NONFARM PARTICIPATION AND FOOD CONSUMPTION: EVIDENCE FROM RURAL ETHIOPIA

By

GENEMO, Kedir Bekeru

THESIS

Submitted to

KDI School of Public Policy and Management

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Abstract

Nonfarm Participation and Food Consumption: Evidence from Rural Ethiopia

The effect of rural nonfarm economic participation has become the focus of international concern given the challenge in low production in the agricultural sector and the bulk of the population lives in rural areas of developing countries. This paper seeks to observe the effect of nonfarm participation on food consumption in rural Ethiopia. Data for this study were obtained from the Ethiopian Socioeconomic Survey and World Bank living standard measurement survey for Integrated Surveys of Agriculture collected in 2014 and 2016. The data were collected repeatedly on each household comprising panel data set. We examined the effect of nonfarm economic participation using instrumental variable panel fixed effect model and generalized estimating equation. We find that participation in nonfarm activities has significantly improved food consumption, but it has shown no significant effect in improving food security in rural Ethiopia. This result may be connected with sustaining the development of rural areas.

Keywords: food-security, rural-development, consumption, nonfarm-participation, Ethiopia

Acknowledgment

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List of Acronyms

SSA - Sub-Saharan Africa

CSA- Central Statistical Authority

WB- World Bank

UNCTAD- United Nation Cooperation on Trade and Development

ESS - Ethiopian Socioeconomic Survey

LSMS- Living standard measurement survey

POLS -Pooled Ordinary Least Squares

FE - Fixed Effect Estimates

GEE - Generalized Estimating Equation and

IVFE - Instrumental Variable Fixed effect

Tables

1. Introduction

The large number of rural households engages in a range of nonfarm activity together with the traditional agricultural labor in Sub-Saharan Africa (SSA). Such diversification is prevalent throughout the rural settings (Davis et al., 2017). Approximately 52 percent and 37 percent of households have practiced in SSA and Ethiopia respectively (CSA, & World Bank, 2017; Davis et al., 2017). A likely explanation for this diversification is either to mitigate risk of seasonality in agriculture or better returns (Barrett et al., 2017). On the other hand, poverty reduction strategies in SSA have been linked with improving agricultural sectors.

Recently, there has been a growing interest in nonfarm activities in SSA. The low production in agricultural sectors and bulk of the population lives in rural areas has been initiated to the importance of nonfarm work (Haggblade et al., 2002; UNCTAD, 2016). It is commonly suggested that participation in nonfarm activities and movement into secondary towns are effective in reducing poverty; nonetheless, its effectiveness depends on work availability and country context (Dillon & Barrett, 2017; Haggblade et al., 2002; Lanjouw & Shariff, 2004; Haggblade et al., 2010; UNCTAD, 2016; Dillon & Barrett, 2017). More importantly, the studies by Haggblade, Hazell, & Reardon, (2007) and Haggblade et al. (2010) claim that income from nonfarm participation constitutes a significant portion of rural income and would likely increase and stabilize consumption over a period of time.

While most of the literature has been focused on the nonfarm effect on income and consumption in general, this paper intends to observe whether it affects food consumption and

food security. Previous literature has paid little attention to current economic situation, particularly in Ethiopia. The effect is also heterogeneous from country to country and even within countries (Abafita & Kim, 2014; Bezu et al., 2012). Moreover, much of previous literature has used cross-sectional data which suffers from measurement error, unobserved variable bias, and few studies used panel data during the model estimations. There are also theoretical reasons to believe that, nonfarm participation and food consumption are jointly determined i.e. household sustained their food security involved in nonfarm economy and vice versa (Seidl, 2010; Seng, 2015; Adjognon et al., 2017; Zereyesus et al., 2017). Failures to address such problems during model estimation may instigate wrong policy formulation (Angrist and Pischke, 2008). Therefore, this paper will seek to observe the effect of nonfarm participation on food consumption by accounting for the problem arisen in the literature such as measurement error, unobserved effect and joint determination in the case of Ethiopia. This research could be of interest to policy makers of rural development and other researchers interested in this area.

The aim of this research paper is to see the effect of nonfarm participation on food consumption in rural Ethiopia. The research shows how the substantial increases of engagement in rural nonfarm activity has significantly affected food consumption. In particular, the paper will put emphasis on the causal effect of nonfarm participation. We will argue that the engagement in the nonfarm sector needs encouragement to sustain rural household livelihood and food consumption. Moreover, the research aims to draw much needed attention to the fact that agriculture alone does not guarantee for household food consumption and that the policy makers needs to pay more attention to the importance of rural household engagement in nonfarm activities.

This research makes an effort to answer the following research questions: first, do rural households involved in nonfarm activity were significantly improved food consumption? Then do they have food secured? Finally to what extent does involvement in nonfarm activities affect food consumption? The remainder of the paper is organized as follows: in the first section we summarize the literature review. In the second section we set out data sources and methods. In the third section we explore the results and discussions. In the final section we present conclusion and recommendation. Having provided context for this research paper, we will now proceed to review of literature.

2. Review of Literature

Nonfarm Participation and Food Consumption

Rural households have been engaged in nonfarm sectors in the rural developing countries. Of the greatest concern is whether the income they have earned through these diversifications has significantly improved food consumption or food security. The primary purpose of this review is to ascertain if there is compelling evidence that efforts to demonstrate nonfarm participation have had this result.

Before proceeding further, it is necessary to define clearly the key terminology referred to in this research paper. At the outset, it is important to clarify what we mean when we talk about rural nonfarm sectors. As far as secondary literature and this study is concerned rural nonfarm sectors includes all economic activities except agriculture, livestock and fishing (Lanjouw & Shariff, 2004). Thus, rural nonfarm participants are persons engaged in commerce, manufacturing and service as wage and self-employment in rural areas. But, the definition of

rural is a slippery concept. Its definition has varied from one country to another country. The definition of rural in Asia is often any settlement with 5000 or fewer inhabitants (Lanjouw, 2001). In some countries like Ethiopia, rural areas are defined in terms of a geography. Thus, the definition of rural sector in this paper is influenced by CSA & World Bank (2017), and simply refers to inhabitants outside of towns and cities regardless of number of settlements.

Again, understanding the definition of food security or food consumption is also crucial. In defining food security, it may be useful to refer to a definition adopted in the 1996 World Food Summit. According to Committee on World Food Security (2013), "food security (is) a situation that exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life" (p4). Despite a complex and multidimensional phenomena of food security, it can be measured by key indicator such as dietary diversity indicators; whether household worried about food; and the share of food on total expenditure (Smith, Dupriez, & Troubat, 2014). Again, food consumption is the quantity and value by any person consumed for a subset food items (CSA, & World Bank, 2017). Similarly, food consumption in this paper is defined as the values of any subset of food items consumed by households to annual basis. Having discussed the concept of rural nonfarm sector and food security or consumption, let as now turn to the theoretical background of nonfarm sectors.

In this section I will provide an account of the development of scholarship in the nonfarm sector. Income from nonfarm sector has recently emerged as an important concern in the economic development of rural areas. Conventionally, rural households in developing nations have been observed as though they were totally involved in agriculture. However, there is a

growing evidence that rural households participate in a very diverse source of income, such as wage and self-employment in manufacturing, commerce and services (Reardon, 1997; Start, 2001; Ashley & Maxwell, 2001; Barrett et al., 2001; Kaur et al., 2010). Such diversification is on the rise, and approximately, 52 percent and 34 percent of households have been practiced nonfarm activities in SSA (Sub-Sahara Africa) and Ethiopia respectively (CSA & World Bank, 2017; Davis et al., 2017).

The motivation to undertake nonfarm activity rely on either pull factors such as better return in nonfarm sector relative to farm sector; or push factors such as inadequate farm output resulting from seasonality, climate change, population growth, risk of farming or land constraints (Ashley & Maxwell, 2001; Christopher et al., 2017; Reardon, 1997). The income received by undertaking this activity has an important feature in household economies and therefore also in food security, since it allows greater access to food, smooth food consumption and prevent natural degradation through overexploitation (Reardon, 1997; Lanjouw, 2001). Again, in the face of credit constraints, it affects the performance of agriculture by providing farmer with cash to invest in production enhancing input (Haggblade et al., 2010; Stifel, 2010).

Although incentive to partake is high, whether the households react to this incentive depends on their capacity. The capacity to diversify will increase with household wealth, and the presence of well-developed infrastructure and insurance market (Reardon, 1997). Again, it is argued that low skilled enterprise engaged workers and socioeconomic barriers have often prevented the poor people from accessing the profitable nonfarm activities and so, it may not necessarily entail the improvement income and then food security (Lanjouw & Shariff, 2004). In sum, although the nonfarm sector has promoted important for rural livelihood and food security,

researchers have cast considerable doubt on the role played by socioeconomic background and context. Having discussed the theoretical background of the nonfarm activities, we will turn to the contemporary empirical debates on the effect of nonfarm participation.

Several studies on developing countries tend to focus on the relationship between nonfarm participation and household welfare, with the objective of testing whether nonfarm engagement reduces poverty and improve household welfare (Abafita & Kim, 2014; Adjognon et al., 2017; Bezu et al., 2012; Kowalski et al., 2016; Owusu et al., 2011; Seidu et al., 2016; Zereyesus et al., 2017). However, there has been relatively little empirical work evaluating the effects of nonfarm participation on food consumption or food security.

Studies from developing countries on the relationship between nonfarm participation and household welfare provides an important understanding of this section. A common finding is that rural households participation in nonfarm activities and movements into secondary towns are effective in reducing poverty and improving welfare; nonetheless its effectiveness depends on socioeconomic background and country context (Lanjouw & Shariff, 2004; Haggblade et al., 2010; Stifel, 2010; Christopher et al., 2017; Barrett et al., 2017). Studies by Bezu et al. (2012) and Adjognon et al. (2017) develop models of panel data, and finds that in Malawi and Ethiopia, householders have used income from nonfarm sectors for purchasing fertilizer to produce more products. They noted that, nonfarm engagement has improved consumption expenditure and food security with higher elasticity for wealthier households. Likewise, Abafita & Kim (2014), Seidu et al. (2016), and Zereyesus et al. (2017) show that in Ethiopia, in Albania and in Ghana, having partially addressed some issues related to wrong estimation through cross-sectional instrumental variable method, nonfarm activities have significantly improved food security.

Moreover, Adjognon et al. (2017) show the nonfarm participation effects on agriculture input as one of the links through which nonfarm might improve the welfare of rural households. They noted that nonfarm wage employment and nonfarm self-employments are welfare improving and poverty reducing. According to the study, households at the higher tail of wealth distribution have benefited significantly. In contrast, Kowalski et al. (2016) develop negative binomial regression models for cross-sectional data and find that, in Ethiopia increases in community income through crop sale generate higher demand for goods and services of nonfarm sectors. They have also shown no evidence that household undertaking nonfarm better able to ward off or reduce incidence of food insecurity.

In general, it seems reasonable to hold the view that has promoted the important and positive effect of nonfarm sector. In fact, all of the works discussed so far add greatly to the body of literature in this area and represent some of the most investigation of the effects of nonfarm participation. However, each work, Abafita & Kim (2014), Seidu et al. (2016) and Zereyesus et al. (2017) fail to have a strong instrumental variable as they used cross-sectional data which suffers from measurement error, and unobserved variable bias. Similarly, Adjognon et al. (2017) fail to account for varaibles that may change over time, and vary across individual. Such problems are also repeated in Kowalski et al. (2016). Failures to clearly address such problems during model estimation may instigate biased and inconsistent results (Angrist and Pischke, 2008). While it is difficult to clearly control these problems, this paper will add to the literature by attempting to address these problems using instrumental variable panel fixed effect model, and by estimating the effect for Ethiopian rural households.

The purpose of this study is not to focus on the effect of nonfarm activities on food consumption of all households in Ethiopia. Instead, this paper will only focus on rural areas. The reason author excluded urban areas is that, in urban areas, the issue of significant effect of nonfarm activity is clearly understood, and in its early stage for rural areas. It is clear that, with good infrastructure development the livelihoods of most urban householders have depended on nonfarm activities. But, this may not be true for rural areas of this developing country. Therefore, it seems appropriate to limit this study to rural areas of Ethiopia. For practical considerations this study will use the data between 2014 and 2016. Having discussed all theoretical and empirical literature including scope of the study, let as now turn to the features of data and method of estimation.

3. Data and Methodology

3.1 Data

Ethiopian Socioeconomic Survey (ESS) and World Bank Living standard measurement survey (WB-LSMS) for Integrated Surveys on Agriculture have been used in this study. It is a micro data with longitudinal set up which have been collected on each 3790 householders repeatedly. The survey contains information on agricultural data, inter-institutional collaboration, welfare indicators and socioeconomic characteristics. The main advantage of this data is its ability to make inference is enhanced by temporal ordering of observation on each household. For the purpose of observing the effect of nonfarm participations in the rural areas, each rural household was tracked using unique household identifier 'household-id' from two waves 2014, and 2016. For each survey, special questions on food consumption, food security and

participation in nonfarm activity status were asked of households. The sample of household considered here includes household lives in rural area components of the survey. Sample summary statistics are reported in table 1.

Table 1 Summary of important variable in this study[1]

	(1) Participants average	(2) Nonparticipants average
Food security	0.829	0.826
Annual value of food consumption	17277.0	16068.6
Share of food consumption	59.1	62.4
Annual expenditure on nonfood items	4636.0	3580.9
Annual expenditure on education	254.7	223.5
HH Distance in (KMs) to Nearest Major Road	15.34	16.08
HH Distance in (KMs) to Nearest Market	69.20	67.41
Avg. 12-month total rainfall(mm) for Jan-Dec	951.1	899.1
Household owns house	0.945	0.975
Household access to tap water	0.394	0.330
Household access to electricity	0.283	0.186
Household owns latrine	0.823	0.768
Household members owns cell phone or landline	0.491	0.376
Household members between 15-64 years old	2.776	2.647
Head of household is female	0.215	0.246
Age of head of household	44.43	48.22
Years of education of head of household	2.056	1.608

[1] Notes: the table reports average summary in rural nonfarm participant and rural nonfarm nonparticipants groups. Household female is indicator 1 if head of household is female or 0 if male; latrine, electricity, credit, house, tap water, phone ownership are 1 if household own and 0 otherwise; food security is 1 if household food secured and 0 otherwise; household consumption of food, nonfood, and expense on education are also reported to compare amount of expenditure; we have also reported the average amount of rainfall as it is the main input for rural livelihood; percentage in the final rows indicate participation; the final column shows the difference between the two groups.

	(1) Participants average	(2) Nonparticipants average
Education of most educated household member, years	5.109	4.487
Household size	5.370	5.047
Observations	1594 (29%)	4006 (71%)

Mean coefficients; *t* statistics and standard error in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

The first column is the average of the participants in the nonfarm activities and the second column is the average of nonparticipants. In both cases, observations are restricted to households in rural areas. 29 percent of households, between 2014-2016 samples, in rural areas of Ethiopia reported having participated in nonfarm economic activities[2]. The annual value of food consumption is also higher than expenditure on nonfood and education, difference can also be observed between participants in nonfarm activity and nonparticipants.

Another important variable is food security which is indicator 1 and 0. It measures whether household worried about food security. Based on this assumption both groups are seem indifferent. The share of food consumption is also used as an indicator of food security in this paper. There is also the theoretical argument that the share of total household expenditure spent on food measures household food security because the poorer and more vulnerable a household, the larger the share of household income spent on food (Lele et al., 2016). The difference between the two indicators is that the latter (share of food consumption) is objectively measured (Adjognon et al., 2017; Smith et al., 2014). The Share of food consumption is 2.4 percent higher in non-participants than nonfarm engaged household as it have observed in table 1.

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[2] Our samples includes all households in 2014 and 2016 survey who participated in any nonfarm activities in rural areas of Ethiopia

We considered here consumption instead of income because consumption is not volatile as income, and it is often recommended as a better measure of household wellbeing. While food security and food consumption measure similar issue, improvement in food consumption does not mean that household food secured. We use a variety of variables to control for the differences in households. Variable phone ownership is useful since it is our instrument for farm participation (this variable is described in more detail in the next section).

3.2 Econometric Model and Empirical Strategy

The aim of this study is to observe whether participation in nonfarm activities in rural areas results in improvement in household life. We focus on two outcome: log of the real value of food consumption and food security. A natural starting point would be to estimate a model in which each outcome of household respondent is assumed to depend on participation in nonfarm activities, and a set of household specific controls. This study has identified the effect of nonfarm participation on household food consumption and food security. A panel data set has been used with panel model which allows to control for unobserved omitted variable effect that do not vary overtime and different across households. To observe the effect of nonfarm participation, the following fixed effect model have been used.

$$Y_{it} = \alpha + \gamma Z_{it} + \beta X_{it} + \theta_t + \tau_i + \varepsilon_{it} \qquad (1)$$

Where:

- Y_{it} = log of real food consumption, food security (0/1) status or share of food consumption for individual i, year t;
- Z_{it} = is nonfarm participation= 1 if the household i participate in nonfarm activity and 0, otherwise;
- X_{it} = household characteristics

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- γ =is the coefficient of interest
- ε_{it} = error terms

The vector **X** includes a set of observable exogenous variables that are likely correlated with outcome, such as respondent household size, age of households, etc. As noted above the key problem in interpreting equation (1) by ignoring the panel set up of observation is that participation in nonfarm activities is not randomly assigned and covariates may be correlated with unobservable. In that case estimate of the effect of nonfarm participation may leads to biased estimates. Incentive to partake in nonfarm participation depends on either household capacities or household preferences. Failure to control for these intervening will result in being included in error term.

To the extent that these characteristics are correlated with a nonfarm participation estimate of (γ), the effect of participation in nonfarm activity, will be biased. For instance, if household preferred to participate given they can able to participate, then the effect may be overestimated because household preferences is more likely related to participation in nonfarm activity, and again this participation may positively affect household food consumption. Or, if household not preferred to participate given they cannot able to participate, then the effect may be underestimated because household preferences is less likely related to participation in nonfarm activity, and but participation may positively affect household food consumption. In these cases it will the (unobserved) household preferences or ability that leads no improved/improved in food consumption or food security. One approach to addressing this concern is to include measurements of these variables in the vector **X**. However, these variables cannot be observed and difficult to include in the model. To the extent that household ability,

preference are less likely changed over time and not differ across individuals, then it can be absorbed in household specific fixed effects (τ).

The other problems in the correlation of error term to another variable might be the measurement errors. Households are asked retrospectively how much food they have consumed, whether they worried about food or nonfarm participation, and may be contaminated by recall error. Whether household participate in nonfarm activity could not be affected by recall bias because household can correctly recall participation. But, the amount of food consumption may not correctly recalled by households. Despite such error is common in consumption survey data, much attention has been taken during the survey data collection and data edition according to data sources (CSA, & World Bank, 2017).

Moreover, the reverse causality problem may arise in the estimation. If participation in nonfarm works leads to higher food consumption expenditure and this effect feeds back to higher likelihood of participating in off-farm work. Or, if participation in nonfarm works leads to higher food security and this effect feeds back to higher likelihood of food consumption. This situation has been displayed in an academic area (Zereyesus et al, 2016; Seng, 2015). Such problem is systematic and it is hard to solve using fixed effects, instead instrumentals variable method is used. While finding good instruments is also difficult we follow Zereyesus et al (2016), Thomas Reardon (2006) to use phone mobile ownership as an instrument for nonfarm participation. Mobile phone ownership makes household to smoothen access to the nonfarm employment / activity. But it does not determine the value of household food consumption or household food security status.

For the instrumental variable panel model the following two stage estimation equation has been used.

Reduced form model $\quad Y_{it} = \alpha + \gamma Z^{pr}_{it} + \beta X_{it} + \theta_t + \tau_i + \varepsilon_{it}$ (2)

First stage model $\qquad Z^{pr}_{it} = \alpha + \gamma Po_{it} + \beta X_{it} + \theta_t + \tau_i + \varepsilon_{it}$ (3)

Where Z^{pr}_{it} -predicted nonfarm participation and P_o - phone ownership

Again, the response variable food security is binary variable. This requires a method that accounts for a nonlinear effect of nonfarm participation. We used generalized estimating equation methods with logit link function and selected correlation structure.

$$Y_{it} = G(\alpha + \gamma Z_{it} + \beta X_{it} + \theta_t + \tau_i) + \varepsilon_{it},$$ (4)

G- is the link function

Usually a panel study observes subjects over time and traces household-specific change or growth. However, household-specific correlation and change is less relevant for studying change in food consumption in the population over time; furthermore, the correlations over time are often found to be quite small and assumed negligible. For instance, food consumption in the year 2014 of given households is likely to be similar to the food consumption in the year 2016 and in the other years and so on. To account for such correlation we used household id as cluster id to cluster standard error for fixed effect model and different correlation structure for GEE model. Summarizing the data in this way does not result in much loss of information about food consumption and allows analysis of very efficient output. Having discussed the data features and methods of estimation, now we will turn to the results and discussions.

4. Result and Discussions

Table 2, 3 and 4 present our empirical results. For each of the outcomes, we present a set of estimates following the strategy outlined above. In each table, we report the effect of nonfarm participation. Standard errors below the estimates takes into account correlation within the household, and are robust to arbitrary forms of heteroscedasticity and autocorrelation. For simplicity of interpretation of coefficients we present result based on pooled ordinary least squares (POLS); fixed effect estimates (FE); generalized estimating equation (GEE) and instrumental variable fixed effect (IV-FE) estimates provides practically the same results.

We begin with the log of real food consumption. The first and second column is based on POLS estimate of model (1) without and with controlling others covariate respectively. The model includes household member age, household: sex, age, year of education and highest year of education; ownership: house, tap water, latrine, electricity and average annual rainfall. The POLS estimates without controlling for covariates indicate that relative to non-participant households, respondents who reported engaging in nonfarm activities were about 0.09 percent more likely improve food consumption. Column (2) shows that, when we control for observable characteristics, food consumption is independent of nonfarm participation.

Estimates that include household fixed effects are reported in column (3) and (4). As discussed above, these estimates show the effects of controlling for both observed and unobserved characteristics of households that are fixed over time. These estimates are consistent with those shown in column (1) and (2) in that they suggest that the positive, statistically insignificant effect of nonfarm participation shown in column (2) are an artifact of the disadvantages of households in rural areas. In the final column of the table, the phone ownership

instrumental variable with fixed effect model estimates are reported. The results demonstrate once again positively statistically significant effect of nonfarm participation, which is not surprising given the feedback effect of food consumption and nonfarm participation. Finally, for robustness of instrumental variable used we have reported the F on the final rows of the table 2. It has observed that F-stat is greater than 10, indicating strong instrumental relevance.

Table 2 Effect of nonfarm participation on log of real food consumption

	Dependent variable- log of real food consumption				
	(1)	(2)	(3)	(4)	(5)
	POLS	POLS	FE	FE	IV_FE
nonfarm participation	0.0852^{***} (0.0223)	0.0010 (0.0191)	0.1081^{*} (0.0538)	0.0639 (0.0654)	1.7914^{**} (0.6883)
Household members between 15-64 years old		0.0479^{***} (0.0082)		0.0179 (0.0160)	0.0170 (0.0127)
Head of household is female		-0.1542^{***} (0.0222)		-0.1342 (0.0818)	-0.1593^{**} (0.0502)
Age of head of household, years		-0.0015^{*} (0.0006)		0.0045 (0.0025)	0.0044^{*} (0.0019)
Years of education of head of household		-0.0010 (0.0037)		-0.0074 (0.0098)	-0.0048 (0.0072)
Education of most educated HH member, years		0.0261^{***} (0.0033)		0.0130^{*} (0.0061)	0.0125^{*} (0.0054)
Household Size		0.1087^{***} (0.0050)		0.1023^{***} (0.0152)	0.0964^{***} (0.0110)
Avg 12-month total rainfall(mm) for Jan-Dec		-0.0002^{***} (0.0000)			-0.0005^{**} (0.0001)
household owns		0.0539		-0.0272	0.0637

	(1)	(2)	(3)	(4)	(5)
	POLS	POLS	FE	FE	IV_FE
house		(0.0490)		(0.0869)	(0.0788)
household access to tap water		0.0325 (0.0188)		0.0924[*] (0.0367)	0.0484 (0.0274)
Any household access to electricity		0.2364[***] (0.0221)		0.1018[*] (0.0488)	0.0675 (0.0395)
household owns latrine		-0.0061 (0.0217)		-0.0184 (0.0381)	-0.0482 (0.0255)
_cons	9.4305[***] (0.0119)	8.8658[***] (0.0681)	9.4239[***] (0.0155)	8.6211[***] (0.1609)	8.5537[***] (0.2046)
Year fixed effect	No	No	Yes	Yes	Yes
Household fixed effect	No	No	Yes	Yes	Yes
F_stat					17.223
Observations	5331	5274	5331	5274	5274

Standard errors in parentheses
[*] $p < 0.05$, [**] $p < 0.01$, [***] $p < 0.001$
Notes: this table reports POLS estimation without covariate in column (1); POLS estimation with covariate in column (2); fixed effect without and with covariate in column (3&4); instrumental variable (phone ownership) with fixed effect with covariate included in column (5)

Table 3 focuses on the next step in food security. In each column (1) to (4) we reported the GEE estimate by choosing the different correlation structures. Similar to the FE estimates, these estimates show the effects of controlling for both observed and unobserved characteristics of households that are fixed over time periods. As discussed above, it also takes into account the nonlinearity of nonfarm participation on food security given food security is indicator 1 and 0. In column (1) we assumed observation over time are independents or household food security in 2016 does not depends on whether household food secured in 2014. After controlling for different covariates, the results indicate that relative to non-participant households, respondents who reported engaging in nonfarm activities were about 0.07 percent less likely improve food

security. However, due statistically insignificant effect of nonfarm participation, we have no potential to say that nonfarm participation shown in column (1) is an artifact of the disadvantages of households in rural areas.

In column (2) we assumed observation over time periods are exchangeable or have the same correlation. In this case it is assumed that household food security in 2016 has depend on whether household food secured in 2014. After controlling for different covariates similar to column (1), the results demonstrate that relative to non-participant households, respondents who reported engaging in nonfarm activities were about 0.05 percent less likely improve food security. It is statistically insignificant.

Table 3 Effect of nonfarm participation on food security

	Dependent variable is Food Security			
	(1) GEE_in	(2) GEE_ex	(3) GEE_ar	(4) GEE_un
nonfarm participation	-0.0700	-0.0582	-0.0675	-0.0582
	(0.0857)	(0.0859)	(0.0861)	(0.0859)
Household members between 15-64 years old	0.1201^{**}	0.1230^{**}	0.1160^{**}	0.1230^{**}
	(0.0388)	(0.0384)	(0.0384)	(0.0384)
Head of household is female	-0.6861^{***}	-0.6858^{***}	-0.6967^{***}	-0.6858^{***}
	(0.0939)	(0.0937)	(0.0941)	(0.0937)
Age of head of household, years	-0.0013	-0.0010	-0.0005	-0.0010
	(0.0025)	(0.0025)	(0.0025)	(0.0025)
Years of education of head of household	-0.0060	-0.0028	-0.0038	-0.0028
	(0.0178)	(0.0175)	(0.0177)	(0.0175)
Education of most educated HH member, years	0.0770^{***}	0.0697^{***}	0.0715^{***}	0.0697^{***}
	(0.0153)	(0.0150)	(0.0151)	(0.0150)
Household Size	-0.0729^{**}	-0.0728^{**}	-0.0717^{**}	-0.0728^{**}
	(0.0227)	(0.0225)	(0.0226)	(0.0225)
Avg 12-month total rainfall(mm) for Jan-	0.0000	0.0000	0.0000	0.0000
	(0.0002)	(0.0002)	(0.0002)	(0.0002)

	Dependent variable is Food Security			
	(1)	(2)	(3)	(4)
	GEE_in	GEE_ex	GEE_ar	GEE_un
Dec				
household owns house	-0.0710	-0.1495	-0.1379	-0.1495
	(0.2325)	(0.2322)	(0.2328)	(0.2322)
household access to tap water	-0.1983*	-0.1648*	-0.1617*	-0.1648*
	(0.0788)	(0.0774)	(0.0778)	(0.0774)
Any household access to electricity	0.2752**	0.2103*	0.2037*	0.2103*
	(0.1020)	(0.1004)	(0.1011)	(0.1004)
household owns latrine	-0.1444	-0.1939*	-0.2001*	-0.1939*
	(0.0883)	(0.0894)	(0.0898)	(0.0894)
_cons	1.7418***	1.8484***	1.8339***	1.8484***
	(0.3144)	(0.3160)	(0.3171)	(0.3160)
Observations	5540	5540	5482	5540

Standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$
Notes: this table reports the estimation of generalized estimating equation using different correlation structure nonfarm participation with other covariate were included to the model where dependent variable is food security instead of food consumption. Independent correlation structure is used in column (1); exchange correlation structure in column (2); autoregressive correlation structure in column (3); unstructured correlation structure in column (4). Robust standard error were used in all estimation.

Again, in the columns (3) and (4) we assumed observation over time period are autoregressive structure and unstructured. In column (3) the correlation of household food security over time period assumed to decreases as power of time point apart, and in column (4) correlation of household food security assumed to be different at all-time point. Substantively, similar results observed in the columns (1) and (2) were again observed in the columns (3) and (4).

Table 4 emphasizes on share of food consumption as an indicator of food security. In each column (1) to (4) we reported the GEE estimate by choosing a different correlation structure similar to table 3 above. Although the result is consistent with the different correlation structure, we unable to find a significant effect of nonfarm participation on food security.

Table 4 Results for nonfarm participation on share of food consumption (indicator of food security)[3]

	Dependent variable: share of food consumption			
	(1) GEE_in	(2) GEE_ex	(3) GEE_ar	(4) GEE_un
Nonfarm participation	-1.5502***	-1.5275***	-1.4603***	-1.5275***
	(0.3761)	(0.3702)	(0.3796)	(0.3702)
Household members between 15-64 years old	2.1404***	1.9387***	1.9781***	1.9387***
	(0.1604)	(0.1608)	(0.1654)	(0.1608)
Head of household is female	-1.2803**	-1.4198**	-1.5977***	-1.4198**
	(0.4557)	(0.4543)	(0.4702)	(0.4543)
Age of head of household, years	0.1235***	0.1218***	0.1189***	0.1218***
	(0.0118)	(0.0117)	(0.0121)	(0.0117)
Years of education of head of household	-0.4443***	-0.4834***	-0.4740***	-0.4834***
	(0.0753)	(0.0750)	(0.0780)	(0.0750)
Education of most educated HH member, years	-0.0378	-0.0025	-0.0219	-0.0025
	(0.0616)	(0.0606)	(0.0629)	(0.0606)
Household Size	-1.3103***	-1.2804***	-1.3055***	-1.2804***
	(0.1005)	(0.0991)	(0.1030)	(0.0991)
Avg 12-month total rainfall(mm) for Jan-Dec	-0.0033***	-0.0032***	-0.0035***	-0.0032***
	(0.0007)	(0.0007)	(0.0007)	(0.0007)
Household owns house	1.5742	1.4674	1.4654	1.4674
	(1.0310)	(0.9918)	(1.0215)	(0.9918)
Household access to tap water	0.0341	0.2042	0.3013	0.2042
	(0.3414)	(0.3351)	(0.3451)	(0.3351)

[3] Notes: this table reports the estimation of generalized estimating equation using different correlation structure nonfarm participation with other covariate were included to the model where dependent variable is share of food consumption instead of food security indicator. Independent correlation structure is used in column (1); exchange correlation structure in column (2); autoregressive correlation structure in column (3); unstructured correlation structure in column (4).

	Dependent variable: share of food consumption			
	(1)	(2)	(3)	(4)
	GEE_in	GEE_ex	GEE_ar	GEE_un
Any household access to electricity	-2.0978***	-1.5925***	-1.6373***	-1.5925***
	(0.4309)	(0.4230)	(0.4353)	(0.4230)
Household owns latrine	-0.2240	-0.0795	-0.0701	-0.0795
	(0.3533)	(0.3432)	(0.3543)	(0.3432)
_cons	63.3723***	63.4855***	63.9209***	63.4855***
	(1.4605)	(1.4299)	(1.4816)	(1.4299)
Observations	5274	5274	4972	5274

Standard errors in parentheses
$^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$

In sum, there is evidence that participation in nonfarm activity is associated with significant improvement in food consumption. We also find some suggestive evidence that participation in nonfarm activities has not improved food security (though these estimates were not statistically significant).

5. Conclusion

The purpose of our paper was to observe the effect of participation in rural economic activities on household food consumption and food security in Ethiopia. We explored this issue using Ethiopian Socioeconomic Survey and World Bank living standard measurement survey for Integrated Surveys of Agriculture. We examined possible changes in the participation of nonfarm activities and food consumption or food security using instrumental variable fixed effect model and generalized estimating equation. Our main results are twofold. Firstly, participation in nonfarm activity significantly improve household food consumption. Secondly, we find that nonfarm participation does not significantly improved food security. This result was in line with the result of (Kowalski et al., 2016), but it may connect with disadvantaged household

participated in nonfarm activities as emphasized by (Lanjouw & Shariff, 2004). This result appears to imply that, socioeconomic barriers may have prevented the poor people from accessing the profitable nonfarm activities.

It is worth asking if our findings are specific only to the case of Ethiopia, or if they have wider application. We believe that the context under investigation is typical of the majority of rural households with low production in agricultural sectors and bulk of the population lives in rural, participation in nonfarm economic activity contributions are of crucial importance for households who remain in their rural life. Ethiopia is characterized by low production in agricultural and large number of the population lives in rural areas. Whatever the reason behind the rural nonfarm participation provide some crucial contributions to poor household in rural areas. This country may serves as an example of how nonfarm participation play role in helping individuals to fulfill their basic needs in such contexts.

Our results show that nonfarm participation are an effective mechanism in helping to enhance food consumptions of households. Due to the paucity of household survey in the developing countries context, it would be useful to pursue further research in Ethiopia in order to formulate the most appropriate policies; much remains to be understood about how nonfarm participation relates to women empowerment and to sustain economic growth in rural areas. A challenge here is the lack of long time longitudinal data in Ethiopia, which would allow us to track individuals over time and to study how their living standard evolved several years after participated in nonfarm activities. Also it would be useful to consider the income received from these activities to study improvement overtime. Clearly, more detailed data would be welcome in order to further analyze the effect of nonfarm activity may have on rural household life.

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