability to multidimensional poverty in Ethiopia comparable to those carried out by Calvo (2008), Azeem (2016) and Feeny and McDonald (2016) for Peru, Pakistan and Melanesia, respectively, has not been conducted. Those authors conceptualize vulnerability to multidimensional poverty as the risk of falling into future poverty as a result of multiple deprivations and they have used the most common indicators of multidimensional poverty such as deprivations in education, health and living standard. Accordingly, this study assesses household vulnerability to multidimensional poverty using current information.

How vulnerability of the national and regional level appears at the household level requires careful assessment. National or regional studies ignore variations in socioeconomic development at the local level due to the high level of data aggregation. Neglecting heterogeneity which may be found in micro studies may lead to the loss of important information. With this perspective, this paper attempts to address the following important questions: What are the major shocks that rural households experienced in the study area? What shock coping responses are adopted by households in the study area? What is the level of vulnerability of rural households to multidimensional poverty? What are the correlates of vulnerability to multidimensional poverty?

Therefore, the study measures the *ex-ante* risk probabilities of households experiencing multidimensional poverty in the future relative to specific poverty and vulnerability thresholds. Since cross-sectional data are used, the paper employs Chaudhuri et al.'s (2002) methodology to estimate household vulnerability to multidimensional poverty. Alkire and Foster's (2007, 2011) methodology for computing a Multidimensional Poverty Index (MPI) deprivation score was used to identify the multidimensional poverty status of households. Using the MPI deprivation score as a proxy for wellbeing avoids the fundamental limitations of using monetary measurement of wellbeing in Ethiopia. The remaining sections are organized as follows. Section 2 presents the methodology to

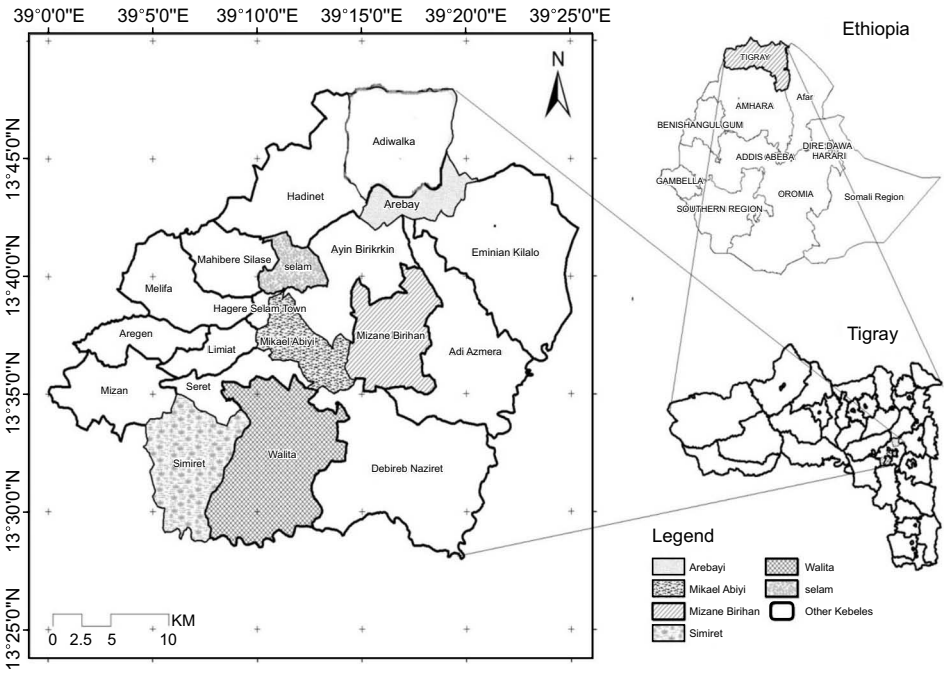

Fig. 1. Map of the selected study sites. Source: Ethio GIS and CSA (2007).

estimate household vulnerability to multidimensional poverty. Section 3 presents the empirical results while section 4 concludes.

METHODOLOGY

Description of the Study Area

Degu'a Tembien District is one of the four districts in the South Eastern Zone of Tigray, Ethiopia (see Fig. 1). It is located 50km from the regional capital, Mekelle. Geographically, the district is situated 39°10' East and 13°38' North. Hagereselam is the capital of the District (Ayenew et al., 2011). Agro-ecologically, the District is classified as lowland, temperate and highland with a proportion of 18.75, 37.5 and 43.75 percent of the District's area, respectively. The area is highly vulnerable to soil erosion due to its mountainous terrain topography. Rainfall is erratic with the annual rainfall ranging from 600 to 800 mm and the average daily minimum and maximum temperature of the District is 8℃ and 24℃, respectively (DTWOPF, 2017).

Data Sources and Samples

Data for this particular study was collected in 2017 using a household survey questionnaire and focus group discussions. Survey questionnaires gathered responses in relation to variables such as demographic and socio-economic characteristics, asset endowments and deprivation statuses, shocks and coping mechanisms. Using a multiple stage sampling technique and applying Yamane's (1967) sample determination formula, i.e.,

$n = \frac{N}{1 + N\,(e^2)}$, data was collected from 420 households from the lowland, midland and highland agro-ecologies of the District randomly and proportional to the population composition of the six sampled Kebele (the smallest local administrative unit in Ethiopia).

Method of Analysis

Measuring Households Multidimensional Poverty

The analysis of vulnerability was based on the multidimensional measure of poverty. Each household's weighted deprivation score was computed using the Alkire and Foster methodology (2011) of computing a Multidimensional Poverty Index (MPI). The use of this method avoids the inherent limitations of using a monetary approach to assess vulnerability to poverty. Indicators and dimensions were selected on the basis of both normative assumptions and empirical evidence (see Appendix 1) and are strongly grounded in the United Nations MDGs and the newly designed Sustainable Development Goals. The MPI combines the information on the Multidimensional Headcount Ratio (H) and Multidimensional Poverty Intensity (A) and is calculated as:

$$MPI = H\ x\ A$$

Where, *H* denotes the percentage of households that are identified as multidimensionally poor and A represents the intensity of multidimensional poverty that measures the average share of weighted indicators in which poor households are deprived. According to Alkire and Foster (2011), the assessment of multidimensional poverty incorporates identification and aggregation methods. The identification method explores who is poor and who is not considering the number of deprivation dimensions they experience. Alkire et al. (2015) indicated that the identification method follows the dual-cutoff method. After the deprived and non-deprived households are identified using single dimensional deprivation cutoffs, multidimensional poor households would be distinguished using the second cut-off across all dimensions. In this paper, households were considered poor if the deprivation score is equal to or greater than 1/3 of the weighted indicators. Using the weights that are assigned

to each indicator, a household's deprivation score was computed as the weighted sum of its deprivations and this was used in the vulnerability analysis. Details on the computation of MPI measures and reasons for the use of MPI design are provided in Appendix 2.

Estimating Household Vulnerability to Multidimensional Poverty

Holzmann et al. (2003) indicated that vulnerability is best assessed through using longitudinal/panel data gathered over an adequately long period to obtain detailed information at various levels. Nonetheless, Chaudhuri et al. (2002), and Jha and Dang (2009), proposed a Vulnerability as Expected Poverty (VEP) approach as the best option whenever we use a single visit household survey. Therefore, following the literature (see Chaudhuri, 2003; Suryahadi and Sumarto, 2003; Jha and Dang, 2008; Azam and Imai, 2009 and 2012; Abrham and Siegfried, 2012; Adepoju and Yusuf, 2012; Agbaje et al., 2013; Dereje, 2013), this study adopts the VEP theoretical framework to measure households' vulnerability to multidimensional poverty. Chaudhuri et al. (2002, p.4) have developed a method for estimating household consumption variance from cross-sectional data and defined vulnerability, in the context of poverty eradication, "as the *ex-ante* risk that a household will, if currently non-poor, fall below the poverty line, or if currently poor, will remain in poverty".

Although Chaudhuri et al. (2002, p.4) used a consumption approach to assess vulnerability to poverty, they admit the drawback of a unidimensional approach, reminding us that "Poverty reflects deprivation on multiple fronts, and hence vulnerability to poverty ought also to be a multidimensional construct". For this reason, this study uses a multidimensional measure of household deprivation in evaluating household vulnerability and the whole model and estimation of vulnerability to poverty follows the methodology developed by Chaudhuri et al. (2002). According to Hoddinott and Quisumbing (2003), this method is not limited to the use of only consumption as a welfare measure. It can also be used to measure non-consumption measures such as education and health. In this context, following Feeny and McDonald (2016), each household *i* deprivation at time *t* given various characteristics can be estimated and expressed using the following simplified formula:

$$d_{it} = f(X_i, S_{it}, R_{it}, e_{it}) \quad (1)$$

Where, d_{it} is the household weighted deprivation score computed using Alkire and Foster's (2007, 2011) method for calculating the MPI; X_i captures a bundle of observable household demographic and socioeconomic characteristics; S_{it} symbolizes the observed covariate and idiosyncratic shocks experienced by household *i* between *t-1* and *t*; R_{it} stands for household *i* means of coping with shocks between *t-1* and *t*; and e_{it} is the error term standing for unobserved household characteristics. Then we have to define the vulnerability context of each household *i* at time *t*. Hence, following Chaudhuri (2003) and Tesliuc and Lindert (2004), for a given household, the vulnerability of household *i* at time $t(V_i, t)$ is calculated as the probability that the level of weighted deprivation score one period ahead, $d_{i,\,t+1}$, will be above a critical threshold, Z. This can be expressed as:

$$V_{i,\,t} = Pr\,(d_{i,\,t+1} > Z) \quad (2)$$

Estimating vulnerability from cross-sectional data requires some strong assumptions about the stochastic process generating household deprivation. The stochastic process that generates the deprivation of household *i* for the expected level of deprivation of household *i* was expressed as:

$$d_i = X_i\beta + e_i \quad (3)$$

Where, d_i stands for the expected level of deprivation of household *i*; X_i denotes a vector of observable household characteristics; β is coefficients to be predicted using *OLS*; and e_i is the mean-zero disturbance term that captures all other unobserved effects.

According to Chaudhuri et al. (2002), making two powerful assumptions is highly relevant to estimate household vulnerability from a cross-sectional data set. One, it is assumed that household wellbeing remains the same across time and the future distribution of idiosyncratic shocks to wellbeing is assumed to be identically distributed over time for each household. Second, it is also necessary to assume that the structure of the economy is relatively stable over time (without any macroeconomic shocks). However, the variance of household deprivation will not be identically distributed across households and will depend upon observable household characteristics. Chaudhuri et al. (2002) also argued that since households face different risks and have different risk management strategies, the variance of household welfare should be heterogeneous across households. Therefore, to have a consistent (non-biased) estimate of the parameters they allow heteroskedasticity (i.e., the variances of the disturbance term to vary between households) in the model by assuming that the variance of the disturbance term, $\sigma^2 e,_i$ depends on the observable characteristics of the household X_i and this is expressed as:

$$\sigma^2 e,_i = X_i\theta + u_i \quad (4)$$

Where, θ is a vector of parameters to be estimated by *OLS*.

Due to the presence of hetreoskedastic errors, *OLS* yields inefficient estimates of the coefficients. Therefore, to estimate the parameter θ of equation (4) and β of equation (3), a three-step Feasible Generalized Least Squares (*FGLS*) procedure was employed as promoted by Amemia (1977) cited in Chaudhuri et al. (2002) and Feeny and McDonald (2016). The intuition of the three-step method is to obtain consistent estimates of the error term and then to use these estimates to transform the original model such that the error terms become homoscedastic.

The three step *FGLS* procedure is explained as follows. First we estimate equation (3) using *OLS* and the generated residuals (error terms) from this equation was then squared and used as dependent variable in equation (4), which was estimated again using *OLS*.

$$\hat{e}^2\, OLS, i = X_i\,\theta + \mu_i \quad (5)$$

The second step is to transform equation (4) to produce the asymptotically efficient feasible generalized least squares estimate of the variance of future wellbeing $(X_i\hat{\theta}FGLS)$ as:

$$\frac{\hat{e}2\ OLS,i}{Xi\hat{\theta}OLS} = \left(\frac{Xi}{Xi\hat{\theta}OLS}\right)\ \theta + \frac{\mu i}{Xi\hat{\theta}OLS} \quad (6)$$

This transformed equation is estimated using *OLS* to obtain $\hat{\theta}\,FGLS.$

Note $(X_i\hat{\theta}FGLS)$ is a consistent estimate of the variance of the idiosyncratic component of household deprivation.

$$\hat{\sigma}_i = \sqrt{Xi\hat{\theta}FGLS} \quad (7)$$

The third, and final, step is to use the predicted standard deviations (Equation 8) to transform Equation (3) in order to yield the asymptotically efficient estimate of $\hat{\beta}$FGLS.

$$\frac{di}{\hat{\sigma}i} = \left(\frac{Xi}{\hat{\sigma}i}\right)\beta + \frac{ei}{\hat{\sigma}i} \quad (8)$$

Finally, household's vulnerability to multidimensional poverty one period ahead is provided by the following generalization of the equation (2):

$$V_{i,\,t} = pr\,(d_{i,\,t+1} > Z \mid X_i) = \Phi\left(\frac{Xi\hat{\beta}FGLS - Z}{\hat{\sigma}i,t+1}\right) \quad (9)$$

Where, V_i represents the probability that a household with characteristics X_i will experience weighted deprivation counts in excess of Z and it is an index which lies between 0 and 1; Z is the threshold for multidimensional poverty applied in MPI estimates; Φ stands for the probability density function of future household deprivation which is the cumulative density function of the standard normal distribution; $Xi\hat{\beta}FGLS$ denotes the expected mean of household deprivation; and $\hat{\sigma}i, t+1$ represents the estimated variance in household deprivation.

Household vulnerability to multidimensional poverty is computed as the probability of a household falling into future poverty based on the predetermined poverty threshold. Households can be vulnerable due to an extremely low level of current wellbeing. Most of the time, this includes households that have a high vulnerability because they are currently poor and are expected to remain poor in the future. In addition, the currently non-poor households can be vulnerable due to having high variation in their expected wellbeing (i.e., households with a severe form of vulnerability who may not be currently poor, but because of their exposure to risk, face a sufficiently high likelihood of being pushed into poverty in the future)(Feeny and McDonald, 2016). These two sources of vulnerability should be considered in vulnerability analysis as they give an important insight on what preventive actions should be taken.

For any meaningful assessment of household vulnerability, a choice of vulnerability threshold is important. Chaudhuri et al. (2002) suggested a threshold of 0.5 to determine household's vulnerability to poverty. This threshold is used by many authors as the most common, preferred and natural candidate for the vulnerability threshold (see Suryahadi and Sumarto, 2003; Azam and Imai, 2009; Jha and Dang, 2009; Jha et al., 2010). Therefore, households who have an estimated vulnerability above 0.5 were considered as highly vulnerable; those households with an estimated vulnerability level lower than 0.5 but are in a current state of poverty were considered as relatively vulnerable; and those households with an estimated vulnerability level below 0.5 and not currently in poverty were considered as non-vulnerable. This classification differentiates the vulnerable from the non-vulnerable and helps in drawing meaningful comparisons of vulnerability to multidimensional poverty across the household characteristics.

The poor comprises the chronically poor and the transient poor. The chronically poor are the currently observed poor households who have high vulnerability due to inordinately low expected level of wellbeing. The transient multidimensionally poor (i.e., the frequently poor plus the infrequently poor households) are those households who have high/low variability in their expected wellbeing. The distinction between the chronic poor and the transient poor is based on the question "how often is the household poor?" and the distinction between vulnerability to frequent poverty and vulnerability to chronic poverty of households is based on the question "why is the household poor?" (see Tesliuc and Lindert, 2004, p.66). Total vulnerability is defined as a combination of all those who are currently multidimensionally poor (poor and remain in chronic and frequent poverty) and those households who are currently multidimensional non-poor (non-poor but vulnerable to chronic and frequent poverty), but who have a relatively strong chance of experiencing poverty in the near future. The high vulnerable households are those who are poor and non-poor households with low expected level of wellbeing, while the relative vulnerable are those poor and non-poor households with high-expected volatility in their wellbeing.

Selection of Indicators of Vulnerability to Multidimensional Poverty

Dercon (2001) has indicated that data on outcomes, assets, risks, coping abilities and strategies are needed and should be gathered to measure, examine and explain vulnerabilities quantitatively. Various studies (see Chaudhuri et al., 2002; Chaudhuri, 2003; Suryahadi and Sumarto, 2003; Azam and Imai, 2009; Feeny and McDonald, 2016) used different indicators of household vulnerability to poverty in a vector of household demographic characteristics, asset endowments, income sources, observed experiences of shocks and their response mechanisms. Depending on these theoretical underpinnings, indicators that were considered highly relevant to assess vulner-

ability of study households were selected for this research. These are household characteristics, household assets, shocks and coping strategies.

Household characteristics refer to a bundle of demographic attributes that are expected to affect vulnerability to poverty in differing ways. Household characteristics such as age, gender, education of household heads, household size, and dependency ratio were used in the estimation. The household's level of vulnerability is also dependent on assets like the human, natural, physical, social and the financial assets of households. The physical asset index, social asset index and financial asset index were constructed using the Multiple Correspondence Analysis (MCA) procedure to construct an asset score using various indicators (see Booysen et al., 2008; Asselin, 2009; Ezzrari and Verme, 2012; Dawit et al., 2014). Moser (2011) stated that vulnerability is closely related to lack of asset possession of households. Households with more asset endowment are less vulnerable than those with less and insecure assets. Thus, various forms of assets were indexed to assess their association on the vulnerability of households to multidimensional poverty, and households with greater asset score were expected to have lower vulnerability.

Shocks are sudden, temporary and totally unpredicted events that can have damaging impact on a household's wellbeing. It is an event that erodes household wellbeing and can lead to the loss of life and households resource base. Ethiopia is one of the most "shock-prone countries"(Dercon et al., 2005, p.23; Zelalem, 2015, p.9), regularly affected by drought, disease, pests and soil erosion. In conceptualizing household vulnerability as the probability of experiencing future poverty (particularly consumption poverty), various studies addressed the role of shocks as a source of vulnerability (see Dercon, 2001; Chaudhuri et al., 2002; Chaudhuri, 2003; Azam and Imai, 2009). Acquiring an in-depth understanding of the shocks experienced by households, identifying the consequence of various shocks and investigating the contribution of these shocks in increasing poverty is highly valuable to design effective social protection policies (Chaudhuri et al., 2002; Dercon et al., 2005; Bonfrer and Gustafsson-Wright, 2016). Households' exposure to shocks is an essential element of vulnerability analyses. A shock is an event that can trigger declines in wellbeing and affect an individual household, groups of households, communities or villages, regions or nations (World Bank, 2001). Based on the scope of its impact on household livelihoods, shocks can be categorized under two broad groups: idiosyncratic and covariate shocks (Dercon, 2002). Household idiosyncratic shocks are household specific shocks while covariate shocks are negative events that affect the village or the community of the District. Shocks that occurred during the previous 24 months from the time of interview as reported by households were considered in the analysis. Depending on households' perceptions, idiosyncratic and covariate shocks were separated. Hence, a shock variable scores the value of 1 if a household has experienced a particular shock and 0 otherwise.

Coping strategies are an array of strategies or actions adopted by households in order to cope with and react to various experienced shocks so that their adverse impacts would be relieved. According to Naude (2009, p.185), "means of coping" should be evaluated when vulnerability to various shocks are assessed. Therefore, coping strategies were dummy variables which take the value of 1 if a household adopted any coping strategies and 0 otherwise. Table 1 summarizes the description and measurement issues of the selected indicators of vulnerability estimation.

EMPIRICAL RESULTS

The Exposure of Households to Shocks in Degu'a Tembien District

Findings show that a significantly large percentage of the population had experienced at least one type of shock, indicating the risky environment. As shown in Figure 2, climate/weather induced drought was the most common, with 96 percent of households identifying drought as a major shock. Drought was the most severe shock to subsistence farmers, which affects food production and income through harvest failure. In the short run, it increases household's hunger and food insecurity which led to dependency in food aid while in the long run it contributes to asset depletion among rural people. Data obtained from the District Bureau of Agriculture

Table 1. Description, measurement issues and summary statistics of variables used in the estimation

Dimensions	Indicator descriptions	Measurement	Exp. Sign	Obs	Mean	St.dev
Weighted MPI deprivation score (DV)	Percentage of multiple deprivations that poor households experience at the same time	Index		420	0.482	0.153
Household characteristics						
Gender head	Sex of the household head	0 = Male 1 = Female	+/–	420	0.205	0.404
Age head	Household head's age at the time of interview	Years	+/–	420	49.62	10.56
Dependency ratio	The ratio of dependent household members (> 64 and < 15) to working age household members	Ratio	+/–	420	1.064	0.806
Head years of education	Formal years of education completed by head	Years	–	420	2.531	3.148
Household size	Number of persons living in the household	Number	+/–	420	6.090	1.722
Household asset						
Physical capital index	Composite of durable consumer goods, agricultural assets & basic infrastructural services	Index	–	420	0.781	0.067
Social capital index	Composite of social participation, mutual support, trust, relationships & remittance	Index	–	420	0.376	0.100
Financial capital index	Composite of household financial resources	Index	–	420	0.014	0.013
Number of plots	Number	Continuous	–/+	390	2.431	0.996
Shocks experienced	Hail	0 = no; 1 = yes	+	420	0.712	0.453
	Flood	0 = no; 1 = yes	+	420	0.383	0.487
	Decreases in output prices	0 = no; 1 = yes	+	420	0.260	0.439
	Drought	0 = no; 1 = yes	+	420	0.964	0.186
	Pest attack before harvest	0 = no; 1 = yes	+	420	0.248	0.432
Shock coping mechanisms	Reducing food consumption	0 = no; 1 = yes	–	420	0.850	0.357
	Draw down on savings	0 = no; 1 = yes	–	420	0.821	0.383
	Sold livestock	0 = no; 1 = yes	–	420	0.821	0.383
	Formal borrowing of money	0 = no; 1 = yes	–	420	0.548	0.498
	Joining safety net program	0 = no; 1 = yes	–	420	0.440	0.497

Note that indicators which passed the model diagnosis are included in this Table.
Source: Own computation, 2017 data.

(2017) shows that total crop production of the District had decreased by 76% in the drought year of 2015. As a result, 29,276 individuals were beneficiaries of Productive Safety Net Programs (PSNP) in 2015, and the number increased to 29,775 in 2016. This shows the District is highly affected by drought and households had not built resilience to food insecurity.

Qualitative data also show that drought significantly reduced livestock productivity due to shortage of pasture. In a time of drought, animals were chronically starved. Drought makes animal feed less available and increases its price, and it also reduces water availability for stock. Consequently, households were forced to sell their livestock at very cheap prices because they had to feed their children. Such distressed sales reduced the value of livestock and the productive capacity of the household in the future. Another critical effect discussed was the effect of natural shocks on water availability. During the study year, there was an acute water shortage in the study District. Hand pump wells, streams and rivers dried-up, which led to a reduction in household water consumption by households and livestock. Discussants also added that water scarcity increased the burden on women and children. They travelled longer distances and spent long hours collecting water because they are considered as the guardians of the household water supply, and this also forced girls to lose a number of school days.

Next to drought, 71 percent of households identified hail as a shock and this shock indicator was reported

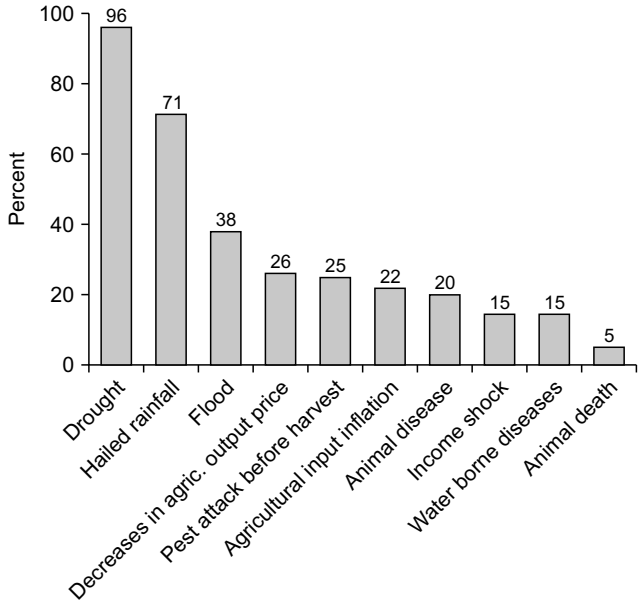

Fig. 2. Percentage distribution of shock incidence in the study District.
Source: Own computation, 2017 data.

with the second highest incidence. Large hail stones directly damage the major staple crops of the District such as wheat, barley, taff, horse beans and peas. This type of shock has a severe impact on crops through stripping leaves, bending/breaking stalks and generally leading to harvestable crop losses.

Flooding was reported as the third major shock, experienced by 38 percent of surveyed households. Households were affected by rainfall induced flooding that erodes fields into rivers and streams which also caused food and income reductions. Households, during group discussions, indicated that during the dry season they have been participating in soil and water conservation campaign programs for the last 20 years. They engaged in such activities because they believe that water conservation would be profitable through increasing yields and pastures in normal years. In a few areas, the conservation was efficient, but since the majority of the topography of the District is hilly and mountainous, households cannot protect their small plots of land from soil erosion. Periodic flooding wipes out farmers' staple crops and poses threats, especially to those who have a small plot on the hills. Nyssen et al. (2005) indicated that erosion in the study District is due to heavy rainfall.

Decline in the price of agricultural products due to limited market access was reported by 26 percent of households. It is one of the most negative shocks affecting households in the study District. Discussants indicated that farm products such as crops and livestock are not supported by good marketing systems and cooperatives, and households are expected to cover all transport and transaction costs associated with the marketing of their farm or non-farm outputs and sell their product at a very low price. The low bargaining power of producers and low purchasing power of the consumers were also indicated as factors that led to a price decline. A considerable proportion of households (22 percent) have also experienced agricultural input price inflation. Discussants indicated that higher prices for fertilizers and improved seeds are among the major factors determining low agricultural productivity. As a result, farmers did not apply adequate fertilizer to their small plots of land. This has led to low crop yields.

Severe pest attacks before harvest adversely affected 25 percent of surveyed households. Pest infestation leads to loss of crops and reduces food production through damaging food crops. Such a shock reduces farm income and forced households to divert their resources towards purchasing pest control inputs. Households that rely on a single crop are more vulnerable to crop damage due to crop specific pests. If households relatively diversify their economy, they will face a lower relative burden from pest damage. Conversely, if the household economy is

highly dependent on a single crop, the burden may be severe. Pests caused huge destruction in plants and animal pasture for some households.

In terms of other shocks, 20 and 15 percent of households were affected by animal and water born disease outbreaks, respectively. Livestock diseases are intensified by the absence of veterinary medicines and other agricultural extension services. They represent important shocks that affect the utilization of draught power, directly affecting crop production and food security. The immediate impacts of animal disease include a reduction in the productive capacity of the animals and a subsequent reduction in the supply of animal products such as meat and milk. Animal disease also reduces the demand for meat and meat products. Focus group discussants indicated that livestock diseases reduced income (from the sale of livestock and livestock products as sick animals cannot be sold or fetch a low price) and a decline in the quantity of livestock. Water borne diseases are caused by drinking and washing with contaminated or unprotected water (such as unprotected wells, unprotected springs and surface water) which can have significant impacts on the health and socioeconomic conditions of households. Water borne disease is a burden to the study area as the outbreaks are not rare and occur in situations of inadequate access to good quality water and sanitation. The economic burdens of these diseases are not limited to loss of productivity, but also led to considerable out of pocket expenses for treatment and loss of assets. Various forms of diarrheal diseases are the common diseases associated with the use of inadequate and unsafe water.

Farmers are engaged in risky and subsistence rain-fed agricultural activities which are highly vulnerable to various shocks. Their vulnerability was also the result of income shocks. The prices of agricultural inputs and outputs are volatile and can lead to an unforeseen household income reduction. In the study District, 15 percent of households were negatively affected by income reduction shocks. This adversely affects the wealth and health status of those households.

Scope of Shocks

Analyzing the nature of shocks on the basis of how widespread they are, or the distinction between idiosyncratic and covariate shocks, has valuable policy implications. It is very helpful to understand the available shock coping responses. For example, if any covariate shock such as crop failure occurs in a given village, food sharing through social networks may not be an appropriate coping strategy. In this regard, Table 2 shows the extent to which reported shocks are idiosyncratic or covariate. As one would expect, drought, hail, the decline in output prices, input inflation and pest invasion are covariate or community level shocks with 86, 62, 70, 57, and 86 percent of affected rural households indicating the scope of these shocks covers all surveyed households in a particular Kebele, respectively. Flood, animal disease, income shock, water borne diseases, and animal death are idiosyncratic shocks with 52, 73, 58, 57 and 62 percent of affected households reported that the extent of these shocks covers at least only some surveyed households in each Kebele, respectively. Looking at the exact scope of shocks, we find water borne disease as the most idiosyncratic shock as 32 percent subjectively declared it affects only the household itself. However, some type of health shock such as diarrhea can also be characterized as covariate as their effects tend to be widespread and affect a larger number of households. Such types of shock are more common in low income countries where poor physical infrastructure for the provision of drinking water and sanitation facilities are common. Drought and input price inflation shocks were found to be more purely covariate shocks as 60 and 38 percent of the respondents reported that they affect areas beyond their communities, respectively.

***Ex-post* Shock Coping Responses Employed by Households**

Households were not passive to respond or manage the effect of past multiple shocks. Rather, they employed a combination of different *ex-post* shock coping strategies (see Table 3). Results show that reducing food intake and consuming lower quality food were prominent households shock coping actions in the study District. The largest proportion of sampled households (85 percent) reduced the frequency and quality of food consumed to smooth the effect of shocks on their wellbeing and to protect their assets. This means households consumed

Table 2. Percentage distribution of scope of shocks

Shocks	N	Idiosyncratic			Covariate
		Only my household	Some households in this Kebele	All households in this Kebele	Areas in and beyond this Kebele
Drought	405	0.3	13.6	26.1	60.0
Hail	299	0.3	37.5	42.5	19.7
Flood	161	9.3	42.8	25.5	22.4
Decline in output prices	109	6.4	23.9	35.8	33.9
Pest invasion	104	1.9	12.5	67.3	18.3
Input price inflation	93	7.5	35.5	19.4	37.6
Animal disease	85	9.4	63.5	12.9	14.2
Income shock	65	24.6	33.8	33.9	7.7
Water borne diseases	65	32.3	24.6	21.5	21.5
Animal death	21	23.8	38.1	33.3	4.8

Source: Author computation, 2018.

cheaper and lower quality food in the time of shock occurrence. Elders from Walta explained that households reduce the frequency and quality food intake to sustain the household through the lean season and avoid skipping meals during the peak of it. They also explained that reducing the frequency of consuming food was a helpful strategy to prepare household members for more challenging times while consuming less preferred/low quality of food was important to ensure that household members (particularly children) were able to sustain the consumption of three meals per day even during the period of food shortages. This shock coping response somewhat mitigates the burden of malnutrition and associated health problems in the area, but they remain severe.

Drawing on savings was the second important coping strategy, being employed by 82 percent of the shock affected households in the study District. Although the average savings are very low, households reported their savings were accumulated through the sale of various products such as crops and livestock. Qualitative data show that although some households were not able to save due to meager earnings, they coped through receiving cash and in kind remittance from relatives.

In addition to the provision of manure and draft power, livestock serves as a buffer against household shocks. 82 percent of the households sold livestock, which includes the sale of sheep, cattle, goats and poultry, as a shock coping response. The findings accord with Birhan (2018), who documented that in Ethiopian rural households in general, and Tigray in particular, savings and the sale of livestock were the most important coping strategies to multiple shocks in the periods of 2012, 2014 and 2016. Sale of livestock in response to a shock is different from regular sales as it is characterized by low prices. Households were forced to sell their livestock at depleted prices to buy other food stuffs. Discussants indicated that households attempt to safeguard major productive assets such as oxen and cows when experiencing shocks like drought. However, if they do not have an adequate fodder supply and water accessibility, households sell their assets to obtain income during the lean season for their survival. The decision to sell key assets like oxen is a clear indication of absence of alternative coping options. The sale of livestock may not provide a large buffer to poor households owing to the limited number of livestock they typically own.

Among the other multiple coping strategies, borrowing of money from formal financial institutions was used by 55 percent of rural households. They borrowed money from saving and credit cooperatives and microfinance institutions to help manage or respond to shocks. Participation in Productive Safety Nets Program (PSNP) in the form of a food-for-work program was found to be an important resilience strategy against shocks for 44 percent of vulnerable households. Devereux et al. (2006) remarked that Ethiopia's PSNP aims to guard households against recurrent drought through smoothing household food consumption, protecting household assets, creat-

ing community assets, strengthening household and community resilience to shocks, and breaking the country's chronic long-term dependence on food aid. The majority of the beneficiaries became members of the PSNP after they faced shocks. The program helps households to smooth consumption and build assets. They graduate from the program when they are able to meet their basic needs through their own capacity. Qualitative data show that PSNP benefited rural households either in the form of food-for-work programs or direct welfare support. The beneficiaries of direct support are elders, orphans, disabled persons and households with no labor to supply. Those who can contribute labor when experiencing food shortage are screened for participation in the food-for-work program to cope with shocks. The food-for-work program is focused on conservation of natural resources and is the most common type of safety net in the study District. This includes rural road construction, soil and water conservation, reforestation, and digging wells. Chronic food insecure households who faced a continuous food shortage were selected by District officials using administrative guidelines and community knowledge. Beyond increasing income and food of the household, the program is significant in rehabilitating the environment.

Reliance on support from families, friends and various organizations like NGOs, government and cooperatives, forms a coping strategy for 39 percent of the sampled households. Increasing wage work or temporary migration to towns in search of wage employment were important responses to the effect of shocks for 30 percent of households. Migration of any household members occurred due to the absence of local employment opportunities. It is also quite evident that some households were employing various strategies such as selling crop stock kept for in-house consumption (29 percent), sale of fixed assets (26 percent), reducing spending on clothes (25 percent), and gathering and selling of firewood and charcoal (6 percent) to deal with adverse events.

Results show that households in the study District follow a mix of erosive, reversible or regenerative *ex-post* coping strategies to resist the adverse effect of shocks. Reduction in food consumption, relying on savings, formal and informal borrowing of money, sale of crops, and reducing spending on non-essential items like clothes are reversible coping strategies practiced by the sampled households. However, strategies like eating less and consuming lower quality food may disturb a household's health status. Some strategies may be erosive and exert negative consequences on household's wellbeing and future growth. Erosive coping strategies practiced by households include the sale of fixed assets, sale of livestock, migration, and consuming seed stocks preserved for the next cropping season. Sale of productive assets, mainly oxen and cows, reduces households' future productive capacity while migration increases time spent in farm work due to loss of household labor although families left behind may or may not benefit from remittance inflows. Positive or regenerative coping strategies used by

Table 3. Percentage distribution of households by coping strategies

Shock coping strategies	Frequency	Percent
Reducing the frequency and quality of food	357	85
Draw down on savings	345	82
Sell livestock	345	82
Formal borrowing of money	230	55
Food-for-work	185	44
Reliance on relief support/aid	162	39
Short term migration	126	30
Sell crop stock	123	29
Sell fixed assets	110	26
Reduce spending on cloth	103	25
Informal borrowing of money	65	15
Consume seed stock	52	12
Sell firewood and charcoal	25	6

Source: Author computations, 2017 data.

households were the sale of firewood and charcoals and joining Productive Safety Net Programs.

Correlates of Household Vulnerability to Multidimensional Poverty

Table 4 shows the predicted coefficients on the determinants of vulnerability to multidimensional poverty that form the basis for the computation of the aggregate vulnerability discussed in the next sections. Household vulnerability to multidimensional poverty was estimated using expected mean and variance of household's weighted MPI deprivation score. The predicted residuals of the model satisfy the properties of normal distribution. This was tested using various normality tests such as histogram, probability plots and Shapiro-Francia W' test. The result shows good performance for the model, with a statistically significant F-value. R-squared for the level of expected deprivations shows that 49.7 percent of the variation in the values of the predicted deprivation score is explained by the selected independent variables. The specification of the model was also checked by testing for the problem of multicollinearity using Variance Inflation Factor (VIF) for continuous variables and contingency

Table 4. Estimation of household's vulnerability to expected multidimensional poverty

Variables		Weighted MPI deprivation score	Variance
Household characteristics	Sex of household head	0.081***	–0.149
	Household size	–0.005	–0.012
	Age of household head	0.000	–0.004
	Head years of education	–0.002	–0.008
	Dependency ratio	0.001	0.067
Assets	Physical capital index	0.744***	–2.706**
	Social capital index	–0.332***	0.406
	Financial capital index	–1.385**	5.232
	Number of plots	–0.045***	0.065
Shocks	Hail	0.068***	–0.195
	Flood	0.005	–0.005
	Decreases in output prices	0.004	–0.096
	Drought	0.231***	–3.009***
	Pest attack before harvest	0.115***	–0.180
Coping strategies	Reducing food consumption	–0.023	–0.094
	Draw down on savings	–0.063***	0.246
	Sold livestock	–0.157***	0.321
	Formal borrowing of money	–0.131***	0.334*
	Joining safety net program	0.009	0.109
Kebele (Simret is base)	Selam	–0.005	0.082
	Arebay	–0.015	–0.227
	Walta	0.109***	–0.071
	Michael Abiy	–0.022	–0.096
	Mizane Brhan	0.038	–0.162
Constant		0.130	5.642***
Observation		390	390
R-squared		0.497	0.090
Adjusted R-squared		0.464	0.030

Note: ***, **, *significant at 1 percent, 5 percent and 10 percent levels, respectively. Negative sign of the deprivation score coefficients indicated a reduction in predicted multidimensional deprivations and thus an improvement in households' wellbeing. Negative sign of the predicted variance shows lower volatility of expected MPI deprivations. Source: Author computation, 2017 data.

coefficients for dummy variables. The result of the VIF shows that there was no correlation among predictors in the regression model. The VIF values range between 1.03 and 1.21 with mean VIF 1.10. This value is significantly lower than the VIF threshold of 10 (Chatterjee and Hadi, 2012). The result of the coefficient of contingency also shows that the maximum correlation between any two dummy variable is very low indicating that multicolinearity is not a problem.

The estimated results shown in Table 4 provide key insights into the relative importance of different factors to household vulnerability and multidimensional poverty. Controlling all other determinants, households with a better social capital index tend to be less vulnerable owing to their lower rates of expected multidimensional poverty. This is probably due to the fact that households in rural areas have strong informal social networks and cooperation that may help provide mutual insurance against idiosyncratic uncertainties or adverse events such as drought, pests and floods. Social capital is also an important safety net, providing risk management and mutual assistance. It also facilitates the supply of informal credit in rural areas. Moreover, rural areas have strong social capital that enables them to join together, mobilize resources and act collectively to protect themselves from a range of risks and vulnerabilities.

Financial capital, as a fungible monetary resource, allows households to have better control over other productive assets and help households cover their livelihood needs that cannot be met from other assets. It affects the household's asset accumulation and determines the ability to cope with shocks and risks through a wide range of saving and borrowing strategies. The result shows that, holding everything else constant, households that are relatively well endowed with financial assets are less vulnerable and have a lower level of expected multidimensional poverty. This is due to the fact that financial capital increases farmers' investment choices and has direct vulnerability reducing effects. Given agriculture is the foundation of the Ethiopian economy, financial asset helps households to improve farm productivity of smallholder agriculture and reduce poverty.

Previous studies show that the number of plots (as a proxy of land fragmentation) could have either positive or negative influence on the dependent variable and the influence can also be seen from the demand side and supply side (Bentley, 1987; Sundqvist and Anderson, 2006; cited in Abrham and Bauer, 2012). On the supply side, land fragmentation can limit productivity as it constrains mechanization. Whereas on the demand side, households may prefer to have more plots of land to reduce the risk of crop failure through diversification.

In this study, the number of plots were found to have a significant impact on household vulnerability to poverty. The negative coefficient implies that households with a greater number of plots were less vulnerable. An increase in a household's number of plots decreases its weighted MPI deprivation score by around 0.04, all else kept constant. This may be due to the fact that the study District is highly exposed to soil erosion due to its sloping and hilly topography. Thus, though it is very difficult to apply modern agricultural technologies to ensure even the smallest economies of scale with fragmented, small plots of land, households with more dispersed plots of land face reduced risk from harvest failure through diversifying crops and land types. This will make a substantial contribution to lowering the probability of households being multidimensional poor in the future.

On the other hand, households with a greater physical capital index are found to be more vulnerable owing to a higher average level of deprivation with lower volatility of expected MPI deprivations. The significant and positive coefficient of the physical assets index suggests that the index is positively correlated with household's vulnerability to MPI poverty, and the negative and significant variance shows that this asset index reduces the variance of expected MPI poverty. Various variables which include composite of durable consumer goods, agricultural assets and basic infrastructural services has entered in the vulnerability analysis as a composite index physical capital. The existing physical capital of the study District is inadequate and do not support households to reduce vulnerability and improve wellbeing. This result that greater physical assets increase vulnerability is contradicted by previous studies (see DFID, 2000; Sen, 2003; McKay, 2009; Alkire and Santos, 2010; Moser, 2011), which indicated access and supply of infrastructural services and production goods support household's wellbeing. This is probably due to the fact that households in the study District have very poor and inadequate physical assets such as various infrastructural facilities such as market, transportation, electricity and irrigation

dams to achieve valuable functioning. The traditional nature of household's productive assets and the generally quality of farm implements may also contribute to lower crop productivity and this cannot increase agricultural production which in turn increases vulnerability to poverty.

Gender as a demographic characteristic provides an important insight into household vulnerability to future deprivations. When controlling for all other factors, female-headed households are more likely to be vulnerable to future poverty than male-headed households. In general, female-headed households in rural Ethiopia are poor and vulnerable due to many factors. According to Lemlem et al. (2011), women play an important role in agricultural production (crop and livestock production). However, despite their contribution, they have historically had limited access to productive resources such as land, livestock, farm implements, knowledge, and financial capital. Less access to, and less control over, vital productive resources such as land, credit and employment opportunities are probably some of the reasons that may contribute to their higher level of vulnerability to multidimensional poverty. In Ethiopia, female-headed households emerge when married women are separated from their husbands (mainly by divorce) and become heads of their own households (Yigremew, 2002). Even if they possess a small plot of land, they did not cultivate it by themselves due to many factors (for example, insufficient labor for farming activities due to smaller family size) and hence they rented it out to others. Given the absence of local markets and the low productivity of the land, it is difficult to produce adequate food for the household. The strong cultural beliefs and traditional practices may also constrain women's active involvement in all socio-economic activities, which in turn increases women's vulnerability to multidimensional poverty.

Hail caused considerable physical damage to crops and lead to sudden loss of harvestable produce. The results of the regression analysis shows that households' experiences of hail shocks are associated with increased vulnerability to multidimensional poverty as it is correlated with higher expected levels of wellbeing deprivation. It is also evident that households that experienced drought shocks are highly vulnerable with a higher average level of deprivation and lower expected level of volatility in future wellbeing. The positive sign of drought shocks on the deprivation score coefficient indicated an increment in the predicted multidimensional deprivations and thus reduction in households' wellbeing. Hence, drought experience increases the vulnerability of households to its multidimensional deprivation score by 0.231 for an average sample household in the study District. This is probably due to the fact that drought reduces crop production income and other productive asset holding capacities (e.g. livestock) of households which also adversely affect future income generation. Households that experienced pest attack were found to be more vulnerable to multidimensional poverty by 0.115. This shows that pest invasions stress crops, reduce yields and households expected wellbeing. Overall, the excessive dependence of household livelihoods on small scale agriculture (crop production and livestock farming) make them highly vulnerable to adverse effects of climate related natural hazards such as drought, hail, and pest invasions which mainly affects household's wellbeing through disrupting and lowering food production, income generation, and asset creation.

Turning to households' experiences of shock coping strategies, ceteris paribus, households who coped through running down savings and formal borrowing of money from financial institutions such as Micro Finance Institutions (MFI) and cooperatives were found to be less vulnerable, because the coefficients of these coping strategies are associated with a lower expected level of MPI deprivations. Although the use of own savings and formal borrowing of money were commonly reported shock coping strategies, both are mostly utilized by the wealthiest households and have a limited role for poor households. However, using savings and credit fulfill the immediate financial needs to manage households' exposure to shocks in a timely manner and enhances household welfare through increasing investments, improving income and assets accumulation. Formal borrowing is also associated with higher expected volatility in the household's future level of wellbeing. Finally, households that sold livestock following shocks were observed to be less vulnerable to multidimensional poverty, although this coping mechanism is also mostly used by those households who have a higher number of livestock. Rural households kept and made investment in livestock such as goats and sheep in normal times and these investments can be easily converted into monetary value to respond to adversity. These help households reduce the probability of

experiencing future poverty.

Aggregate Poverty and Vulnerability Profile

As shown in Table 5, the analysis of the estimated vulnerability level (Eq. 9), shows that the mean vulnerability or the average vulnerability level of the studied households is 0.55, and the standard deviation is 0.17. This means that the distribution of vulnerability level is skewed to the right side, and the mean of the vulnerability level is typically greater than the median. According to Chaudhuri et al. (2002), the mean vulnerability should be closer to the estimated multidimensional poverty rate for vulnerability estimates. Hence, the predicted household multidimensional poverty rate is 0.60, which is reasonably close to the average vulnerability. Households with a higher vulnerability score are more likely to be vulnerable to multidimensional poverty. Many households have vulnerability scores greater than the average vulnerability level, which implies that those households have higher deprivation scores than the average level. The result also shows that the average vulnerability score of the poor households is greater than the average vulnerability level/score of the non-poor households, which implies a positive correlation between current poverty and vulnerability to future multidimensional poverty.

As presented in Table 6, households' vulnerability is cross tabulated with households' multidimensional poverty status to assess which households are vulnerable to future poverty. The table also demonstrates the overlapping categories of households which enable us to differentiate the chronic poor from transient poor households, and the highly vulnerable non-poor and relative vulnerable non-poor households. In this regard, of the 80 percent of vulnerable households, 56.9 percent are vulnerable due to chronic factors, i.e. high vulnerability, while 23.4 percent of households are vulnerable due to transitory factors, representing relative vulnerability. Specifically, the greater majority of the currently poor households (that is, 44.6 percent) remain chronically poor (poor due to high vulnerability resulting from a low expected level of wellbeing). This means nearly 75 percent of households who are poor are highly vulnerable, with a high probability of experiencing future multidimensional poverty. This finding shows the importance of chronic factors to determine households expected multidimensional poverty. High dependence of households on small-scale rain-fed agriculture and the existence

Table 5. Mean vulnerability of the poor and non-poor households

Multidimensional poverty status	Number	Percent	Mean vulnerability
Multidimensional non-poor	156	40	0.47
Multidimensional poor	234	60	0.60
Total	390	100	0.55

Source: Author computation, 2017 data.

Table 6. Estimates of poverty and vulnerability to multidimensional poverty grouping

Estimated vulnerability	Observed multidimensional poverty		
	Current poor 60%	Current non-poor 40%	
Total vulnerability 80.3%	Chronic poor 44.6%	Vulnerability to chronic poverty 12.3%	High vulnerability 56.9%
	Frequently poor 11.3%	Vulnerability to frequent poverty 12.1%	Relative vulnerability 23.4%
Not vulnerable 19.7%	Infrequently poor (poor but not vulnerable) 4.1%	Not vulnerable and not poor 15.6%	

*Shaded area comprises total vulnerability; Numbers may not sum to 100 percent due to rounding. Source: own computation based on Chaudhuri et al.(2002), Suryahadi and Sumarto (2003) and Feeny and McDonald (2016).

Table 7. Comparison of observed poverty and estimates of vulnerability

Kebele	Percentage of population		Vulnerability to poverty ratio
	Vulnerable	Poor	
Overall	80	60	1.34
Simret	46	61	0.75
Selam	57	79	0.72
Arebay	50	35	1.43
Walta	70	78	0.89
Michael Abiy	65	52	1.25
Mizane Brhan	53	47	1.13

Source: Author computation, 2018.

of extremely high uncertainty about future risks may be a possible explanation for this high estimated vulnerability at current observed multidimensional poverty incidence. In addition, the remaining poor households are estimated to be transitory poor, with 11.3 percent of the poorest households estimated to be frequently poor (at risk of becoming poor due to high expected variation in their wellbeing), while 4.1 percent are infrequent poor. Coming to the vulnerability level of non-poor households, 24.4% of the households are currently non-poor, but vulnerable to multidimensional poverty. Only 15.6 percent of households are found to qualify as non-poor and non-vulnerable to future multidimensional poverty.

As shown in Table 7, another important finding is that 80 percent overall vulnerability incidence exceeds the current multidimensional poverty incidence of 60 percent. This shows the chance of experiencing future multidimensional poverty is significantly greater than the present multidimensional poverty incidence of households. Hence, the current poverty level underestimates the fraction of households who are susceptible to multidimensional poverty. The magnitude of underestimation is examined by computing the vulnerability to poverty ratio, which is 1.34. Chaudhuri et al. (2002, p.11), stated that "a higher vulnerability to poverty ratio indicates a more dispersed distribution of vulnerability, whereas a lower ratio suggests that vulnerability is concentrated among a few". Hence, the findings on vulnerability to a multidimensional poverty ratio of each study Kebele indicated that vulnerability is generally more widespread or dispersed than the current poverty in Arebay, Michael Abiy and Mizane Brhan, respectively, with estimated vulnerability greater than observed multidimensional poverty. In contrast, the result revealed a lower level vulnerability to poverty ratio in Selam (0.72) which suggests a vulnerability to poverty is highly concentrated in this study Kebele, followed by Simret and Walta.

CONCLUSION

This study has made an attempt to estimate vulnerability to multidimensional poverty by adopting Chaudhuri et al.'s (2002) vulnerability-as-expected-poverty theoretical framework. The paper first examines households' exposure to different shocks' and the coping mechanisms that households use when faced with a shock, and then assesses the household's level of vulnerability. The results shows that the problem of household vulnerability in the study area is very high due to their exposure to a range of shocks, particularly drought, hail and rainfall induced flood which adversely affected the household's wellbeing. These natural shocks influence household wellbeing for the reason that the major economic activity of the district is agriculture where the majority of households derive their means of livelihoods such as income and employment from agriculture. Households were not passive when facing different shocks. They attempted to reduce the impact of shocks by employing a range of coping strategies on the basis of shock characteristics and available resources.

Analysis of correlates of households' vulnerability to multidimensional poverty indicated that, holding all other determinants constant, male-headed households and households with greater social capital, financial assets

and number of plots are associated with reduced vulnerability to multidimensional poverty while households with only better physical capital are found to be highly vulnerable. Households exposed to drought, hailed rainfall and pest attack were found highly vulnerable to multidimensional poverty with a higher average level of MPI deprivation and with lower expected variance in their wellbeing. This suggests local and regional governments should increase household resilience to agricultural shocks through providing saving and timely credit services, and introducing early maturing and drought resistant crops. Our estimated findings also show that households that relied on savings, sale of livestock and formal borrowing of money better managed shocks, correlating with reduced vulnerability to future multidimensional poverty. This is because such assets provide households with insurance against risks and shocks. Livestock can be easily converted and households that own livestock sell some animals to raise money for engaging in different income generating activities, and for purchasing food when natural shocks such as drought and pests damaged their crop production. Savings are the best way of coping with shocks while borrowing was also helpful to increase access to cash to cover the costs incurred from shocks.

With respect to the linkage between multidimensional poverty and vulnerability, results show that a greater proportion of households (80 percent) were vulnerable to multidimensional poverty. Out of these total vulnerable households, 24 percent of the current non-poor households were at risk of becoming multidimensional poor, while 56 percent of households who are currently poor will remain vulnerable to staying in future multidimensional poverty. This key result shows that the probability of falling into future multidimensional poverty exceeds the currently observed incidence of household's multidimensional poverty (which is 60 percent of the total population), indicating that the predicted probability of experiencing poverty in the near future is higher than the currently observed incidence of poverty in the population. This implies that poverty reduction interventions should not be passive to the probability of falling into multidimensional poverty. Because a higher proportion of the currently poor and non-poor households in the study District are likely to face the risk of various deprivations in their future wellbeing, there should be an integrated focus on multidimensional poverty and the risk of falling into such poverty.

Therefore, poverty reduction interventions should be targeted at the poor and vulnerable households to reduce observed household poverty and prevent the non-poor from becoming multidimensional poor in the future. Since the majority of the highly vulnerable households are chronically poor, poverty reduction strategies should focus on building the assets of chronically poor households. Providing skills training on how they can build-up livelihood assets using improved knowledge and technology, and the provision of financial service can help in this regard. In addition, given that vulnerability to poverty is associated with low asset endowments, any inclusive and pro-poor development action that raises poor households control over livelihood resources may directly improve their wellbeing. On the other hand, some prevention and protection measures should be enhanced to protect the high and relatively vulnerable non-poor households.

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Appendix 1. Selected dimensions, indicators and deprivation cut-off values

Wellbeing dimensions (weight)	Deprivation indicators (weight)	Deprivation cutoffs
Education (1/5)	Years of schooling (1/10)	1 = if no household member has completed five years of schooling; and 0 otherwise
	Child school enrollment (1/10)	1 = if any school-aged child* in the household is not attending school; and 0 otherwise
Health (1/5)	Health care access (1/15)	1 = if a household does not have access to health care services in their village and 0 otherwise
	Health functioning (1/15)	1 = if any member unable to pursue household main activities due to serious disease for at least three months; and 0 otherwise
	Child mortality (1/15)	1 = if any child had died in the household in the past five years prior to this survey; and 0 otherwise
Standard of Living (1/5)	Access to safe drinking water (1/20)	1 = if households use unimproved drinking water sources ; and 0 otherwise
	Access to improved sanitation (1/20)	1 = if the household's sanitation facility is not improved ; and 0 otherwise
	Energy for cooking (1/20)	1 = if the household cooks with dung, wood, or charcoal; and 0 otherwise
	Electricity (1/20)	1 = if the household has no electricity; and 0 otherwise
Wealth (1/5)	Land ownership (1/10)	1 = if the household does not own more than local average (i.e., 0.66 ha. of land); and 0 otherwise
	Livestock ownership in TLU (1/10)	1 = if the household does not own TLU more than local average (4); and 0 otherwise
Empowerment (1/5)	Decision making (1/10)	1 = if household decision making on the use of income is not participatory; and 0 otherwise
	Cooperative membership (1/10)	1 = if any member of the household is not member of cooperatives; and 0 otherwise

*According to FDRE (2009), the compulsory school age for children in Ethiopia is 6-14 years.

Appendix 2. Computation and reasons for the design of MPI measures

Poverty can be defined as "*the failure of basic capabilities to reach certain minimally acceptable levels*" (Sen, 1992, p.109). This definition focuses on outcomes that define quality of life of persons, and show a shift in evaluation of wellbeing from the monetary to non-monetary measures. However, Sen does not reject the important role of income in human wellbeing rather he regarded it as necessary means for enhancing capabilities and functioning. But he indicated that there are some elements of life such as respect, freedom and culture, which are not adequately described and addressed by income. This is because wellbeing is basically multidimensional. According to Sen's capability approach, a person is considered to be poor if he/she failed to achieve certain defined levels of functioning. Therefore, the theoretical underpinning behind moving from a one-dimensional poverty measurement to evolving a multidimensional measurement of poverty in this paper rests on Amartya Sen's capability framework, and as studies such as Jenkins and Miclewright (2007) and Anand (2008) indicated, this approach is considered to have novel and extensive significance for the conceptualization of wellbeing and multidimensional poverty.

Alkire and Foster developed a new tool (Alkire and Foster, 2007, 2011) which allows the measurement of multidimensional poverty using the concepts of the capability approach. This methodology clearly shows the incidence and intensity of multidimensional poverty based on clearly identified dimensions and indicators. With this methodology the MPI which is interpreted as a partial measure of capability poverty can be computed. This method assumes various sets of dimensions which represent functionality and capabilities that an individual may or may not have. A person being deprived in at least a minimum set of widely valued achieved functionings is interpreted as multidimensionally poor. In this case, poverty is considered as a state of basic capability failure. Poverty as capability failure is understood as the incapacity of households to realize basic functionings that they consider as important and valuable for their own wellbeing.

The MPI is an index designed to measure acute poverty. Households who are living in acute poverty fail to satisfy the minimum threshold of listed indicators and at the same time they are deprived in several wellbeing indicators. In other words, the main reason for the design of MPI measure is that it shows households who experience multiple deprivations. In addition to this, the MPI combines information on the incidence of poverty (the proportion of people who are multidimensionally poor) and the intensity of their deprivation (average deprivation among the poor). This information is very important for poverty measurement. The MPI measure of poverty includes various indicators to show the different picture of poverty which is important to inform policies aimed at reducing the multiple dimensions of poverty. The other reason for the use of the MPI measure is that the paper used binary indicators which is appropriate to observe the direct joint distribution of deprivations (see Alkire et al., 2015)

The headcount ratio which measures the percentage of households that are identified as multi-dimensionally poor can be calculated as: $H = q/n$, where, H denotes the head count ratio, q is the number of households who are identified as poor according to the thresholds vector z and the cut-off k, and n represents the total population. The headcount ratio does not consider the breadth of poverty and it does not show how poor are the poor. Thus, the headcount does not change if only already poor individuals suffered deprivation in another new indicator. Moreover, headcount ratio is not decomposable into constituent dimensions and indicators (Haughton and Khandker, 2009). To fix such problems, additional information on the intensity of deprivations experienced by the poor is required. Therefore, the intensity of multidimensional poverty measures the average share of weighted indicators in which poor

rural households are deprived can be calculated as $\boldsymbol{A = \sum_{i=1}^{n} ci(k) / q}$, where A stands for intensity of multidimensional poverty, and $c_i(k)$ denotes the

censored deprivation score of household i. Therefore, the Adjusted Headcount Ratio, MPI, is given by, $\boldsymbol{MPI = H \, x \, A}$.