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The effect of the productive safety net programme on household food consumption and dietary diversity in Ethiopia

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Abstract

This study empirically investigates the effect of the productive safety net programme (PSNP) on household food consumption and dietary diversity in Ethiopia. The study applied random effects with instrumental variables to estimate the effect of PSNP membership. The results of the study indicate that, although PSNP membership improves household food consumption, it reduces the household dietary diversity score. Household food consumption and dietary diversity are also significantly influenced by sex, age, education status of household head, household size, livestock ownership, distance to the nearest market and participation in non-farm activities. The findings of this study suggest that PSNP membership should be reinforced by building household awareness of the benefits of consuming a variety of foods. In addition, PSNP membership should be designed to endow the households to accumulate essential assets, especially livestock.

Key words: PSNP; household food consumption; household dietary diversity; random effect; instrumental variable

1. Introduction

Farmers in Ethiopia are highly dependent on rain-fed agriculture and are producing in a climate-related shock-prone environment. This situation exposes them to vulnerability to food insecurity and poverty (Hagos *et al*. 2011). Despite significant increases in cereal output at the national level in recent years, Ethiopia continues to experience frequent severe food insecurity crises, which are frequently associated with the occurrence of drought (Lewis 2017). For over three decades, emergency food aid was used as a response to food insecurity in Ethiopia. The emergency food aid saved the lives of vulnerable families, but the programme often failed to protect livelihoods, which became a growing source of concern for the country (ESSP 2014). Significantly, roughly 73% of Ethiopia's smallholders, who are primarily food producers, are net food consumers, putting them at risk from both production- and market-related concerns. This underscores the necessity of social protection schemes that support agriculture (De Janvry & Sadoulet 2011). Nonetheless, because the majority of people are employed in the informal sector, dependence on international aid is substantially higher, and food insecurity is a more contiguous challenge in Ethiopia, where social security coverage is lower (HLPE 2012).

As a result, the Ethiopian government changed its emergency food aid system in 2005 and launched the productive safety net programme (PSNP), a more productive and efficient strategy to providing social support to needy communities. Ethiopia's PSNP is one of Sub-Saharan Africa's major social protection schemes (HLPE 2012). It is aimed at households that are both chronically food insecure and poor, as well as those that are often affected by shocks (Coll-Black *et al*. 2011; ESSP 2014; Ministry of Agriculture 2014). The goal of the programme is to ensure food security for vulnerable households, while also enabling them to overcome their vulnerabilities without weakening their assets

and, over time, assisting them to build their assets. Households in the programme receive payments depending on their participation in public works, or unconditional cash and/or food transfers if labour contribution is limited or unattainable. The PSNP supported more than seven million people in 2015 (Cochrane & Tamiru 2016).

PSNP's fourth phase (2015 to 2020) broadened the programme's goals to include building shock resilience, increasing livelihoods, and improving food security and nutrition for rural households facing food insecurity (Ministry of Agriculture 2014). It aims to benefit around eight million people, making it one of Sub-Saharan Africa's greatest social protection programmes (Berhane *et al*. 2020).

PSNP has been found to be a well-designed social safety net that has resulted in beneficial changes (Dicks 2012), as well as increased household food security (Berhane *et al*. 2015; Gebrehiwot & Castilla 2017). Berhane *et al*. (2015) indicate that PSNP has helped in reducing hunger and modestly in asset formation. Moreover, PSNP has improved child meal frequency (Bahru *et al*. 2020) and has assisted beneficiaries in smoothing their consumption, accumulating assets and contributing to the local community's development (Welteji *et al*. 2017). According to Araya (2020) and Knippenberg and Hoddinott (2017), PSNP has enhanced the usage of organic fertiliser such as manure, and strengthened the resilience of its beneficiaries against adverse shocks. On the other hand, there is no evidence that PSNP improved household food security, child nutrition, child anthropometry, child dietary diversity or household dietary diversity, with this data coming from a limited number of studies (Berhane *et al*. 2017; Gebrehiwot & Castilla 2017; Bahru *et al*. 2020).

The mixed findings in these empirical studies may be attributed to differences in the target population under study, the methodological framework, the period covered and the nature of data used by the studies. Some of these studies considered PSNP participation as exogenously determined, while others assumed that participation was determined based on the prior PSNP food insecurity status of the households and asset-holding criteria. However, the climate conditions in the area where the households live, especially the amount of rainfall and precipitation, largely determine households' participation in PSNP. Thus, this study assumes that participation in PSNP is endogenously determined by the amount of rainfall and precipitation in the areas surrounding the household. Moreover, households change their pattern of food consumption following PSNP membership. They may adjust the amount and/or frequency of meals consumed, as well as the diversity of food items. Thus, it is important to analyse the effect of PSNP on different indicators of household well-being. The main objective of this study was to examine the effect of PSNP on household food consumption (HFC) and dietary diversity, given that PSNP is a reasonably endogenous variable.

This research paper adds to the existing body of knowledge in three ways. The study used the household dietary diversity score (HDDS) as a measure of food security, which is calculated based on twelve food groups consumed by a household during the previous seven days. HDDS is viewed as the best indicator of food security compared to other measures (Swindale & Bilinsky 2006; Kennedy *et al*. 2011), for various reasons. First, HDDS indicates a number of health outcomes, such as child anthropometric status, birth weight, calorie and protein intake, and improved haemoglobin concentrations. Second, HDDS is also used as a proxy measure of a household's socioeconomic status. Third, the data collected through dietary diversity questionnaire can be analysed in several ways.

The study also applied the instrumental variable (IV) approach, which was hardly used by the previous studies, to address the potential endogeneity problem arising in PSNP membership. Economists frequently apply IV and the general method of moments (GMM) to address the problem of endogeneity. If heteroscedasticity is identified, the GMM estimator is more efficient than the IV estimator; however, if the disturbance term is homoscedastic, GMM requires very large sample sizes, and IV would be preferred in this situation (Baum *et al*. 2003). The disturbance term was found to be

homoscedastic by the heteroscedasticity test following IV regression in this study. Furthermore, GMM is more of an econometric trick than a proper endogeneity solution.

Finally, this study employed the three waves of the Ethiopian Socioeconomic Survey (ESS) data, while the previous studies used only the first and second waves to address the problem of the study. Using more waves of panel data increases the number of observation, and hence improves the estimation efficiency (Hsiao & Yanan 2006). As a result, model parameters can be inferred more accurately. Long panel data is also better at capturing the complexities of human behaviour and revealing dynamic relationships.

The rest of the paper is organised in the following manner. The second section gives an overview of the theoretical and empirical literature. Data, model specification and estimation methods are presented in Section 3. Section 4 is devoted to the results and the discussion, and Section 5 provides the conclusion and policy implications.

2. Overview of the literature

Production (what one grows), labour (what one works for), trade (what one buys) and transfers (what one is given) are the four ways to obtain food entitlement (Sen 1981). Social protection measures, such as input subsidies, farm insurance, public works programmes, school feeding, supplementary feeding and unconditional cash or food transfers, can be used to address failure to meet each source of food entitlement (Devereux *et al*. 2008). The Ethiopian PSNP is a social protection programme with two components: public works (temporary employment) for households with labour capacity, and direct assistance (unconditional cash or food transfers) for households with limited labour capacity.

Cash transfers might influence food consumption and food security in various ways (Holmes & Bhuvanendra 2013). First, increasing cash transfers increases income spent on essentials, which directly increases food intake by raising food expenditure and decreasing negative food security behaviours, such as skipping meals. Second, cash transfers provide the beneficiaries the freedom to choose whatever they wish to consume, implying that it can better improve the quality and diversity of the diet when compared to food transfers (Bailey & Hedlund 2012). Third, cash transfers can be used to invest in agricultural inputs and resources, boosting agricultural productivity and food production for domestic consumption. For instance, cash might be spent on improved seeds, fertiliser and pesticides to produce more agricultural outputs, which will enhance consumption or yield additional income. Fourth, cash transfers can stimulate local markets by increasing demand, which can prompt local producers to respond with higher production and supply. This improves food availability, which contributes to an improvement in food consumption and security. When food markets are weak and food prices are high or fluctuating, however, direct food transfers may yield better food security outcomes than monetary transfers (HLPE 2012). Fifth, by sustaining a stable level of household income, cash transfers can possibly play an essential role in smoothing seasonal variations and abrupt shocks. The four pillars of food security – food availability, access, stability and utilisation – cannot be realised without a stable household income. More importantly, monetary transfers may promote food consumption indirectly by increasing household income through investments in livelihoods.

Public works programmes have distinctive advantages (HLPE 2012). They are self-targeting and avoid dependency on gifts because the scheme requires work accomplishment, and often low wages are offered. Well-designed public works projects can create useful physical infrastructure, while simultaneously transferring food or cash to poor people. Agricultural-related public works projects, such as hillside terracing or soil and water conservation, can also improve farm yields and provide long-term benefits for household food security.

Although there is a paucity of theory on social protection programmes, there are several bodies of empirical research that have focused on the effects of social protection responses to chronic poverty-related food insecurity, which is known by various names in different African nations. In Ethiopia, this kind of social protection intervention is known as the productive safety net programme (PSNP), which explicitly targets food-insecure households.

Studies done at the national level show mixed findings, e.g. some studies reveal a positive contribution of PSNP, whereas others show negative contribution of PSNP to household food consumption and security. Knippenberg and Hoddinott (2017) used a Hausman IV estimator and found that receiving PSNP payments reduced the first impact of drought shocks by 57% and eliminated their negative effect on food security. Similarly, according to HLPE (2012), the PSNP has increased household resilience to repeated drought-induced food insecurity; public works programmes have resulted in significant poverty reduction and food security gains. Berhane *et al*. (2017) also found that the PSNP is effective in improving household food security. In contrast, using two-stage least squares, reduced-form IV and generalised propensity score matching with a continuous treatment, Gebrehiwot and Castilla (2017) found that the rise in PSNP transfers between 2012 and 2014 had no influence on household dietary diversity in Ethiopia. Likewise, using inverse probability-weighted regression-adjustment estimators, Berhane *et al*. (2017) found no evidence that the PSNP reduces child undernutrition or child consumption of pulses, oils, fruits, vegetables, dairy products or animal-source proteins.

Cross-sectional studies also reveal mixed findings. Mohamed (2017) used propensity score matching to examine the impact of Ethiopia's PSNP on households' livelihood in Babile District and found that PSNP has a positive and statistically significant influence on food consumption, and then on households' livelihood. Welteji *et al*. (2017) investigated the PSNP's contribution to the food security of rural households in the Bale Zone, finding that the PSNP had improved the food security status of recipient households by maintaining the minimum level and smoothing consumption. Berlie (2014), on the other hand, used multivariate analysis to assess the role of PSNP in promoting household food dietary diversity in Lay Gayint District and discovered that households receiving benefits from the safety net programme appeared to be lacking in food dietary diversity.

3. Materials and methods

3.1 Data and description of variables

This study used data from the Ethiopian Socioeconomic Survey – a panel household survey performed every two years – for the years 2011/2012, 2013/2014 and 2015/2016. The study used a sample of 1 015 households for each of the observed years. Therefore, the data consists of 3 045 observations, which were used in the analysis. The sample covered households from ten regions of Ethiopia: Tigray (9.16%), Afar (4.83%), Amhara (21.38%), Oromia (19.51%), Somali (7.09%), Benishangul Gumuz (4.63%), SNNP (15.07%), Gambella (3.84%), Harari (7%) and Dire Dawa (7.49%). The datasets include information on household socio-economic and demographic characteristics, agricultural practices, livestock ownership, food consumption and expenditure, housing, climate shocks, assistance, agricultural technology adoption, and financial resource use.

The study utilised two dependent variables, which are household food consumption (HFC) and the household dietary diversity score (HDDS).

HFC is the annual value of different food items consumed by a household. This variable's kernel density graph showed that it was highly skewed to the right. A logarithmic transformation is an appropriate means of transforming a highly skewed variable into one that has approximately normal distribution. As a result, HFC was converted into a logarithm.

HDDS is defined as the number of food groups consumed by a household over a specified period of time (INDDEP 2018), and it indicates a household's ability to access food (Kennedy *et al*. 2011). It is calculated based on twelve food groups consumed by the household, where each food group is assigned a score of 1 (if consumed) or 0 (if not consumed). According to INDDEP (2020), these food groups are cereals, roots and tubers, vegetables, fruits, meat (including poultry and offal), eggs, fish and seafood, pulses (including legumes and nuts), milk and milk products, oil/fats, sugar/honey and miscellaneous. The HDDS is equal to the total number of food groups consumed by the household, and it ranges from 0 to 12.

Furthermore, the following explanatory variables are assumed to affect HFC and HDDS, based on previous studies (Olayemi 2012; Ahmed *et al*. 2017; Christian *et al*. 2019; Araya 2020; Kissoly *et al*. 2020):

1. Sex of the household head (HHsex): This is a dummy variable representing whether the household head is male or female. It takes a value of one if the household head is male, and zero if the household head is female.
2. Age of household head (HHage): This is a continuous variable indicating the number of years that the household head has lived since he/she was born.
3. Education level of household head (HHeduc): It is a dummy variable representing whether the household head can read and write in any language, which is equal to one if the household head can do so, and zero otherwise.
4. Size of household (HHsize): It is the number of individuals living in the household. It is an important demographic factor that affects the household's food consumption pattern.
5. Total livestock units the household owns (lvstock): This is the total number of different types of livestock units owned by the household.
6. Non-farm (Nfarm): It is a dummy variable representing whether or not the household participates in non-farm activity. It takes a value of one if the household engages in non-farm activities, and zero if the household does not.
7. Area of land the household holds (Land): This is the total area of land held by the household, measured in square metres. For the purpose of this study, the square root of area of land is used.
8. Drought: This is a dummy variable expressing whether the household was affected negatively by drought shock during the last twelve months in each observed year. It takes a value of one if the household faced the shock, and zero otherwise.
9. Distance to nearest major road (Distroad): It is the distance of the household residence measured in kilometres from the nearest major road.
10. Distance to nearest market (Distmkt): This is the distance of the household residence measured in kilometres from the nearest market.
11. PSNP membership (PSNP): This is a dummy variable expressing whether any member of the household has received assistance from the PSNP in the past twelve months. It takes a value of one if the household received assistance from the PSNP, and zero otherwise.

3.2 Model specification

Household food consumption and dietary diversity are influenced by various interactive factors, which might include demographic, socio-economic, environmental and institutional factors (SPRING 2015; Koppmair *et al*. 2016; Ochieng *et al*. 2017; Mekuria *et al*. 2017; Ayenew *et al*. 2018; Gupta *et al*. 2020). This study used two dependent variables, namely annual household consumption expenditure and the dietary diversity score, to analyse the effect of PSNP on household food consumption and food security. The relationship between each dependent variable and the explanatory variables is assumed to be linear and can be specified as follows:

$$\ln HFC_{it} = \mathbf{X}_{it}\boldsymbol{\beta}'_{it} + \varepsilon_{it} \quad (1)$$

$$HDDS_{it} = \mathbf{X}_{it}\boldsymbol{\beta}'_{it} + \varepsilon_{it}, \quad (2)$$

where X and $\boldsymbol{\beta}$ represent vectors of explanatory variables and parameters, respectively.

PSNP membership is the variable of prime interest for this study. Participation in the PSNP is non-random variable as a result of a government plan to include food-insured households in the programme. As a result, the error term can be correlated with the PSNP membership status variable contained in the above models. In other words, the PSNP membership status is assumed to be endogenous. Thus, there is a need to account for the possibility of PSNP membership becoming endogenous. To do this, this study applies instrumental variables that can determine PSNP membership. Accordingly, we formulate PSNP membership as a function of a vector of exogenous explanatory variables, which explain HFC or HDDS, X_{it}, and a vector of instrumental variables, Z_{it}, in the following form:

$$PSNP_{it} = \beta_0 + \boldsymbol{\beta}_i\mathbf{X}_{it} + \boldsymbol{\gamma}_i\mathbf{Z}_{it} + v_{it} \quad (3)$$

Two variables were used as instruments in this study: rainfall availability and precipitation availability in the area where the household resides. Some studies have used a dummy variable, which indicates whether the household has been exposed to a shortage of rainfall in the previous years before the start of the PSNP as the instrumental variable for PSNP membership (Araya & Holden 2018; Araya 2020). However, this study assumes that areas where PSNP has been operating repeatedly face a shortage of rainfall and precipitation, and therefore the availability of rainfall and precipitation does not show significant variation before and after PSNP intervention.

Moreover, the presupposed instrumental variables are continuously variable, but they are changed into a dummy variable for the purpose of this study. First, based on the rainfall and precipitation data for the years under consideration, we computed the mean of each instrumental variable. Then, we generated the first dummy variable, representing whether the household faces a rainfall shortage or not. This takes a value of one if the household resides in an area that receives less than the mean rainfall, and zero otherwise. We also generated the second dummy variable, representing whether the household faces a precipitation shortage or not. This takes a value of one if the household resides in an area that receives less than the mean precipitation, and zero otherwise. Households residing in an area that receives less than the mean rainfall and less than the mean precipitation are likely to be a member of the PSNP.

3.3 Estimation

The PSNP membership model, which is formulated in Equation (3), takes the form of a panel probit, which exemplifies a non-linear panel data model. In non-linear panel data models, the fixed effects estimators can be severely biased because of the incidental parameter problem (Graham *et al*. 2009). Thus, this study used correlated random effect (CRE) method to estimate the PSNP membership model. A CRE approach allowed us to unify the fixed and random effects-estimation approaches, and it involved adding time averages of all explanatory variables that change across household and time in the regression analysis (Wooldridge 2010). The endogeneity of PSNP membership was tested empirically using the control function approach. First, we predicted the residuals after estimation of panel probit model using CRE. Then, we added the predicted residuals as an additional regressor in the specification of models formulated in equations (1) and (2). These were estimated by random effects. The result of the regression shows that the predicted residual is found to be statistically significant at 1% in both panel data regressions. This confirms that PSNP is an endogenous variable, and therefore applying the IV approach is appropriate.

We thus used random effects with the instrumental variable (REIV) method to estimate the models specified in equations (1) and (2) above. The REIV was chosen based on the Sargan-Hansen test of fixed effects vs. random effects. This test can also be seen as a test of over-identifying restrictions (orthogonality conditions) for a panel data estimation (Schaffer & Stillman 2006). Schaffer and Stillman's test of over-identifying restrictions can be used to conduct a Hausman test of random effects vs. fixed effects after the random effects estimation of the linear IV panel data models (Baum 2007). This is a test of the null hypothesis that the excluded instruments are valid instruments, meaning they are uncorrelated with the error term and properly excluded from the equation in IV estimation. The test statistic is distributed as chi-squared, and a rejection of the null hypothesis casts doubt on the validity of the instruments.

4. Results and discussion

4.1 Summary statistics

The descriptive statistics of the variables are reported in Table 1, with particular emphasis on the mean, minimum, maximum and standard deviation for continuous variables and percentage for categorical variables. Household annual food consumption shows significant variation, with mean and standard deviations of about Birr 18, 720 and 17 018 respectively. Even though HDDS is constructed in such a way that it takes values between 0 and 12, in this study we found that it ranges from 0 to 11, because no household was familiar with the consumption one of the listed food groups, which is fish and seafood. The results of the descriptive statistics show that the average HDDS of food consumption was 4.634. More than 75% of households consumed less than the average number of food groups. Cereals are the food group that all households (100%) consume. About 83% of households are headed by men (husband), and only about 40% pf household heads can read and write in any language. During the years considered by this study, more than 50% of households faced a shortage of rainfall and precipitation, but only about 23% of households were exposed to drought. Only 5.4% of the sample households were members of the PSNP.

Table 1: Descriptive statistics of the key variables

Continuous variables	**Observations**	**Mean**	**Standard deviation**	**Min.**	**Max.**
HFC	2 948	18 719	17 017.58	780	339 929
HDDS	3 045	4.634	1.65	0	11
Total livestock units the household owns	3 045	14.92	17.50	0	284
Total area of land the household holds	2 753	1 012.11	6 682.00	0	304 690
Household residence distance to the nearest major road	3 045	15.92	20.53	0	241
Household residence distance to the nearest market	3 045	60.53	50.74	0.83	283.1
Household head age	3 041	46.53	14.36	17	90
Household size	3 045	5.53	2.20	1	16
Discrete variables				Obs.	%
Percentage of male-headed households				3 043	82.6
Percentage of literate household heads				3 040	39.5
Percentage of households participating in non-farm activities				3 042	31.5
Percentage of households exposed to drought				3 045	22.6
Percentage of households facing shortage of rainfall				3 045	51.7
Percentage of households facing shortage of precipitation				3 045	52.8
Percentage of PSNP member households				3 041	5.4

4.2 Econometric results

Before we looked at the HFC and HDDS regressions, we first examined factors that significantly influence membership in the PSNP using a CRE probit regression. The results of the regression are reported in Table 2 below.

Table 2: CRE estimation result of membership in PSNP [1]

Dependent variable: PSNP membership	
Explanatory variables	**Coefficients**
HHsex	0.834 (0.634)
HHage	0.011 (0.013)
HHeduc	0.131 (0.191)
HHsize	-0.039 (0.052)
Lvestock	-0.001 (0.004)
Nfarm	0.589** (0.298)
Land	0.002 (0.002)
Drought	0.226 (0.144)
Distroad	-0.001 (0.003)
Distmkt	0.001 (0.001)
Dummy for rainfall shortage	0.176* (0.103)
Dummy for precipitation shortage	0.756*** (0.158)
Constant	-2.512 (0.413)
No. of observations	2 745
No. of households	1 005
Wald test p-value	0.000

Note: values in parentheses are robust standard errors. *, ** and *** represent significance at 10%, 5% and 1%, respectively.

Table 2 reveals that household participation in non-farm activity significantly influenced membership in the PSNP. Households that engaged in non-farm enterprises are more likely to be included in the PSNP. This is a likely outcome, because non-farm activities are low-paying activities that often are practised by informal self-employed workers. Therefore, households participating in non-farm activities are one of the most vulnerable groups and have a higher likelihood to be included in social protection programmes such as PSNP. More importantly, this regression is fitted to assess whether the chosen instrumental variables for this study are significant or not. As shown in Table 2, the first instrument (dummy for shortage of rainfall) and the second instrument (dummy for shortage of precipitation) are found to be statistically significant, at 10% and 1% respectively. The regression result shows that households that faced a shortage of rainfall and precipitation were more likely to be included in the PSNP than those that did not, which is consistent with the standard expectation.

The regression result that demonstrates how PSNP membership and other factors affect HFC and HDDS is presented in Table 3. The last two rows in Table 3 show that both the Sargan-Hansen and

[1] We have included the mean of all time-variant variables in the estimation, but they are not reported here to save space.

traditional Hausman tests support the REIV in the estimation of the lnFC model. However, the two tests provide different conclusions on the estimation of HDDS, as the traditional Hausman test affirms the fixed effects with instrumental variable (FEIV), but the Sargan-Hansen test supports REIV. This study chooses to depend on the result of the Sargan-Hansen test, and therefore reports the estimation of HDDS using REIV. Also, the Sargan-Hansen test fails to reject the null hypothesis, which means that the instrument variables are valid.

A closer look at Table 3 indicates that the coefficient of PSNP is statistically significant for both lnHFC and HDDS. The coefficient is positive for lnHFC but negative for HDDS, implying that, although PSNP membership improves households' consumption of food, it reduces the diversity of food items consumed by the households included in the programme. This result is consistent with Berlie's (2014) findings, which demonstrated that users of the safety net programme appeared to suffer from a lack of dietary diversification. This might be due to the motivation of the PSNP to provide social protection services in terms of basic food items, like cereals, while disregarding the importance of vegetables, fruits and other varieties.

The regression output shows that HFC is also significantly affected by various factors, including the sex, age and education status of the household head, household size, livestock ownership and distance of household residence from the nearest market. Likewise, HDDS is significantly influenced by the sex and education status of the household head, household size, livestock ownership and household participation in non-farm activities.

Table 3: Results of REIV estimation of HFC and HDDS

Independent variables	**Dependent variables**	
	lnHFC	**HDDS**
PSNP	3.523*** (0.829)	-4.394*** (1.560)
HHsex	0.260*** (0.076)	-0.329** (0.127)
HHage	-0.007*** (0.002)	0.002 (0.004)
HHeduc	0.127*** (0.045)	0.784*** (0.087)
HHsize	0.127*** (0.012)	0.040** (0.020)
Lvstock	0.006*** (0.001)	0.004** (0.002)
Nfarm	-0.061 (0.053)	0.598*** (0.105)
Land	0.001 (0.001)	0.002 (0.002)
Drought	-0.113 (0.078)	0.057 (0.131)
Distroad	0.001 (0.001)	0.000 (0.002)
Distmkt	-0.002*** (0.000)	-0.001 (0.001)
Constant	8.825*** (0.127)	4.300*** (0.213)
No. of observations	2 656	2 745
No. of households	1 004	1 005
Wald test p-value	0.000	0.000
Sargan-Hansen test p-value	0.275	0.721
Hausman test p-value	0.665	0.041**

Note: values in parentheses are robust standard errors. *, ** and *** represent significance at 10%, 5% and 1% respectively.

As shown in Table 3, male-headed households consume more food than female-headed households, but the female-headed households have a higher dietary diversity score than male-headed households. This implies that female-headed households are more attentive to the benefits of the consumption of a variety of food groups. This result contrasts with the findings of a study done by Misker *et al*. (2016), who found that dietary diversity increased by nearly four times if the household head was male.

Household size, education status of the household head and livestock ownership have positive effects on both HFC and HDDS. The positive effect of household size on HFC seems sensible. The reason is that households with a large family size need more food than those with a small family size, all other factors remaining constant. This result contradicts the finding obtained by Siman *et al*. (2020), who indicated that the number of household members did not affect household food expenditure. On the other hand, the positive effect of household size on HDDS revealed by this study appears unlikely, since a large household size is often associated with poverty, especially in the rural areas of Ethiopia (Muhammedhussen 2015; Demissie 2016). A large household size can reduce the dietary diversity of the foods consumed by households. A similar study done by Olayemi (2012) concluded that a large family size has a negative effect on household food security.

The positive relationship between the education status of the household head and HFC as well as HDDS implies that educated household heads empower their family to consume larger amounts and a greater diversity of food groups. This might be due to the reason that education helps individuals to be conscious about the health benefits associated with the consumption of a balanced diet. This result is consistent with Moreira and Padrão's (2004) finding that the associations between food choices were stronger in relation to educational attainment than income categories, implying that having more knowledge may influence the perceived relationship between diet and health. Likewise, Singh *et al*. (2020) found that educational intervention played the major role in preventing the consumption of junk food among school adolescents in Nepal.

Fundamentally, the positive influence of livestock ownership on both HFC and HDDS seems to provide robust evidence, because household ownership of more livestock units, especially cattle, is associated with the higher production of agricultural outputs and earning a larger income, hence higher food consumption and the consumption of a variety of food items. According to Christian *et al*. (2019), having more livestock may improve household food security by increasing the accessible disposable income that can be used to buy food, hence boosting food access. It may also improve the availability of animal-source meals at home, particularly milk and milk products, as well as eggs.

The age of the household head influences HFC negatively, which implies that households with older heads have lower food consumption expenditure. In contrast, Mao and Xu (2013) found that the shares of food expenditure in the total household consumption tend to rise along with population ageing. The distance of the household residence to the nearest market also influences HFC negatively, which confirms that a longer distance to the nearest market exposes households to large transportation costs, which can limit access to food items.

The coefficient of household participation status in non-farm activities was found to be statistically insignificant in the HFC regression, but it was significant and positive in the HDDS regression, implying that household participation in non-farm activities enabled households to consume a greater variety of essential foods. This finding is also verified by Rahman and Mishra (2018), Pritchard *et al*. (2019) and Kissoly *et al*. (2020), who showed that engagement in non-farm activities leads to greater household dietary diversity.

5. Conclusion and policy implications

Social protection interventions, such as the PSNP, play an important role in improving and sustaining household food consumption and security in Ethiopia. The objective of this study was to analyse the effect of the PSNP on household food consumption and dietary diversity. This study applied the control function approach to test the endogeneity of PSNP membership. It was confirmed that PSNP membership is found to be endogenous and is significantly affected by the household's exposure to rainfall and precipitation shortages, which were assumed to be instrumental variables for the purposes of the study. Therefore, the study used random effects with instrumental variables to estimate the effect of PSNP membership on household food consumption expenditure and dietary diversity. The main finding of the study is that, even though the PSNP influences HFC positively, it affects HDDS negatively. Furthermore, both HFC and HDDS are significantly affected by factors such as the sex and educational status of household head, household size and livestock ownership. Except for the sex of the household head (being male), which had a positive effect on HFC and a negative effect on HDDS, all these factors influenced both of the dependent variables positively. There were also other determinants that had a significant influence on either HFC or HDDS, but not on both. The age of the household head and distance to the nearest market had a negative effect on HFC. On the other hand, HDDS was positively affected by household engagement in non-farm activities.

The results of this study have important policy implications. First, PSNP membership should be complemented by building households' awareness of the benefits associated with the consumption of a variety of food items to improve both household food consumption and food security. Second, the results of the study show that ownership of more livestock, which have more than one purpose, increases both HFC and HDDS. This implies that PSNP should be designed not only to provide urgent social protection services, but also to endow the households to accumulate essential assets, especially livestock. Third, local governments need to prioritise the provision of infrastructure to help households access markets easily, which will mean that the households will be able to purchase cheap food products at the local level. Finally, non-farm employment opportunities in rural areas need be created to accommodate surplus labour from the agriculture sector, both to increase farm income and to generate supplementary income to boost household dietary diversity.

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