zef
Center for
Development Research
University of Bonn

ZEF-Discussion Papers on
Development Policy No. 315

Tigabu Getahun and Gebeyehu Fetene

Determinants of Participation in Rural Off-Farm Activities and Its Effects on Food Shortage, Relative Deprivation and Diet Diversity

PARI

Bonn, January 2022

The **CENTER FOR DEVELOPMENT RESEARCH (ZEF)** was established in 1995 as an international, interdisciplinary research institute at the University of Bonn. Research and teaching at ZEF address political, economic and ecological development problems. ZEF closely cooperates with national and international partners in research and development organizations. For information, see: www.zef.de.

ZEF – Discussion Papers on Development Policy are intended to stimulate discussion among researchers, practitioners and policy makers on current and emerging development issues. Each paper was subjected to internal discussion and quality control at the Center for Development Research (ZEF). The papers mostly reflect work in progress. The Editorial Committee of the ZEF – DISCUSSION PAPERS ON DEVELOPMENT POLICY includes Matin Qaim (Chair), Christian Borgemeister and Eva Youkhana. Alisher Mirzabaev is the Managing Editor of the series.

Tigabu Getahun and Gebeyehu Fetene. Determinants of Participation in Rural Non-Farm Activities and Its Effects on Food Shortage, Relative Deprivation and Diet Diversity, ZEF – Discussion Papers on Development Policy No. 315, Center for Development Research, Bonn, January 2022, pp. 39

ISSN: 1436-9931

Published by:
Zentrum für Entwicklungsforschung (ZEF)
Center for Development Research
Genscherallee 3
D – 53113 Bonn
Germany
Phone: +49-228-73-1861
Fax: +49-228-73-1869
E-Mail: zef@uni-bonn.de
www.zef.de

The authors:
Tigabu Getahun, Center for Development Research (ZEF), University of Bonn, and Policy Studies Institute (PSI), Ethiopia. Contact: tigyget14@gmail.com
Gebeyehu Fetene, Policy Studies Institute (PSI), Ethiopia. Contact: gebeyehumd@gmail.com

Acknowledgements

We are grateful to Joachim von Braun, Heike Baumüller, Zaneta Kubik and participants at the ZEF research colloquium for numerous comments, guidance and insightful suggestions.

This paper was developed within the project “Program of Accompanying Research for Agricultural Innovation” (PARI), which is funded by the German Federal Ministry of Economic Cooperation and Development (BMZ).

Abstract

This study investigates the determinants of smallholders' participation in rural off-farm activities, which includes rural non-farm own business and wage employment, and its effect on food shortage, relative deprivation and dietary diversity. To address these objectives, we use a three-wave panel dataset of 7,110 smallholder farm households in Ethiopia. The estimation result suggests that the gender composition of households, age, education, natural shocks, participation in community meetings, exposure to media, access to credit, farmland, agricultural markets and rural infrastructure such as electricity are the key determinants of smallholders' participation in rural off-farm activities. The estimation results also suggest that smallholders' participation in rural wage employment aggravates relative deprivation, while participation in rural non-farm own business activities reduce relative deprivation and food shortage. On the other hand, our estimation results indicate that participation in both non-farm own business activities and wage employment improve the dietary diversity of smallholder farmers. Hence, well-designed policy interventions aimed at enhancing smallholder farmers' rural wage employment and non-farm own business participation could help to enhance dietary diversity and reduce food shortages and relative deprivation

Keywords: Rural off-farm income, wage employment, non-farm own business, farm income, food shortage, relative deprivation, diet diversity

JEL codes: J00, J20, J43

Contents

1 Introduction

Food and nutrition insecurity remains one of the main policy challenges in the world, with around one in nine people still being food insecure and undernourished in 2017 (FAO, 2018). Food insecurity and micronutrient deficiency are higher in rural areas of developing countries as their livelihood mostly depends on erratic rain-fed agriculture, with limited access to credit and rural infrastructure (Jones et al., 2014; Pinstrup-Andersen, 2007; Zereyesus et al., 2017). Traditionally policy-makers and researchers alike have focused only on improving agricultural productivity to enhance rural food and nutrition security, while placing less emphasis on the role of rural non-farm own business and wage employment (Kilic et al., 2009).

There are divergent views in the literature over what constitutes non-farm and off-farm income (Rahman & Mishra, 2020). According to Babatunde & Qaim (2010), off-farm income includes agricultural wages, non-agricultural wages, self-employed income, remittances, and other income such as capital earnings and pensions. On the other hand, Anang & Yeboah (2019) define off-farm activities as participation in remunerative work outside the participant's own farm regardless of whether the participant earns profit or labour income. Following Anang & Yeboah (2019), we define *off-farm income* as income from wage employment and non-farm self-employment (non-farm own business). Hence, *off-farm activities* include wage employment and non-farm own business activities. Following the definition by Barret et al. (2001), *farm income* in this study is defined as income derived from the production or gathering of unprocessed crops or livestock or forest or fish products from natural resources. Likewise we define *non-farm activities*, following Haggblade et al. (2010), as all economic activities other than the production of primary agricultural commodities, including for instance agro-processing, mining, manufacturing, utilities, construction, commerce, transport, and a full gamut of financial, personal and government services. *Wage employment* refers to employment both in agriculture and non-agriculture sector.

Recently there is a growing recognition that rural off-farm activities (hereafter OFAs) – which include both non-farm own business and wage employment – can play a key role in addressing rural food and nutrition insecurity (Babatunde and Qaim, 2010; Barrett et al., 2001; Bezu et al., 2012; Corsi and Salvioni, 2012; Davis et al., 2017; Rahman & Mishra, 2020). The income share of OFAs has been increasing over time in many developing countries (Babatunde and Qaim, 2010; Barrett et al., 2001; Pfeiffer et al., 2009; Rahman & Mishra, 2020).

Studies across developing countries mostly document a positive correlation between participation in OFAs and households' income and food and nutrition security status (Canagarajah et al., 2001; Haggblade et al., 2010; Rahman & Mishra, 2020; Zereyesus et al., 2017). This has fostered the hope that participation in OFAs may serve as a way out of poverty and ensure food and nutrition security. The proponents of participation in OFAs argue that rural OFAs are a source of off-season employment and income for rural households whose

livelihood is mostly dependent on rain-fed agriculture, and it is a residual employer for rural households with no or fragmented land holdings. For cash-constrained smallholder farmers with limited credit access, it also helps to purchase modern agricultural inputs, smooth consumption expenditure and invest in children's schooling, all of which increase farm productivity and farm income in the years ahead (Babatunde and Qaim, 2010; Davis et al., 2009; Oseni and Winters, 2009). It may even increase their access to credit as lenders may use the evidence of steady pay in the rural OFAs as collateral for loans (Collier and Lal, 1984, Reardon et al., 2000). In the absence of a rural insurance market, it can also serve as a safety net for households facing income shocks, not only protecting the sale of productive assets but also increasing their willingness to adopt new technologies, which increases households' future farm income (Abdulai and Delgado, 1999).

On the other hand, other studies such as Huang et al. (2009), Kilic et al. (2009) and Pfeiffer et al. (2009) also unveil that labour-constrained smallholders' participation in OFAs might cause a reallocation of labour from farming to OFAs whenever households face seasonal income shocks, despite the lower expected labour returns from the latter. Consequently, although the direct income effect of participation in OFAs increases total household income and farm income, the indirect substitution effect of participating in OFAs on farm income depends on the existence of rural insurance and credit markets, as well as the vulnerability of smallholder farmers to natural shocks. The net effect of participating in OFAs compared to specializing in farming depends on the strength of its income and substitution effect. Therefore, while the net income effect of participating in OFAs is obvious for less labour-constrained households and those with little or no cultivation land, its effect for labour-constrained households who own or have rented sizable cultivable farm lands is theoretically ambiguous. For the labour-constrained land holders, the indirect substitution and the direct income effect of participating in OFAs might have an opposing impact on the overall household income, while the net income depends on the stronger of the two effects. This is typically true for poor and vulnerable smallholding farm households who have less access to rural insurance and credit markets.

As studies such as Babatunde and Qaim (2010), Pfeiffer et al. (2009) and Rahman & Mishra (2020) have indicated, the income and thereby the poverty and food and nutrition security effect of smallholder farm households' participation in OFAs is not only theoretically ambiguous but also empirically under-researched, thus calling for more context-specific rigorous studies. Hence, our study will contribute to the thin literature in the area by providing micro-econometric evidence on the poverty and food security effects of OFAs using three rounds of large-scale panel data from Ethiopia.

Our study is also related to a strand of literature which aims at identifying factors that influence smallholders' decision to participate in OFAs. In the labour economics literature, factors determining households' participation in OFAs are categorized as: (i) push factors,

including rural population growth, farm fragmentation risk reduction and the response to diminishing agricultural productivity; and (ii) pull factors, including the realization of strategic complementarities between farming and OFAs and high returns of OFAs (Bezu, 2011; Degefa, 2005). A number of empirical studies (CroleRees, 2001; Ahearn et al., 2006; Ellis, 2000; Gibson and Olivia, 2010; Kimhi, 1994; Shittu, 2014) find that the gender composition of households, age, education, and access to credit, electricity and markets are the key factors determining smallholder participation in OFAs. However, most of these studies use cross-sectional data and hence are unable to control for village and household heterogeneities. Our study uses a large three-wave panel data set and implements a fixed effect and Mundlak Chamberlin pseudo fixed effect models to control for time-invariant heterogeneities and selection on observables.

In summary, the study (i) assesses the patterns, types and dynamics of OFA, (ii) identifies the key internal and external factors that influence smallholder households' participation in OFAs vis-a-vis specializing in farming and (iii) evaluates the effect of income from rural non-farm own business on food shortage, relative deprivation and smallholder household diet diversity, as well as the relative effect of participation in rural wage employment and non-farm self-employment compared to farming.

2 Data and Descriptive Statistics

2.1 Data and Sampling Technique

In order to address the aforementioned research objectives, we use three-wave panel data that was collected in August 2011, August 2013 and March 2017 from smallholder farmers located in four major regions of Ethiopia by the Central Statistical Agency (CSA) of Ethiopia in collaboration with the Ethiopian Development Research Institute (EDRI) and the International Food Policy Research Institute (IFPRI).

The sample households were selected using a multi-stage sampling technique. At the first stage, the four major regions were selected. In the second, stage 93 woredas (the third largest administrative unit in Ethiopia, after zone and region) were selected from the four main crop-producing regions, namely Amhara, Oromia, Tigray and Southern Nations, Nationalities and Peoples (SNNP) region. At the third stage, three enumeration areas (villages) were randomly selected from each of the selected woredas of Amhara, SNNP and Oromia region and five enumeration areas from each of the selected woredas of Tigray. At the fourth stage, 26 households were randomly selected from each enumeration area. Out of the selected households, about 7,110 were interviewed in all three survey waves. The cumulative attrition rate over the three wave periods was less than 10%. This study therefore makes use of the data collected from these 7,110 smallholder farmers in three survey waves.

Covering the most important agricultural zones in Ethiopia, the dataset has rich information and covers a large geographical and ecological area that is well suited for this study. The dataset has detailed household characteristics, socio-economic variables and households' participation in meetings and trainings, the types of agricultural produces and harvesting methods, the number of livestock owned, the size of land cultivated, the type and quality of the plots, the existence of and access to markets, revenue from the sale of agricultural products, access to credit and labour markets, information about whether the households have had price information and media access, the types of non-farm activities that the households engaged in, members of households who participate in such activities, the seasons in which they participate, information about food shortages, relative deprivation and the types of food that the household consumes.

2.2 Descriptive Statistics

In this sub-section, we briefly describe the type, pattern and dynamics of the livelihood activities of our sample households. Figure 1 presents the percentage of households who participated in farming, non-farm own business, wage employment and a combination of these activities over the three survey periods. Almost all of our sample households engaged in farm activities over the three survey periods. The second and third most dominant

livelihood activities of our sample households are wage (off-farm) employment and non-farm self-employment. Our data indicates that (during the period from 2013 to 2017) our sample households recently started to diversify their livelihood activities. The number of households who were engaged in all the three livelihood activities was increased by three percentage points from 2013 to 2017. Similarly, the percentage of sample households who participated in OFA – which includes both non-farm self-employment and rural wage employment – also recently increased from 26% in 2013 to 43% in 2017. The larger fraction of this change comes from an increase in rural wage employment participation[1]. Nevertheless, the pattern of livelihood activities is not linear. For example, the percentage of households who participated in OFA decreased from 2011 to 2013 but increased from 2013 to 2017.

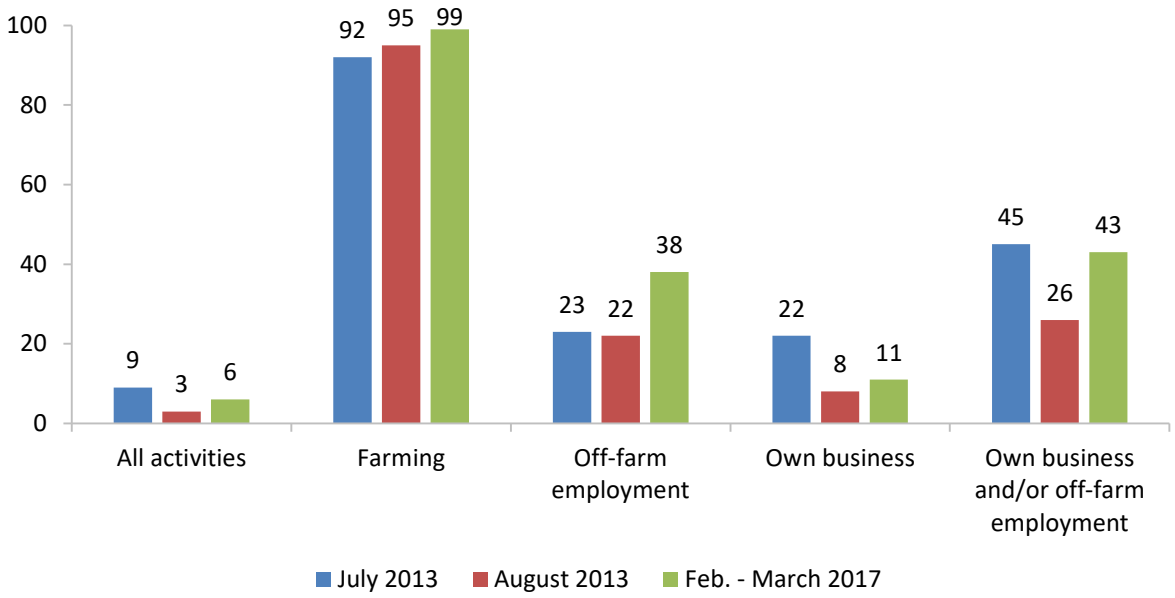

Figure 1. Participation in farming, non-farm own business & wage employment (%)

Figure 2 presents the types of non-farm businesses that the rural households were practicing, along with the percentage of the households engaged in each of the activities over the survey period. Most of the households were engaged in micro businesses such as making and selling local beverages and food, grain and livestock trading, handicrafts, weaving, retail trades, milling and transportation services by a pack of animals. Indeed, the activities that households worked on in wage employment were also similar. Among households who participated in rural non-farm own business, around 22% of them were engaged in food and beverage making and selling activities in 2011, whereby the figure declined to 18% and 19% in 2013 and 2017, respectively.

[1] Our data also indicates that the percentage of households who reported farming as their primary livelihood activity declined throughout the survey period, from around 89% in 2011 to 87% in 2013 and 81% in 2017.

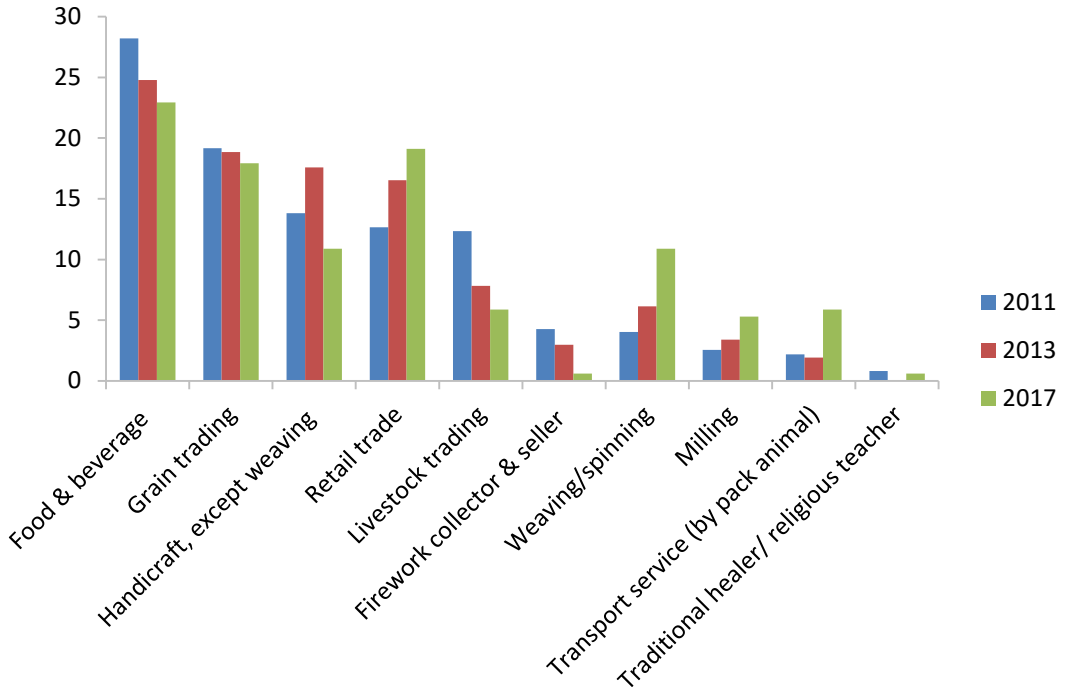

Figure 2. Types of non-farm own business activities along with the percent of households practicing the activities (%)

In the study, we also look at the intra-household allocation of labour in OFAs. The analysis of our data discloses that household heads and their spouses are the first and second main participants of OFAs. As shown in Table 1, around 78% and 65% of the households reported in the 2011 survey that the heads of the households participated in wage and self-employment activities, respectively. However, the participation of the heads of households in wage employment declined dramatically to 31% in 2013 and 32% in 2017, and their participation in non-farm self- and wage employment was 31% and 69% in 2017, respectively. In addition, the data unveils that in the overwhelming majority of households only a single member of households participated in OFAs, suggesting that the contribution of OFAs in reducing rural youth unemployment was marginal. This clearly entails that interventions aiming to enhance rural youth access for rural self and wage employment will substantially reduce the prevalence of rural youth unemployment in Ethiopia.

Table 1. Members of households participating in wage and non-farm own business (%)

Surveys	Household head		Spouse		Son (aged from 15 to 30 years)		Daughter (aged from 15 to 30 years)	
	Wage employment	Non-farm business	Wage employment	Non-farm business	Wage employment	Non-farm business	Wage employment	Non-farm business
July 2011	77.8	65.0	29.5	33.4	16.8	8.7	8.6	9.3
August 2013	31.0	74.2	18.4	46.9	12.7	17.3	7.8	16.9
Feb. & Mar. 2017	32.1	68.8	17.3	34.0	11.1	13.4	4.7	7.5

Note: The horizontal sum of the percentage of households participating in each of the wage and self-employment types does not add up to 100% since more than one household member could participate in the activities and since some of the household did not specify which household member participated in the activities.

The study suggests that a lack of access to credit is the main reason for the limited OFA participation. As shown in the figure, the main source of finance for starting own non-farm business was borrowing from relatives, friends and neighbours. Only less than 1% of the households received loans from formal banks to start their own business. About one-fifth of them also received starting capital from microfinance institutes, which charge high interest rates in group collateral. Thus, providing start-up capital with minimal collateral requirements and low interest rates could help to enhance OFAs.

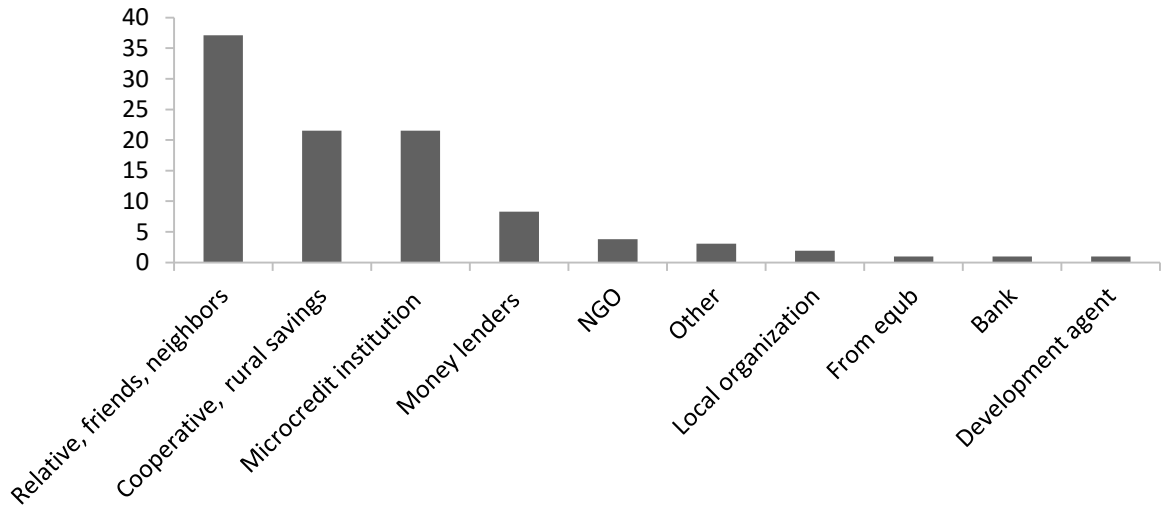

Figure 3: Sources of finance for non-farm own business (%)

The analysis of our data also indicates that rural self- and wage employment is a source of off-season employment and it is a residual employer for rural households with no or fragmented land holding. As shown in figures 4a and 4b, the percentage of households who participated in rural self- and wage employment varies across the 12 months preceding the three survey years. Our data indicates that the peak months for own non-farm business were November,

December and January, which are a slack period for agriculture, while for wage employment it was June, July and August, when the demand for labour is high

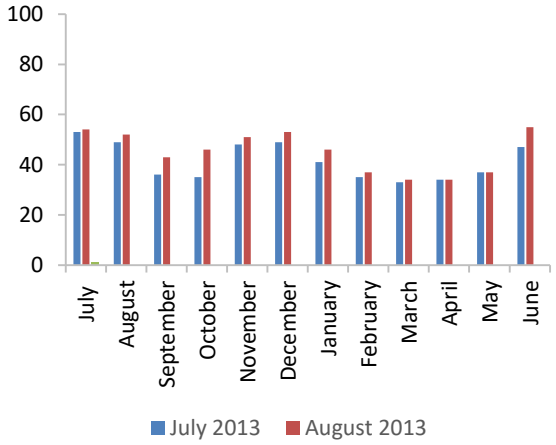

Figure 4a: Non-farm own business participation by month (%)

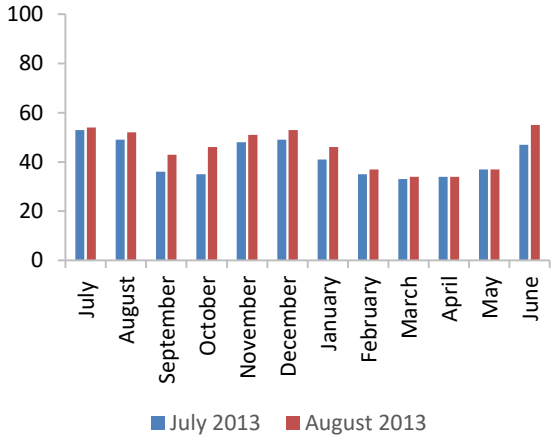

Figure 4b: Wage employment participation by month (%)

The disaggregation of our analysis by the type of livelihood activities of sample rural households reveals important socio-demographic and economic difference between households who participated in OFAs and those who specialize only in farming. As shown in Table 2, the socio-demographic and economic characteristics of the two groups significantly differ. In terms of land and livestock holding, households who participated in OFAs owned less cultivation area, harvested less agricultural value, and owned less livestock value than households who did not participate in OFAs. This is in line with the argument that OFA income is a residual employer for rural households with no or fragmented land holding. On the other hand, households who participated in OFAs had better information and media access, they adopted more farm technologies, and they lived closer to the market centres than the non-participating households. The disaggregation of shock exposure by participation status also disclosed that households who participated in OFAs experienced more natural, social and market shocks than the non-participating households. This is not unexpected as OFAs are believed to serve as a social safety net in the absence of a rural insurance market.

Table 2: Comparison of the characteristics of OFA participants and Non-OFA participants

Variables	Participants (mean/percent)	Non-participants (mean/percent)	Difference (mean/percent)	Two-way t-test (t-value)
Demographic characteristic				
Household size	4.98	4.77	0.21***	6.9922
Mean age of the household	25.6	29.1	-3.5***	20.6326
Male-headed households, %	72.4	69.2	3.2***	4.9915
Age of the household head	43.7	45.8	-2.1***	9.759
Household head is illiterate, %	59.5	65.6	-6.0***	8.9064
Married household head, %	76.5	76.5	0.0	0.0156
Mean number of children aged <5 years	0.74	0.63	0.11***	10.2074
Mean highest years of schooling in the HH	4.8	4.4	0.4***	7.4487
Age of the mother	36.7	40.7	-4.0***	20.0967
Household wealth				
Land holding, Ha	1.6	1.8	-0.2***	8.0572
Mean value of livestock owned, ETB	35,639.1	49,601.1	-13962.0	0.9409
Mean value of agricultural harvest, 1000 ETB	43.70	57.50	-13.8	0.9233
Household commercialization index	0.123	0.133	0.010***	3.8318
Household has poor well-being relative to villagers, % of households	36.4	35.1	1.3*	1.9893
No. of agricultural technologies adopted	3.5	3.1	0.5***	17.0583
Media and information access				
Percent of households following price information	26.8	18.7	8.1***	13.9407
Percent of households participating in community meetings & trainings	48.8	36.3	12.5***	18.2187
Percent of households having media access	28.3	19.5	8.8***	14.9485
Distance in minutes to the market centre	76.7	80.1	-3.4***	3.7717
Infrastructural development in the area				
Altitude of living area, meter	2093.6	2072.5	21.0	1.9358
Area is desert or semi-desert, %	24.9	28.0	3.1***	4.7368
Bank in the *woreda* town, %	13.8	15.2	-1.4**	2.8344
Producers' association in the *woreda*, %	23.7	17.9	5.8***	10.0718
Development agent in the area, %	96.1	96.2	-0.1	0.2176
Access to electricity, %	37.5	30.6	6.9***	10.108
Access to piped water, %	47.9	47.0	0.9	1.2631
Has mobile network in the area, %	71.5	67.4	4.1***	6.0942
Experience of shocks				
Percent of households who experienced a natural shock such as drought and flooding	41.0	33.3	7.7***	11.4252
Percent of households who experienced a market shock (inflated input price/deflated output price)	18.0	13.7	4.3***	8.429
Percent of households in which the spouse is sick/dead	17.6	16.1	1.5**	2.9006
Percent of households who experienced family disputes	3.0	1.8	1.2***	5.6749
Percent of households who experienced crop damage	74.1	66.1	8.0***	12.099

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.00$

3 Model Specification and Estimation Strategy

In order to motivate our empirical strategy, we model intra-household labour allocation following Huffman and Lange (1989). According to them, rural households allocate their time endowment among non-income earning activities (leisure and home production (Ll)), farm work (Lf), non-farm own business (Ln), and rural wage employment (Lo)). Assuming homogeneity between male, female and children labour time, this can be mathematically expressed as:

$$L = L_j^l + L_j^f + L_j^n + L_j^o; \qquad j = m,\ w,\ c \tag{1.1}$$

The returns from farming (yfi), non-farm own business (yn) and rural wage employment (yo) can be expressed by the following production functions:

$$y_i{}^f = Y^f(L_j^f, X_i{}^f, \lambda_i, \eta_i, \delta) \tag{1.2}$$

$$\begin{aligned} y^n &= F^n(L_j^n, \psi) \\ y^o &= L_j^o(W_j, \omega) \end{aligned} \tag{1.3}$$

where Lfj (j = m, w, c) is family labour allotted for farming, Xf is a vector of non-family labour inputs used for farming, including hired labour, λi denotes household-specifics factors that affect farm output, ηi is a vector of exogenous shocks (such as rainfall variability, price shocks, flooding and crop damage by other factors) that affect income from farming, and δ is a discount factor, Ljn and Ljo (for j = m, w, c) respectively denote labour allotted to non-farm own business and off-farm wage employment, Wj is the market wage rate for household member j, ψ denotes all other observable and unobservable factors affecting the return from non-farm own business and ω denotes all other observable and unobservable factors affecting wage income from off-farm employment.

The farm household is assumed to maximize the composite household utility from the consumption of goods and leisure of the household members subject to income and time constraints of the household. The income constraint comprises from farm income, off-farm own business profit and wage employment. The composite household utility function can be stated as:

$$U = U(L_m^l, L_w^l, L_c^l, Y; \phi) \tag{1.4}$$

where Ljl (j = m, w, c) are the leisure of the husband, wife and adult children, Y is family consumption and φ denotes other household-specific observable and unobservable factors affecting household utility.

The household maximizes utility (equation 1.4) subject to the following income and time constraint:

$$\begin{aligned} &L = L_j^l + L_j^f + L_j^n + L_j^o; \qquad j = m,\ w,\ c \\ &p_{y^f} y^f + p_{y^f} y^n + L_j^o(W_j)W_j + V = p_y Y + p_x X \end{aligned} \tag{1.5}$$

The first-order condition of the associated Lagrangian function of the aforementioned maximization function yields the structural function of the determinants of non-farm own business participation and off-farm wage employment. In this paper, we do not make a clear conceptual distinction between rural non-farm and off-farm activities; rather, we define rural non-farm activities as rural own business and rural wage employment. Accordingly, we categorized our sample of households into three groups, namely those who specialized in faming activities, those who specialized in OFAs and those who participate in both farming and OFAs. Thus, households' choice to participate in one of these three sets of choices can be estimated using a multinomial logit fixed effects model (Pforr, 2014)[2].

Following Pforr (2014), we define y*itk as the latent propensity for household i at time t to choose outcome k, where k denotes the choice sets, namely farming only, OFAs only or both farming and OFAs. The latent propensity can be given by:

$$\forall k \in (1, 2, ..., K) : y^*_{itk} = \alpha_{ik} + x_{itk}\beta_k + \varepsilon_{itk} \tag{1.6}$$

where αik is a time-invariant and household-specific unobservable random variable (unobserved heterogeneity), X is a vector of observed covariates affecting the household's choice, βk is a vector of population parameters to be estimated and εitk is a type I (Gumbel-type) extreme-value random variable, independently and identically distributed across all outcomes k.

The probability that household i chooses outcome k ∈ (1, 2, …, K) at time t is given by:

$$\Pr(y_{it} = z_k \mid \alpha_i, \beta, x_{it}) = \begin{cases} \dfrac{\exp(\alpha_{ik} + x_{itk}\beta_k)}{1 + \sum_{z \neq g} \exp(\alpha_{ik} + x_{itk}\beta_k)}, k \neq g \\ \dfrac{1}{1 + \sum_{z \neq g} \exp(\alpha_{ik} + x_{itk}\beta_k)}, k = g \end{cases} \tag{1.7}$$

Where k = z is the arbitrarily-chosen base outcome.

[2] Indeed, we also considered five choice sets: only farming, only off-farm employment, only non-farm own business, only off-farm employment or non-farm business, and participating in all activities (i.e. off-farm employment, non-farm business and farming). However, the sample size for some of the choices is small (as small as 58 observations in a survey), which may result in inconsistent estimates. Nevertheless, we present the regression results from the five choice sets in the appendix.

Chamberlain (1980) stated that if observed covariates are exogenous conditional on the unobserved heterogeneity and the error terms are independent across time, the term

$$\theta_{ij} = \sum_{t=1}^{T_i} \delta_{y_{it} z_k} \tag{1.8}$$

where δ denotes the Kronecker delta function with respect to yit and zk is the sufficient statistic for the unobserved heterogeneity αik. The sufficient statistics for the unobserved heterogeneity allow reformulating the likelihood function to eliminate the unobserved heterogeneity. The overall log likelihood function for the sample after αik is removed is then given by:[3]

$$\ln L(\beta / y, x) = \sum_{i=1}^{N} \ln l_i(\beta / y_i, x_i), \tag{1.9}$$

where li is the contribution to the log likelihood of individual i.

To check for the robustness of the results, we also estimated a pooled multinomial logit model augmented by the time-average values of time-varying explanatory variables to partially control for the unobserved heterogeneity by assuming that $\mathrm{D}(\alpha_{\mathrm{i}} \mid \mathrm{X_i}) = \mathrm{D}(\alpha_{\mathrm{i}} \mid \overline{\mathrm{h_i}})$, where $\overline{\mathrm{h_i}} \in \{X_i\}$ is the time average of the time-varying explanatory variables (Wooldridge, 2010). Indeed, the pooled model has an advantage over the fixed effects multinomial logit model since the latter drops time-invariant covariates including community development and market access variables that do not change over time.

Since the number of households who specialize in OFAs is very small, we also categorized our sample of households into two, namely those who engage in OFAs and those who do not engage in OFAs at all. In this case, we employed a fixed effects logit (Chamberlain, 1980) and the Mundlak-Chamberlin fixed effects models, where the dependent variable is a dummy variable (y1) indicating whether a household i participated in OFAs at time t or not. We also use the Mundlak-Chamberlin fixed effects logit model (Mundlak, 1978) to estimate the impact of OFA participation on household food shortage and relative deprivation. We measure food shortage by a dummy variable indicating whether the household experienced a food shortage problem in the last 12 months preceding the surveys and we use a self-reported binary variable indicating whether the household felt that they are poorer relative to other households in their village to measure relative deprivation. The observed binary outcome variables indicating whether household i experienced a food shortage problem at time t (i.e.

[3] Interested readers for the derivation of the equations may refer to Chamberlain (1980) and Pforr (2014).

y2it = 2) or whether the household feels that they are worse off /poorer relative to other households in their village at time t (i.e. y3it = 3) are defined as:

$$y_{git} = \begin{cases} 1 & \text{if } y^*_{git} \geq 0 \\ 0 & \text{else} \end{cases}, g = 2,3 \quad (1.20)$$

Where y*git (for g = 2, 3) is the latent dependent variable, specified as:

$$y^*_{git} = \alpha_i + X_{it}\beta + \varepsilon_{it} \quad (1.21)$$

where X is a vector of wage, net income/return from rural own business or a dummy indicating whether the household h participates in non-farm own business or rural wage employment at time t and exogenous variables, αi is the household-level unobserved heterogeneity and εit is i.i.d. ~N(0, δ2).

The unobserved heterogeneity could be correlated with the covariates in the sense that estimates without controlling for it results in inconsistent results. One way of removing it is to use a fixed effects model, namely the fixed effect logit model (Chamberlain, 1980). The sufficient statistic for αi from equation (1.12) is ∑t y2it. Subsequently, the conditional – conditional on ∑t y2it – log likelihood function of the sample after αi is eliminated depends only upon β and δ, and is given by:

$$L = -N(T-1)\ln\delta - \frac{1}{2\delta^2}\sum_t \left[\left(\mathrm{y}_{2\mathrm{it}} - \overline{y_{2i}}\right) - \left(x_{it} - \overline{x_i}\right)\right]^2 \quad (1.22)$$

which is estimated using the maximum likelihood estimation that will give consistent estimators provided that the usual regularity conditions are satisfied.

In order to overcome the main limitation of the fixed effects model – that time-invariant covariates including most of household and plot characteristics are dropped – we also consider the Mundlak-Chamberlin approach in the sense that we explicitly model the relationship between time-varying covariates and the unobserved effects in an auxiliary regression. Specifically, αi can be approximate by a linear function given by:

$$\alpha_{\mathrm{i}} = W_{ht}\theta + \varepsilon_{ht} \quad (1.23)$$

Where W denotes time-varying observed covariates and θ is a vector of parameters to be estimated. Subsequently, the averaging overtime for each household i is $\alpha_{\mathrm{i}} = \overline{W_h}\theta$. Clearly, θ = 0 if time-varying observed covariates and the unobserved heterogeneity are unrelated in the sense that we can use a random effects logit/probit model. Otherwise, we substitute $\overline{W_h}\theta$ for αi into the model and we estimate a random effects logit model.

Another important modelling issue is the potential reverse causality between food security and participation in off-farm activities. On the one hand, poor households who have immediate cash constraints may choose to participate in wage employment to overcome their immediate food shortage problem; given that food insecurity increases the probability of participating in wage employment. Moreover, households need capital to establish their own non-farm business, and the financial sector performs poorly in rural areas. As a result, rural households primarily depend on their own capital and their relatives' loan to open non-farm business. Indeed, empirical studies show that wealthier households are more likely to own non-farm businesses in rural Ethiopia compared with relatively poor households (Weldegebriel et al., 2015), implying that food security affects non-farm participation. On the other hand, off-farm income generates income and eases the cash constraint problem to buy modern inputs for farming in that it affects food security. Thus, there is a potential for the reverse causality problem. In order to overcome this reverse causality problem, we use land size that households own as a proxy for food security, since land size is the main source of wealth in rural Ethiopia (Tsighe, 1995). We believe that controlling for land size (off-farm participation does not affect it, since land is either inherited or provided by the government) overcomes the problem of reverse causality. An instrumental approach could be ideal to deal with such reverse causality, although it is very difficult to find a good IV that create an exogenous link between off-farm participation and food security.

In order to investigate the effects of participation in OFAs on dietary diversity scores (DDSs) of households, we use a Poisson model as DDSs is a count variable as specified below:

$$DD_{ht} = exp(\beta_1 PD_{ht} + \beta_2 y_{ht} + \beta X_{ht}\gamma + \theta S + \bar{y}_h\lambda + \varepsilon_{ht}) \quad (1.25)$$

Where DDht is the dietary diversity score of household, h, at time, t. The household dietary diversity score (HDDS) is measured using the FAO standard measure of dietary score comprising ten groups, namely (1) cereals, (2) roots and tubers, (3) pulses, legumes, and nuts, (4) vegetables, (5) fruit, (6) meat, poultry, and offal, (7) egg, (8) dairy products, (9) sweets and sugar, and (10) condiments[4]. yht denotes wage and profit from rural own business or a dummy indicating whether the household h participates in non-farm own business or rural wage employment at time t. X is a vector of exogenous variables affecting DDS, PD is the production diversity of the household, and $\bar{y}$ is the overtime mean of time-varying covariates used to control for time-invariant unobserved effects following Mundlak (1978). S is a seasonal shift dummy variable used to control for the differences in data collection season: while the 2017 survey data were collected at a time when households had a relatively high stock of crops (in February and March, when most farmers in Ethiopia had recently finished trashing

[4] The standard measure of household dietary diversity includes two additional food groups, namely fish and sea food and oil and fat, which were not included in our data.

and collecting crops), the 2011 and 2013 survey data were collected in July and August, when the stock of crops is low and when proportionally larger number of households experienced a food shortage problem (Getahun and Fetene, 2018). The parameters β1, β2, β3, θ and the vectors γ and λ are population parameters to be estimated. The last term is an error term assumed to have a zero mean and constant variance. The error (disturbance) term includes various errors attributed to the measurement errors, model misspecification, simultaneity bias and exclusion of relevant variables

In order to minimize the estimation bias associated with the exclusion of relevant variables, we augmented the economic model with socio-demographic variables such as household size, education, sex and marital status of the household head, relative and absolute income levels of the household, media and price information access, participation in trainings and meetings and village-specific factors such as the infrastructure level of development. In the selection of the augmenting exogenous explanatory variables, we are guided by the pioneer empirical literature such as Bellon et al. (2016), Hirvonen and Hoddinott (2017), Islam et al. (2018), and Sibhatu et al. (2015).

4 Estimation Results and Discussion

In this section, we present the estimation results regarding the determinants of OFAs and their effects on food shortage, relative deprivation and dietary diversity.

4.1 Determinants of Participation in Off-Farm Activities

Table 3 presents the estimation results from the fixed effects logit model, the Mundlak-Chamberlin pseudo fixed effects logit model, the fixed effects multinomial logit model and pooled multinomial logit model augmented by the time average of time-varying covariates. In the first two models, the dependent variable is a binary outcome variable that indicates whether the household participated in OFAs, while in the latter two models the dependent variable is a multinomial categorical variable with triple outcomes indicating whether the household engaged only in farming, only in OFAs or in both farming and OFAs. As shown at the bottom of Table 3, the Wald test statistic has a large chi value in all four models. This suggests that the regressors are jointly statistically significant in all four models. The LR test confirms the same. An estimation result from a fixed effects multinomial logit model and pooled multinomial logit where the dependent variables have a five-choice outcome is also reported in Annex A. The five choice sets indicate whether the household engage only in farming, only in wage employment, only in non-farm own business, only in OFAs (wage or own business) and in all three activities (wage employment, non-farm own business and farming).

The estimation result from the fixed effects multinomial logit model and pooled multinomial logit model yields a qualitatively similar result regarding the major factors that determine household participation in OFAs, thus supporting the robustness of our findings. The estimation results suggest that the gender composition of households, age of the head, education, natural shocks, participation in community meetings, exposure to media, access to credit, farm land, agricultural markets and rural infrastructure such as electricity are the key determinants of smallholders' rural non-farm participation. Thus, improving smallholder farmers´ access to media, credit, agricultural markets and rural infrastructure is essential for rural households to participate in rural self- and wage employment activities. The estimation results also suggest that smallholders' participation in rural wage employment aggravates relative deprivation, while participation in rural self-employment reduces relative deprivation and food shortage. Our result is more or less similar to the findings in other strands of literature, such as Ali and Peerlings (2012).

Specifically, the estimation result from the more harmonious Mundlak-Chamberlin fixed effect logit model indicates that younger but larger households, single households, those headed by literate and more-educated persons, male-headed households, households with better media access and those who participate in community meetings, households with better access to credit and improved access to infrastructure such as electricity and mobile

network, households who experienced natural shocks and crop damage are more likely to participate in OFAs than their counterparts. On the other hand, households who hold a larger land size and those who live in semi-desert areas are less likely to participate in OFAs than their counterpart, ceteris paribus.

The results from Mundlak-Chamberlain pooled multinomial logit model suggest a qualitatively similar result. The results suggest that as the size of the household increases by one member, the odds of participating only in OFA activities relative to participating in only farming activities increases by 2.4%. Similarly, as the household size increases by one, the odds of participating in both farming and OFA activities relative to participating in only farming activities increases by 2.3%, ceteris paribus. By contrast, an increase in the mean age of household members, illiteracy of the head of the household and being a married couple reduces the odds of participating in both farming and OFAs versus the odds ratio of participating in only farming activities, ceteris paribus. The results further reveal that media and credit access increases the odds ratio of participating in only OFAs and in both farming and OFAs versus participating only in farming activities. Experiencing natural shocks and crop damage increases the odds of participating in only OFAs versus the odds of participating in only farming. This result is similar to the findings of Abay et al. (2017).

Table 3. Non-farm own business and off-farm employment participation decisions

	Fixed effects logit model	Mundlak-Chamberlin pseudo fixed effects logit	Multinomial logit fixed effects[5] (Baseline outcome: only farming)		Pseudo Mundlak (pooled) multinomial logit model[6] (Baseline outcome: only farming)	
Explanatory variables	OFA participation	OFA participation	Only OFA participation	Farming & OFA participation	Only OFA participation	Farming & OFA participation
Household characteristics						
Household size	0.0187***	0.0198***	0.0234***	0.0223***	0.0152*	0.0183***
	(6.60)	(7.76)	(3.47)	(8.11)	(2.11)	(7.59)
Mean age of the household	-0.0113***	-0.00978***	-0.00422	-0.0113***	-0.00141	-0.00991***
	(-4.11)	(-4.28)	(-0.68)	(-4.38)	(-0.31)	(-4.64)
Male-headed household	0.00199	0.202**	-1.663***	0.353***	-1.672***	0.526***
	(0.02)	(3.07)	(-9.32)	(4.46)	(-13.30)	(7.83)
Mature (age >34 years) head	-0.0409	-0.0481	-0.176	-0.0174	-0.258*	-0.0189
	(-0.67)	(-0.96)	(-1.19)	(-0.31)	(-2.43)	(-0.40)
Illiterate household head	-0.146*	-0.110*	-0.457**	-0.106	-0.235*	-0.0891*
	(-2.36)	(-2.49)	(-2.74)	(-1.80)	(-2.36)	(-2.20)
Married household head	-0.209*	-0.407***	-0.742***	-0.173*	-0.521***	-0.368***
	(-2.28)	(-5.87)	(-4.39)	(-2.15)	(-4.77)	(-5.00)

[5] 2,684 groups (7,295 obs.) were dropped due to all positive or all negative outcomes.

[6] We call it the 'pseudo Mundlak-Chamberlin pooled multinomial model' since we included the time-mean values of the time-varying covariates to partly control for the unobserved heterogeneity (Wooldridge, 2010).

Highest years of schooling in the household	0.00613 (0.56)	0.0194** (2.83)	0.0286 (1.22)	0.00531 (0.52)	0.0738*** (5.20)	0.00936 (1.59)
Years of schooling of the mother	0.0680 (0.81)	-0.0151 (-0.28)			-0.0293 (-0.28)	-0.0128*** (-6.00)
Age of the mother	-0.0116* (-2.56)	-0.0152*** (-6.65)	-0.0204* (-2.27)	-0.00881* (-2.20)	-0.0212*** (-4.71)	0.0495 (1.15)
Household has a child aged < 5 yrs	0.119 (1.88)	0.0659 (1.30)	0.110 (0.76)	0.0735 (1.26)	0.0885 (0.83)	-0.0426** (-3.17)
Cultivated land, fertility of soil and desertedness						
Cultivated land area, ha	0.0175 (1.00)	-0.0400** (-2.79)	-0.0344 (-1.00)	0.00895 (0.54)	-0.0555 (-1.38)	-0.00113* (-2.46)
Fertility of cultivated land, %	-0.000476 (-0.80)	-0.000967* (-2.09)	-0.000161 (-0.11)	-0.000813 (-1.38)	0.000461 (0.47)	0.0287 (0.69)
Sufficient rain for farming	-0.0597 (-1.10)	0.00539 (0.11)	-0.228 (-1.93)	-0.0733 (-1.45)	-0.0959 (-1.03)	0.452*** (11.69)
Lives in desert or semi-desert area		-0.159** (-3.24)			-0.163 (-1.67)	0.219*** (5.39)
Media and market access, & active participation in meetings and trainings						
Participated in community meetings	0.404*** (8.10)	0.455*** (11.42)	0.226 (1.84)	0.400*** (8.71)	0.176 (1.86)	0.000110 (0.38)
Has media access	0.200*** (3.59)	0.253*** (5.41)	0.232 (1.70)	0.217*** (4.07)	0.434*** (4.18)	0.119** (2.62)
Distance in minutes to the market centre	0.000467 (0.90)	0.000112 (0.37)	0.00242* (2.26)	0.000352 (0.75)	-0.000260 (-0.34)	0.138** (3.22)
Had no credit problem	0.222*** (3.72)	0.146** (2.90)	0.0175 (0.14)	0.243*** (4.40)	0.168 (1.41)	0.307*** (7.42)
Infrastructure and development of the community						
Availability of development agent		-0.0814 (-0.87)			-0.632*** (-3.49)	0.501*** (10.86)
Availability of electricity at least every other day		0.274*** (6.15)			0.240** (2.83)	-0.0159 (-0.35)
Availability of pipe water		0.0213 (0.47)			0.106 (1.27)	-0.141** (-3.23)
Accessibility of mobile network coverage		0.128** (2.80)			0.192* (2.00)	0.0143 (0.16)
Shocks experienced						
Experienced natural shocks such as drought	0.205*** (3.96)	0.160*** (3.95)	0.193 (1.68)	0.216*** (4.57)	0.153 (1.60)	0.250*** (6.36)

Experienced crop damage by snow, pests, weeds	0.474*** (9.29)	0.334*** (7.84)	0.390** (3.27)	0.390*** (8.03)	0.165 (1.82)	0.00640 (0.16)
Year 2017 dummy	0.629*** (12.60)	0.580*** (12.19)	0.646*** (5.36)	0.612*** (12.35)	0.694*** (6.20)	0.104** (2.72)
Controls for time-invariant unobserved heterogeneity						
Mean family size		-0.0258*** (-4.65)			-0.0121 (-0.97)	-0.0245*** (-4.88)
Mean of value of agricultural produce		-5.06e-08 (-0.46)			-7.79e-08 (-0.04)	-4.25e-08 (-0.93)
Mean family labour size		-0.000393 (-1.49)			-0.00358*** (-4.12)	-0.000069 (-0.29)
Mean revenue		-0.00000863* (-2.03)			-0.000021* (-2.07)	-0.0000064 (-1.87)
Constant		-0.164 (-0.96)			-0.383 (-1.09)	-0.622*** (-3.82)
lnsig2u		-0.748***				
_cons		(-5.91)				
Sigma_u		.6878343				
Rho		.125729				
LR test of rho=0: chibar2(01)		102.64				
Log pseudo likelihood	-3380.7702	-9747.2825	-4266.7847		-11588.894	
Wald chi2 test	chi2(20) = 576	chi2(29) = 1017.56	*chi2(38)=* 944.33		chi2(58) = 2091.05	
Pseudo R2			0.1240		0.0764	
N	10220	15614	12796		15614	

Note: t statistics in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

4.2 Effect of Participation in Off-Farm Activities

As indicated before, in order to investigate the effect of household off farm participation on food shortage, relative deprivation and household diet diversity, we use two measures of OFA participation. The first measure is a dummy variable indicating whether the household has participated in OFAs, and the second measure is the wage and the net income that the household generated from participating in wage and non-farm own business, respectively. Other strands of studies also use the share of OFA income to measure the effect of OFAs. However, such studies do not help to compare the elasticities of wage employment, own farm employment and non-farm own business. However, our approach will help to compare and contrast the relative importance of rural wage employment, non-farm own business income and farm income on household food shortage, diet diversity and relative deprivation.

4.2.1 Effect on Food Shortage and Relative Deprivation

The estimated effect of OFAs on food shortage and psychosocial/self-evaluated relative deprivation using the more harmonious Mundlak-Chamberlin fixed effects logit model is

reported in Table 4 below. The first two columns of Table 4 report whether households who participate in OFAs are more likely to have experienced food shortage problems during the last 12 months preceding the survey month and whether they feel that they are poorer relative to other households in their village, respectively. The last two columns present the relative effects of farm income, non-farm income and wage employment on the likelihood that households experience food shortage and felt poorer than other households in their village, respectively. The estimation result of the four models reported in Table 4 fits well, as evidenced by the larger chi-square of the Wald joint test statistics, while the log likelihood test result also indicates that the regressors are jointly significant.

The estimation results suggest that smallholders' participation in rural wage employment aggravates relative deprivation, while participation in rural self-employment reduces relative deprivation and the likelihood of experiencing food shortage problems. Other strands of studies also find that participation in non-farm own business generates income that reduces food shortage (Babatunde and Qaim, 2010; Ellis, 2000; Pfeiffer et al., 2009).

On the other hand, the results reveal that participation in wage employment does not have a statistically significant effect on the probability of experiencing a food shortage problem, although it has a positive and statistically significant effect on the relative (perceived) poorness of the household. The reason that participation in off-farm employment does not have a statistically significant effect on food insecurity could be because the wage rate is usually low in rural areas (Woldehanna, 2002), as most of them were working in unskilled non-farm activities, on other households' farms and work-for-food activities. Moreover, the largest percentage of wage employment is performed in the months from June to August (see Figure 4), when the food price usually peaks in Ethiopia, given that the wage that they earned from wage employment may not be sufficient to buy enough food. On the other hand, the result that wage employment participation increase the likelihood of feeling poor relative to villagers is consistent with the Ethiopian context. In rural Ethiopia, it is usually the poor who supply labour to work in unskilled non-farm activities of other persons, farm activities of other households and food-for-work. Working on other households' farms and food-for-work may have a distaste of feeling relatively poor. Moreover, the largest percentage of participants in wage employment worked off-farm during the peak crop production season, given that the participation may reduce their income from farming by a magnitude higher than the wage income that they earned from employment. The results further reveal that income from farming is less important for the participants in wage employment compared with the non-participants.

Regarding the remaining covariates, the results reveal that most of the covariates have the expected sign. For instance, the probability of experiencing a food shortage problem and relative deprivation decreases with agricultural income. Food insecurity decreases with years of schooling of the mother and literacy of the head of the household head, since education

increases managerial skill and return from labour (Babatunde and Qaim, 2010; Canagarajah et al., 2001; Woldehanna, 2002). The results also show that crop diversity reduces the likelihood of households suffering from a food shortage since diversity may have a net positive effect due to the high variability and unreliability of rain in Ethiopia (Di Falco and Chavas, 2009). The size of land holding and the quality of the land reduces the probability of food shortage as larger land holding and better quality land increase agricultural produce. The results further reveal that – as expected – while media access, credit access, active participation in community meetings, the on-time arrival of rain and location-development indicators (availability of pipe water and electricity in the community) reduce the probability of a food shortage and exposure to natural shocks (such as drought and flooding), and sickness/death of the spouse increases the likelihood of smallholder farmers suffering from food shortage problems.

Table 4. Mundlak-Chamberlin Fixed Effects logit model

Explanatory variables	OFA Participation dummy (1)		Monetary Earning Measures(ETB)(2)	
	food shortage	relative deprivation	Food shortage	relative deprivation
Participation in non-farm own business	-0.162*	-0.138*		
	(-2.67)	(-2.36)		
Interaction: own business & agricultural income	0.0000004*	0.0000006**		
	(2.33)	(3.42)		
Participation in wage employment	0.0102	0.230***	-0.00223	0.220***
	(0.24)	(5.50)	(-0.05)	(5.30)
Interaction: wage employment & agricultural income	0.000000102*	0.000000108*	0.0000001**	0.0000001**
	(2.60)	(2.27)	(2.85)	(2.74)
Profit from non-farm own business			-0.000009	-0.00002*
			(-1.64)	(-2.45)
(Log) agricultural income, ETB	-0.269***	-0.680***	-0.263***	-0.674***
	(-13.82)	(-27.86)	(-13.57)	(-27.69)
Household size	0.00477	-0.00189	0.00481	-0.00151
	(0.44)	(-0.16)	(0.45)	(-0.13)
Illiterate household head	-0.0164	0.0958*	-0.0162	0.0939*
	(-0.41)	(2.28)	(-0.41)	(2.24)
Years of schooling of the mother	-0.160**	-0.273***	-0.162***	-0.273***
	(-3.32)	(-5.28)	(-3.37)	(-5.28)
Production diversity	-0.0539***	-0.0482***	-0.0547***	-0.0490***
	(-6.65)	(-5.58)	(-6.74)	(-5.66)
Cultivated land area, ha	-0.0431*	-0.0981***	-0.0422**	-0.0971***
	(-3.00)	(-5.98)	(-2.94)	(-5.93)
Soil quality dummy (percentage)	-0.00219***	-0.00256***	-0.00219***	-0.00256***
	(-4.78)	(-5.42)	(-4.78)	(-5.42)
Participants in community meetings	-0.00620	-0.248***	-0.0107	-0.252***
	(-0.16)	(-6.19)	(-0.27)	(-6.31)

Has media access	-0.159**	-0.407***	-0.162***	-0.407***
	(-3.36)	(-8.29)	(-3.42)	(-8.30)
Has no credit problem	-0.217***	-0.105*	-0.221***	-0.108*
	(-4.16)	(-2.11)	(-4.23)	(-2.15)
Distance in minutes to the town	0.00155***	0.00108**	-0.00153***	0.00108***
	(-5.14)	(3.47)	(-5.10)	(3.46)
Rain arrived on time	-0.139*	-0.194***	-0.139**	-0.194***
	(-2.98)	(-4.09)	(-2.98)	(-4.09)
Has electricity access at least every other day	-0.219***	-0.0638	-0.219***	-0.0623
	(-5.24)	(-1.41)	(-5.23)	(-1.38)
Has piped water	-0.267***	-0.196***	-0.267***	-0.195***
	(-6.86)	(-4.71)	(-6.85)	(-4.68)
Experienced natural shock such as drought & flooding	0.489***	0.243***	0.484***	0.241***
	(11.60)	(5.85)	(11.50)	(5.80)
Spouse sick/dead	0.270***	0.334***	0.265***	0.330***
	(5.06)	(6.36)	(4.97)	(6.29)
Crop was damaged by pets, weeds, etc.	0.0751+	0.141**	0.0746	0.141***
	(1.82)	(3.36)	(1.81)	(3.36)
The cultivated land area was irrigated	-0.240*	0.0876	-0.240**	0.0868
	(-3.18)	(1.20)	(-3.18)	(1.19)
Year 2017 dummy	-1.681***	0.151**	-1.680***	0.150**
	(-34.95)	(3.30)	(-34.92)	(3.28)
Unobserved heterogeneity controls				
Time-average family labour size, days	-0.00106**	-0.00234***	-0.00104***	-0.00234***
	(-3.73)	(-6.71)	(-3.66)	(-6.69)
Time-average value of agricultural produce	7.53e-09	5.00e-08	6.34e-09	4.91e-08
	(0.26)	(1.12)	(0.22)	(1.09)
Time-average family size	0.0153*	-0.0401***	0.0154**	-0.0401***
	(3.16)	(-6.87)	(3.17)	(-6.87)
Constant	2.004***	2.616***	1.981***	2.597***
	(19.91)	(24.65)	(19.75)	(24.50)
lnsig2u	-2.009***	-0.734***	-2.005***	-0.731***
_cons	(-5.15)	(-5.79)	(-5.17)	(-5.77)
Log pseudo likelihood	-9111.8103	-9893.1465	-9113.7828	-9892.7299
Wald chi2(26)	2034.53	2234.86	2031.74	2220.39
N	15228	17503	15228	17503

Note: t statistics in parentheses. + p<0.10, * p<0.05, ** p<0.001, *** p<0.0001

4.2.2 Effect on Household Dietary Diversity

We use the GMM IV Poisson model and the Mundlak-Chamberlin fixed effects Poisson model to estimate the effect of OFAs on the household food dietary diversity score. For the present case, the use of Poison regression instead of the linear regression approach is profitable, because a linear regression estimate may not provide the best fit over the values of the HDDS

determinants since dietary diversity score (number of food groups) is a count variable (Wooldridge 2009). However, since the Poison regression model is intrinsically heteroskedastic, a robust estimate of VCE for Poison MLE is used in the study to retain the consistency of the parametric leisure demand estimates. The estimation results are reported in Tables 5 and 6. The overall chi-square statistic has a p-value less than 0.05 in all models. This suggests that the regressors are jointly statistically significant in all of the Poison regression models reported in Tables 5 and 6. The results reported in Table 5 are based on the OFA participation dummy, while the estimation result in Table 6 is based on the net income from non-farm own business and net earnings from rural wage employment. The estimation result indicates that participation in rural non-farm activities increases the diet diversity of smallholder farmers. As shown in Table 6, the amount of profit that the household obtained from own non-farm business positively and statistically significantly increases the diet diversity scores of households (in both the GMM Poisson model and Chamberlain-Mundlack fixed effects Poisson model). Hence, well-designed policy interventions that aim to enhance smallholder farmers' rural wage and non-farm own business participation could help to enhance diet diversity.

Table 5. Effects of participation in OFAs on HDD

	GMM Poisson Model	Mundlak Fixed Poisson Model
Explanatory variables	HDDS	HDDS
Participation in non-farm own business	0.152*	0.591*
	(3.21)	(2.60)
Interaction: own business & agricultural income	-0.00977*	-0.0383
	(-2.01)	(-1.59)
Participation in off-farm employment	0.123*	0.389*
	wage(2.96)	(2.10)
Interaction: Wage employment & agricultural income	-0.0108*	-0.0323
	(-2.48)	(-1.60)
Production diversity	0.0644*	0.297+
	(2.35)	(1.73)
Agricultural income, ln	0.0379*	0.196*
	(3.19)	(2.99)
Distance in minutes to the market	-0.0003***	-0.00094*
	(-5.28)	(-2.99)
Lives in desert or semi-desert area	0.0229*	0.112+
	(2.00)	(1.70)
Years of schooling of a daughter	0.00251*	0.0143*
	(2.45)	(2.64)
Years of schooling of the mother	0.0575***	0.221***
	(7.21)	(4.79)
Age of the mother	-0.000407	-0.00251
	(-1.26)	(-1.49)
Household size	0.00119	0.00377
	(0.69)	(0.41)
Illiterate household head	-0.0279***	-0.154***
	(-4.13)	(-4.39)
Male household head	-0.0209*	-0.0310
	(-2.13)	(-0.62)
Married household head	-0.0109	-0.0664
	(-0.98)	(-1.20)
Household is poor	-0.0484***	

	(-5.92)	
Household has poor well-being	-0.0578***	
	(-8.12)	
Has media access	0.0391*	0.144+
	(2.75)	(1.96)
Follows price information	0.0489*	0.229*
	(3.23)	(2.87)
Participants in community meetings	0.0324**	0.214***
	(3.40)	(4.46)
Year 2017 dummy	-0.0592***	-0.282***
	(-8.02)	(-7.15)
Male child		
Age in months of the child		
Child was breastfed in the last 24 hours preceding the survey		
Mean (overtime) size of the household		0.0000326**
		(3.40)
Mean of labour days the household hired in		0.000199
		(1.42)
Mean size of the family labour days		-0.000587
		(-1.48)
Constant	1.280***	3.334***
	(22.09)	(10.36)
N	10174	10174

Note: t statistics in parentheses. + p<0.10, * p<0.05, ** p<0.001, *** p<0.0001

Other covariates have the expected effect on dietary diversity. Ceteris paribus, production diversity (as measured by food groups produced) increases the HDDS since households in rural areas mainly produce for self-consumption, given that households who produce more varieties also consume more varieties of food. Other covariates affecting the HDDS include income from farming, distance to the town, years of schooling of the mother and literacy of the head of the household head, media access and shock variables, all of which have the expected sign. Our finding is comparable with those of other studies, such as Bellon et al. (2016) and Sibhatu et al. (2015).

Table 6. Effects of profit from own non-farm business and wage employment participation on nutrition

	GMM IV Poisson Model	Mundlak Fixed Poisson Model
Explanatory variables	HDDS	HDDS
Profit from non-farm own business	0.0000006***	0.0000024*
	(4.02)	(3.26)
Participation in wage employment	0.143**	0.469*
	(3.51)	(2.54)
Interaction: Wage employment & agricultural income	-0.0122*	-0.0384+
Production diversity	0.0567*	0.284
	(2.05)	(1.63)
Agricultural income, ln	0.0383*	0.195*
	(3.19)	(2.90)
Distance in minutes to the market	-0.000283***	-0.000979*
	(-5.36)	(-3.16)
Lives in desert or semi-desert area	0.0187	0.100
	(1.63)	(1.50)
Years of schooling of a daughter	0.00261*	0.0146*
	(2.57)	(2.71)
Years of schooling of the mother	0.0591***	0.231***
	(7.42)	(5.03)
Age of the mother	-0.000447	-0.00266
	(-1.39)	(-1.59)
Household size	0.00187	0.00624
	(1.09)	(0.67)
Illiterate household head	-0.0291***	-0.157***
	(-4.32)	(-4.53)
Male household head	-0.0228*	-0.0396
	(-2.34)	(-0.80)
Married household head	-0.0126	-0.0740
	(-1.15)	(-1.35)
Household is poor	-0.0463***	
	(-5.70)	
Household has poor well-being	-0.0585***	
	(-8.23)	
Has media access	0.0398*	0.147*
	(2.81)	(2.01)
Follows price information	0.0516**	0.242*
	(3.41)	(3.04)
Participants in community meetings	0.0375***	0.227***
	(3.90)	(4.61)
Year 2017 dummy	-0.0600***	-0.289***
	(-8.20)	(-7.46)
Male child		
Age in months of the child		
Child was breastfed in the last 24 hours preceding the survey		
Mean (overtime) size of the household		0.0000334**
		(3.47)
Mean of labour days the household hired in		0.000191
		(1.37)
Mean size of the family labour days		-0.000591
		(-1.50)
Constant	1.311***	3.407***
	(22.54)	(10.43)
N	10174	10174

Note: t statistics in parentheses. + p<0.10, * p<0.05, ** p<0.001, *** p<0.0001

5 Conclusion

Rural non-farm activities – which include rural self- and wage employment – are the second most important means of reducing rural poverty and food shortage in sub-Saharan Africa. While the effect of participating in rural non-farm activities on rural food shortage, diet diversity and poverty for households with little or no cultivation land is obvious, its effect for households with farm lands has remained inconclusive in the literature due to the contradicting income and substitution effect of allocating labour between farming and OFAs. On the one hand, participation in OFAs generates cash income, which also helps to increase farm income by easing the cash constraint problem to buy modern agricultural inputs. On the other hand, in order to cover the immediate food expenses, cash-constrained farmers may reallocate the farm labour to OFAs even though the labour return from farming could be greater than that from OFA participation, given that participation reduces the farm and overall income of the household. Hence, the effect of participating in OFAs is theoretically ambiguous and empirically under-researched.

This study aims to identify the key internal and external factors that influence smallholder households' participation in OFAs vis-a-vis specializing in farming and evaluates the effect of RNFI on food shortage, relative deprivation and smallholder household diet diversity, as well as the relative effect of participating in rural wage employment and non-farm self-employment compared with farming. The study also assesses the pattern, type and dynamics of the smallholder farmers' livelihood activities.

Accordingly, the study uses three-wave panel data that was collected in August 2011, August 2013 and in March 2017 from 7,110 smallholder farmers located in four major regions of Ethiopia. Almost all of our sample households engaged in farm activities over the three survey periods. The second and third most dominant livelihood activities among our sample households are wage (off-farm) employment and non-farm self-employment. Our data indicates that our sample households have recently (during the 2013 to 2017 period) started to diversify their livelihood activities. The number of households who were engaged in all three livelihood activities was increased by three percentage points from 2013 to 2017. Similarly, the percentage of sample households who participated in OFAs – which includes both non-farm self-employment and rural wage employment – has also recently increased from 26% in 2013 to 43% in 2017.

Most of the households were engaged in micro businesses such as making and selling local beverages and food, grain and livestock trading, handicrafts, weaving, retail trades, milling and transportation services by a pack of animals. Indeed, the activities that households worked on in wage employment were also similar. Among households who participated in rural non-farm own business, around 22% of them were engaged in food and beverage making and selling activities in 2011, whereas the figure declined to 18% and 19% in 2013 and 2017,

respectively. The analysis of our data also indicates that rural self- and wage employment is a source of off-season employment and a residual employer for rural households with no or fragmented land holding

The study suggests that a lack of access to credit is the main reason for the limited OFA participation. Only less than 1% of the households received loans from formal banks to start their own business. About one-fifth of them also received starting capital from microfinance institutes, which charge high interest rates in group collateral. Thus, providing start-up capital with minimal collateral requirements and low interest rates could help to enhance OFAs.

The disaggregation of our analysis by the type of livelihood activities of sample rural households reveals important socio-demographic and economic differences between households who participated in OFAs and those who specialize only in farming. In terms of land and livestock holding, households who participated in OFAs owned less cultivation area, harvested less agricultural values, and owned less livestock value than households who did not participate in OFA. This is in line with the argument that OFA income is a residual employer for rural households with no or fragmented land holding. On the other hand, households who participated in OFAs had better information and media access, they adopted more farm technologies, and they lived closer to the market centres than the non-participating households. The disaggregation of shock exposure by participation status also disclosed that households who participated in OFAs experienced more natural, social and market shocks than the non-participated households. This is not unexpected as OFAs are believed to serve as a social safety net in the absence of a rural insurance market.

The econometric estimation result from the fixed effects multinomial logit model and pooled multinomial logit model yields a qualitatively similar result regarding the major factors that determine household participation in OFAs, thus supporting the robustness of our findings. The estimation results suggest that the gender composition of households, age of the head, education, natural shocks, participation in community meetings, exposure to media, access to credit, farm land, agricultural markets and rural infrastructure such as electricity are the key determinants of smallholders' rural non-farm participation. Thus, improving smallholder farmers´ access to media, credit, agricultural markets and rural infrastructure are essential for rural households to participate in rural self- and wage employment activities. The estimation results also suggest that smallholders' participation in rural wage employment aggravates relative deprivation, while participation in rural self-employment reduces relative deprivation and food shortages. Our result is more or less similar to the findings of other strands of literature, such as Ali and Peerlings (2012).

In order to investigate the effect of household OFA participation on food shortage, relative deprivation and household diet diversity, we use two measures of OFA participation. The first measure is a dummy variable indicating whether the household participated in OFAs and the second measure is the wage and the net income that the household generated from

participating in wage and non-farm own business, respectively. The estimation result suggests that smallholders' participation in rural wage employment aggravates relative deprivation, while participation in rural self-employment reduces relative deprivation and food shortages. On the other hand, our estimation result indicates that participation in rural non-farm activities increases the diet diversity of smallholder farmers. Hence, well-designed policy interventions that aim to enhance smallholder farmers' rural wage and non-farm own business participation could help to enhance diet diversity and reduce food shortages and relative deprivation.

References

Abay, K.A., Berhane, G., Taffesse, A.S., Abay, K., and Koru, B. (2017). Estimating Input Complementarities with Unobserved Heterogeneity: Evidence from Ethiopia. J. Agric. Econ.

Abdulai, A., and Delgado, C.L. (1999). Determinants of Nonfarm Earnings of Farm-Based Husbands and Wives in Northern Ghana. Am. J. Agric. Econ. 81, 117–130.

Anang, B. T., & Yeboah, R. W. (2019). Determinants of off-farm income among smallholder rice farmers in Northern Ghana: Application of a double-hurdle model. Advances in Agriculture, 2019.

Abdulai, A., & CroleRees, A. (2001). Determinants of income diversification amongst rural households in Southern Mali. Food policy, 26(4), 437-452.

Ahearn, M. C., El-Osta, H., & Dewbre, J. (2006). The impact of coupled and decoupled government subsidies on off-farm labor participation of US farm operators. American journal of agricultural economics, 88(2), 393-408.

Ali, M., and Peerlings, J. (2012). Farm households and nonfarm activities in Ethiopia: does clustering influence entry and exit? Agric. Econ. 43, 253–266.

Babatunde, R.O., and Qaim, M. (2010). Impact of off-farm income on food security and nutrition in Nigeria. Food Policy 35, 303–311.

Barrett, C.B., Reardon, T., and Webb, P. (2001). Nonfarm income diversification and household livelihood strategies in rural Africa: concepts, dynamics, and policy implications. Food Policy 315–331.

Bellon, M.R., Ntandou-Bouzitou, G.D., and Caracciolo, F. (2016). On-Farm Diversity and Market Participation Are Positively Associated with Dietary Diversity of Rural Mothers in Southern Benin, West Africa. PLOS ONE 11, e0162535.

Bezu, S., Barrett, C.B., and Holden, S.T. (2012). Does the Nonfarm Economy Offer Pathways for Upward Mobility? Evidence from a Panel Data Study in Ethiopia. World Dev. 40, 1634–1646.

Canagarajah, S., Newman, C., and Bhattamishra, R. (2001). Non-farm income, gender, and inequality: evidence from rural Ghana and Uganda. Food Policy 26, 405–420.

Chamberlain, G. (1980). Analysis of Covariance with Qualitative Data. Rev. Econ. Stud. 47, 225.

Corsi, A., and Salvioni, C. (2012). Off- and on-farm labour participation in Italian farm households. Appl. Econ. 44, 2517–2526.

Davis, B., Winters, P., Reardon, T., and Stamoulis, K. (2009). Rural nonfarm employment and farming: household-level linkages. Agric. Econ. 40, 119–123.

Davis, B., Di Giuseppe, S., and Zezza, A. (2017). Are African households (not) leaving agriculture? Patterns of households' income sources in rural Sub-Saharan Africa. Food Policy 67, 153–174.

Degefa, T. (2005). Rural Livelihoods, Poverty and Food Insecurity in Ethiopia: A Case Study at Erenssa and Garbi Communities in Oromiya Zone, Amhara National Regional State. PhD thesis, Norwegian Science and Technology University (NUTU).

Di Falco, S., and Chavas, J.-P. (2009). On Crop Biodiversity, Risk Exposure, and Food Security in the Highlands of Ethiopia. Am. J. Agric. Econ. 91, 599–611.

Ellis, F. (2000). The determinants of rural livelihood diversification in developing countries. J. Agric. Econ. 51, 289–302.

FAO (2018). State of Food Security and Nutrition in the World 2018. Rome: UN Food and Agriculture Organization.

Getahun, T.D., and Fetene, G.M. (2018). Agricultural Extension Service and Technology Adoption for Food and Nutrition Security: Evidence from Ethiopia (Forum for Agricultural Research in Africa (FARA)).

Gibson, J., & Olivia, S. (2010). The effect of infrastructure access and quality on non-farm enterprises in rural Indonesia. World Development, 38(5), 717-726.

Haggblade, S., Hazell, P., & Reardon, T. (2010). The rural non-farm economy: Prospects for growth and poverty reduction. World development, 38(10), 1429-1441.

Hirvonen, K., and Hoddinott, J. (2017). Agricultural production and children's diets: evidence from rural Ethiopia. Agric. Econ. 48, 469–480.

Huang, J., Wu, Y., and Rozelle, S. (2009). Moving off the farm and intensifying agricultural production in Shandong: a case study of rural labor market linkages in China. Agric. Econ. 40, 203–218.

Islam, A.H.Md.S., von Braun, J., Thorne-Lyman, A.L., and Ahmed, A.U. (2018). Farm diversification and food and nutrition security in Bangladesh: empirical evidence from nationally representative household panel data. Food Secur. 10, 701–720.

Jones, A.D., Shrinivas, A., and Bezner-Kerr, R. (2014). Farm production diversity is associated with greater household dietary diversity in Malawi: Findings from nationally representative data. Food Policy 46, 1–12.

Kilic, T., Carletto, C., Miluka, J., and Savastano, S. (2009). Rural nonfarm income and its impact on agriculture: evidence from Albania. Agric. Econ. 40, 139–160.

Mundlak, Y. (1978). On the Pooling of Time Series and Cross Section Data. Econometrica 46, 69.

Oseni, G., and Winters, P. (2009). Rural nonfarm activities and agricultural crop production in Nigeria. Agric. Econ. 40, 189–201.

Pfeiffer, L., López-Feldman, A., and Taylor, J.E. (2009). Is off-farm income reforming the farm? Evidence from Mexico. Agric. Econ. 40, 125–138.

Pforr, K. (2014). femlogit—Implementation of the multinomial logit model with fixed effects. 16.

Pinstrup-Andersen, P. (2007). Agricultural research and policy for better health and nutrition in developing countries: a food systems approach: Agricultural research and policy for better health and nutrition in developing countries. Agric. Econ. 37, 187–198.

Rahman, A., & Mishra, S. (2020). Does non-farm income affect food security? Evidence from India. The Journal of Development Studies, 56(6), 1190-1209.

Sibhatu, K.T., Krishna, V.V., and Qaim, M. (2015). Production diversity and dietary diversity in smallholder farm households. Proc. Natl. Acad. Sci. 112, 10657–10662.

Tsighe, Z. (1995). The Political Economy of Land Degradation in Ethiopia. Northeast Afr. Stud. 2, 71–98.

Woldehanna, T. (2002). Rural farm/nonfarm income linkages in northern Ethiopia. Promot. Farmnonfarm Link. Rural Dev. Case Stud. Afr. Lat. Am. Rome FAO 121–144.

Wooldridge, J.M. (2010). Econometric analysis of cross section and panel data (Cambridge, Mass: MIT Press).

Zereyesus, Y.A., Embaye, W.T., Tsiboe, F., and Amanor-Boadu, V. (2017). Implications of Non-Farm Work to Vulnerability to Food Poverty-Recent Evidence From Northern Ghana. World Dev. 91, 113–124.

Appendix

Determinants of Participation in non-farm own business, wage employment and farming

Explanatory variables	Pooled multinomial				Fixed effects multinomial[7]			
	Outcome variables: only farming, only non-farm own business, only wage employment, only non-farm own business or wage employment, all activities				**Outcome variables**: only farming, only non-farm business, only wage employment, Non-farm business or wage employment, all activities			
	Base outcome: only farming							
	Only own non-farmbusiness	Only wage employment	Non-farm business or wage employment	All activities	Only own non-farm business	Only wage employment	Non farm business or employment	All activities
Household size	0.00938	0.0146	0.0246	0.0178***	0.0149	0.0237*	0.0399*	0.0214***
	(0.49)	(1.58)	(1.82)	(6.99)	(0.92)	(2.55)	(2.01)	(7.46)
Mean age of the household	0.00599	-0.00161	-0.00365	-0.00968***	0.00392	-0.00502	0.00764	-0.0093***
	(0.62)	(-0.26)	(-0.33)	(-4.32)	(0.34)	(-0.55)	(0.39)	(-3.27)
Male household head	-2.078***	-1.585***	-1.527***	0.519***	-1.788***	-1.842***	-1.710***	0.354***
	(-7.27)	(-10.13)	(-5.73)	(7.79)	(-3.67)	(-7.43)	(-3.50)	(4.04)
Mature household head, age > 34 years	-0.519*	-0.106	-0.263	-0.0131	-0.680	0.0857	-0.560	0.000838
	(-2.33)	(-0.77)	(-1.00)	(-0.28)	(-1.65)	(0.42)	(-1.65)	(0.01)
Illiterate household head	-0.148	-0.186	-0.506*	-0.0955*	0.267	-0.625**	-0.506	-0.111
	(-0.66)	(-1.56)	(-2.10)	(-2.29)	(0.57)	(-2.71)	(-1.19)	(-1.78)
Married household head	-0.388	-0.493***	-0.679**	-0.370***	-0.161	-0.639*	-1.258**	-0.124
	(-1.79)	(-3.38)	(-2.78)	(-5.07)	(-0.40)	(-2.55)	(-2.58)	(-1.31)
Maximum year of schooling in the household	0.0944***	0.0632***	0.106***	0.00827	0.0453	0.00605	0.107	0.00164
	(3.47)	(3.39)	(3.65)	(1.30)	(0.96)	(0.18)	(1.68)	(0.15)
Years of schooling of the mother	0.0816	-0.155	0.144	-0.0231	-0.194	-0.383	0.112	0.0921
	(0.38)	(-1.21)	(0.61)	(-0.48)	(-0.42)	(-1.19)	(0.23)	(1.08)
Age of the mother	-0.0161	-0.0217***	-0.0304*	-0.0122***	-0.0145	-0.0194	-0.0439	-0.00990*
	(-1.62)	(-3.99)	(-2.46)	(-5.80)	(-0.78)	(-1.51)	(-1.93)	(-2.17)
Has child <5 yrs old	0.296	0.0563	-0.217	0.0531	0.688	-0.0295	-0.0159	0.112

[7] 2915 groups (7160 obs) dropped because of all positive or all negative outcomes in the fixed effects multinomial model

	(1.35)	(0.44)	(-0.94)	(1.21)	(1.81)	(-0.15)	(-0.04)	(1.81)
Cultivated area, ha	-0.246*	0.0316	-0.211*	-0.0442**	-0.165	0.0370	-0.121	-0.0006
	(-2.56)	(0.97)	(-2.03)	(-3.22)	(-1.72)	(0.66)	(-1.01)	(-0.04)
Fertility of the soil	0.00236	-0.000471	0.00120	-0.00119**	0.00062	-0.000263	0.00111	-0.001
	(1.08)	(-0.38)	(0.50)	(-2.62)	(0.08)	(-0.13)	(0.27)	(-1.57)
Enough rain for growing crops	-0.178	-0.0298	-0.326	0.0387	-0.234	-0.107	-0.747*	-0.0490
	(-0.93)	(-0.24)	(-1.62)	(0.91)	(-0.81)	(-0.64)	(-2.39)	(-0.91)
Lives in (semi) desert areas	-0.0162	-0.299*	0.190	-0.150***				
	(-0.08)	(-2.36)	(0.92)	(-3.47)				
Participates in community meeting	0.474*	0.107	0.553**	0.404***	-0.0682	0.397*	0.766*	0.361***
	(2.49)	(0.92)	(2.71)	(10.37)	(-0.25)	(2.38)	(2.01)	(7.34)
Has media access	0.255	0.331**	0.924***	0.212***	-0.00285	0.202	0.712	0.201***
	(1.15)	(2.64)	(4.54)	(4.81)	(-0.01)	(1.13)	(1.79)	(3.58)
Receives development agents' counseling	-0.426*	-0.161	-0.414*	0.118**	-0.527	0.00353	-0.341	0.0947
	(-2.24)	(-1.48)	(-2.14)	(3.05)	(-1.86)	(0.02)	(-1.22)	(1.88)
Household commercialization index	1.039*	0.357	0.927	0.476***	0.156	0.419	1.258	0.477***
	(2.15)	(1.10)	(1.91)	(4.47)	(0.24)	(0.90)	(1.55)	(3.33)
Has no credit problem	0.435*	0.0486	0.143	0.117*	0.499	-0.188	0.539	0.262***
	(2.12)	(0.31)	(0.56)	(2.40)	(1.85)	(-1.00)	(1.51)	(4.47)
Bank exists in the community	0.349	-0.286	0.0497	-0.159**				
	(1.64)	(-1.81)	(0.19)	(-3.08)				
Has electricity access at least every other day	-0.0330	0.336**	0.0681	0.262***				
	(-0.19)	(3.04)	(0.35)	(6.51)				
Has piped water access	-0.0470	0.0848	0.241	-0.0119				
	(-0.27)	(0.80)	(1.25)	(-0.31)				
Has mobile network coverage	0.425*	0.121	0.142	0.0854*				
	(2.08)	(1.01)	(0.66)	(2.09)				
Experienced natural shock in the last 12 months	0.442*	0.138	-0.108	0.125**	-0.0278	0.275	-0.302	0.209***
	(2.54)	(1.26)	(-0.53)	(3.15)	(-0.11)	(1.71)	(-0.97)	(4.18)
Experienced crop damage in the last 12 months	-0.111	0.220	0.407	0.294***	0.392	0.112	0.960**	0.386***

	(-0.61)	(1.83)	(1.82)	(7.00)	(1.45)	(0.64)	(2.97)	(7.42)
Year 2017 dummy	-0.0205	1.046***	0.678**	0.501***	0.205	0.872***	0.951**	0.649***
	(-0.08)	(7.65)	(2.73)	(10.53)	(0.66)	(5.27)	(2.78)	(12.17)
Mean household size	-0.0308	-0.00540	-0.00683	-0.0234***				
	(-0.88)	(-0.37)	(-0.26)	(-4.62)				
Mean hired labor days	3.11e-09	-0.000000154	1.43e-08	-3.91e-08				
	(0.04)	(-0.86)	(0.21)	(-1.14)				
Mean family labor size	-0.00341	-0.00215*	-0.00872***	-0.000109				
	(-1.82)	(-2.34)	(-3.55)	(-0.44)				
Mean household total revenue	-0.0000287	-0.00002918*	-0.00000913	-0.0000102**				
	(-0.78)	(-2.33)	(-0.52)	(-2.78)				
_cons	-2.490***	-1.842***	-2.160**	-0.649***				
	(-4.16)	(-5.39)	(-3.27)	(-4.83)				
Wald chi2(120)	2053.04				Wald chi2(84) = 924.57			
Log pseudolikelihood	-11792.641				*-3790.5571*			
Pseudo R2	0.0784				0.1354			
N	15131				11565			