RETRACTED: The Effect of Productive Safety Net Programme on Household Food Consumption and Dietary Diversity in Ethiopia

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This study empirically investigates the effect of productive safety net programme (PSNP) on household food consumption and dietary diversity in Ethiopia. The study applied random effects with instrumental variable to estimate the effect of PSNP membership. The study indicates that though PSNP membership improves household food consumption, it reduces 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.

Keywords: household food consumption, household dietary diversity, random effect, instrumental variable, PSNP

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 problems (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 drought occurrences (Lewis, 2017). For over three decades, emergency food aid was used as a response to food insecurity in Ethiopia. The emergency food aid saved lives of vulnerable families. However, the program often failed to protect livelihoods, which became a growing source of concern for Ethiopia (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 (Janvry and Sadoulet, 2011). Nonetheless, because majority of people are employed in informal sector, dependence on international aid is substantially higher, and food insecurity is a more contiguous challenge in Ethiopia, 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 Program (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 who are often affected by shocks (Coll-Black et al., 2011; ESSP, 2014; Ministry of Agriculture (MOA), 2014). The program's goal 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 in building their assets. Households in the program receive payments depending on their participation to public works, or unconditional cash and/or food transfers if labor contribution is limited or unattainable. PSNP supported more than seven million people in 2015 (Cochrane and Tamiru, 2016).

PSNP's fourth phase (2015–2020) broadened the program's goals to include building shock resilience, increasing livelihoods, and improving food security and nutrition for rural households facing food insecurity (Ministry of Agriculture (MOA), 2014). It aims to benefit around 8 million people, making it one of Sub-Saharan Africa's greatest social protection programs (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 in Ethiopia (Berhane et al., 2015; Gebrehiwot and Castilla, 2017). Berhane et al. (2015) indicated that PSNP has helped in reducing hunger and modestly in asset formation. Moreover, PSNP has improved child meal frequency (Bahru et al., 2020) and 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 fertilizer, 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 in a limited number of studies (Berhane et al., 2017; Gebrehiwot and Castilla, 2017; Bahru et al., 2020).

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

This research paper adds to the existing body of knowledge in three ways. The study used household dietary diversity score (HDDS) as a measure of food security, which is calculated based on 12 food groups consumed by a household during the previous seven days prior to the survey. HDDS is viewed as the best indicator of food security as compared to other measures (Swindale and Bilinsky, 2011; Kennedy) for various reasons. First, HDDS indicates a number of health outcomes such as child anthropometric status, birth weight, calorie and protein intake, and improved hemoglobin 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 analyzed in several ways.

The study also applied 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 General Method of Moments (GMM) to address the problem of endogeneity. If heteroscedasticity is identified, the GMM estimator is more efficient than 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 Ethiopian Socio-economic 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 and Yanan, 2006). As a result, model parameters can be inferred more accurately. Long panel data is also better at capturing the complexities of human behavior and revealing dynamic relationships.

The rest of the paper is organized 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 three. Section four is devoted to results and discussion, and section five provides conclusion and policy implications.

OVERVIEW OF LITERATURE

Production (what one grows), labor (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 work programs, 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 program with two components: public works (temporary employment) for households with labor capacity and direct assistance (unconditional cash or food transfers) for households with limited labor capacity.

Cash transfers might influence food consumption and food security in various ways (Holmes and 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 behaviors, 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 diet when it is compared to food transfers (Bailey and 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, fertilizer and pesticides to produce more agricultural outputs which 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 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 utilization– cannot be realized without a stable household income. More importantly, monetary transfers may promote food consumption indirectly by increasing household income through investments in livelihoods.

Public work 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 work projects can create useful physical infrastructure while simultaneously transferring food or cash to poor people. Agricultural-related public work projects, such as hillside terracing or soil and water conservation, can also improve farm yields and provide long-term benefits for household food security.

Though there is a paucity of theory on social protection programs, there are several 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 Productive Safety Net Programme (PSNP), which explicitly targets food-insecure households.

Studies done at the national level show mixed findings, i.e., some studies reveal 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 impact on food security. Similarly, according to HLPE (2012), the PSNP has increased household resilience to repeated drought-induced food insecurity; public work programs 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. Contrarily, using two-stage least squares, reduced form IV, and generalized 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 under nutrition as well as 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 has 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 program appeared to be lacking in food dietary diversity.

MATERIALS AND METHODS
Data and Description of Variables

This study used data from the Ethiopian Socio-economic Survey—a panel household survey performed every 2 years—for the years 2011/12, 2013/14 and 2015/16. 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 data sets 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 utilized two dependent variables, which are Household food consumption (HFC) and Household dietary diversity score (HDDS).

HFC: It is annual value of different food items consumed by a household. This variable's Kernel density graph showed that it 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 is converted into logarithm.

HDDS: It is defined as the number of food groups consumed by a household over a specified time period (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

(2018), 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 household head (HHsex): This is a dummy variable representing whether household head is male or female. It takes a value of one if household head is male and zero if the household head is female.
2. Age of household (HHage): It is a continuous variable indicating age of household head measured in years.
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 a household. It is an important demographic factor that affect household food consumption pattern.
5. Total livestock units the household owns (lvstock): It 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 the household participates in non-farm activity or not. It takes a value of one if the household engages in the non-farm activity and zero if the household does not.
7. Area of land the household holds (Land): It is the total area of land, which is measured in square meters, the household holds. For the purpose of this study, the square root of area of land is used.
8. Drought: It 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 household residence distance measured in KMs from the nearest major road.
10. Distance to nearest market (Distmkt): It is the household residence distance measured in KMs from the nearest market.
11. PSNP membership (PSNP): It is a dummy variable expressing whether any member of the household receives assistance in the past twelve months from PSNP. It takes a value of one if the household received assistance from PSNP, and zero otherwise.

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; Mekuria et al., 2017; Ochieng et al., 2017; Ayenew et al., 2018 and Gupta et al.,

2020). This study used two dependent variables, namely annual household consumption expenditure and dietary diversity score to analyse the effect of PSNP on household food consumption and food security. The relationship between each dependent variable and explanatory variables is assumed to be linear and can be specified as follows:

$$lnHFC_{it} = \mathbf{X}_{it}\beta'_{it} + \varepsilon_{it} \qquad (1)$$
$$HDDS_{it} = \mathbf{X}_{it}\beta'_{it} + \varepsilon_{it} \qquad (2)$$

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

PSNP membership is the variable of prime interest for this study. The PSNP participation is non-random variable as a result of a government plan to include food-insured households in the program. 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:

$$PSNP_{it} = \beta_0 + \beta_i\mathbf{X}_{it} + \gamma_i\mathbf{Z}_{it} + v_{it} \qquad (3)$$

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

Moreover, the presupposed instrumental variables are continuous variable, but they are changed into a dummy variable for 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, which indicates whether the household is located in a region with less or more rainfall than the mean. If the household is located in a region with annual rainfall below the mean, it is given a value of one; otherwise, it is given a value of zero. We also created a second dummy variable to signify whether the household is in a region with less or more precipitation than the average. It has a value of one if the household lives in a region with less precipitation than the average, and zero otherwise.

Estimation

The PSNP membership model which is formulated in equation 3 takes a form of panel probit, which exemplifies non-linear

TABLE 1 | Descriptive statistics of the key variables.

Continuous variables	Obs.	Mean	Std. Dev.	Min.	Max.
HFC (in Birr)	2,948	18,719.59	17,017.58	780	339,929.1
HDDS (in number)	3,045	4.634	1.655	0	11
Total livestock units the household owns (in number)	3,045	14.919	17.496	0	284
Total area of land the household holds (in hectare)	2,753	1,012.109	6,682.002	0	304,690
Household residence distance to the nearest major road (in KMs)	3,045	15.916	20.534	0	241
Household residence distance to the nearest market (in KMs)	3,045	60.534	50.745	0.833	283.1
Household head age (in years)	3,041	46.527	14.364	17	90
Household size (in number)	3,045	5.532	2.203	1	16
Discrete variables				**Obs.**	**%**
Percentage of male-headed households				3,043	82.6
Percentage of literate headed households				3,040	39.5
Percentage of households participating in non-farm				3,042	31.5
Percentage of households exposed to drought				3,045	22.6
Percentage of households faced shortage of rainfall				3,045	51.7
Percentage of households faced shortage of precipitation				3,045	52.8
Percentage of PSNP member households				3,041	5.4

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 uses correlated random effect (CRE) method to estimate the PSNP membership model. A CRE approach allows us to unify the fixed and random effects estimation approaches, and it involves adding time averages of all explanatory variables that change across household and time into 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 which are 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 endogenous variable and, therefore, applying IV approach is appropriate.

Therefore, we used random effects with instrumental variable (REIV) method to estimate models specified in equations 1 and 2 above. The REIV is chosen based on Sargan-Hansen test of fixed effect vs. random effect. This test can also be seen as a test of over-identifying restrictions (orthogonality conditions) for a panel data estimation (Schaffer and Stillman, 2006). Schaffer and Stillman's test of over-identifying restrictions may be used to conduct a Hausman test of random effects vs. fixed effects after random effect estimation of 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. Moreover, we tested the exclusion restriction condition, which is one of requirements for instrument exogeneity, using the J-test for overidentifying restrictions. When there are more instruments (m) than endogenous regressors (k), as in this study's model, the J-test for overidentification restrictions is used. Under null hypothesis, J has chi-square distribution with $(m - k)$ degrees of freedom. If the null hypothesis is not rejected, the hypothesis of instrument exogeneity is accepted, and the exclusion restriction condition is also met.

RESULTS AND DISCUSSION

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 deviation 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 descriptive statistics results show that the average HDDS of food consumption is of 4.634. More than 75% of households consume less than average number of food groups. Cereals are the food group that all households (100%) consume. About 83% of households are headed by male (husband), and only about 40% household heads are can read and write in any language. During the years considered by this study, more than 50% of households faced shortage of rainfall and precipitation, but only about 23% of households were exposed to drought. Only 5.4% of the sample households are member of PSNP.

Econometric Results

Before we go to HFC and HDDS regressions, we first examine factors that significantly influence membership in PSNP using

TABLE 2 | CRE estimation result of membership in PSNP[a].

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

Values in the parentheses are robust standard errors. *, ** and *** represent significance at 10, 5, and 1%, respectively. [a]We have included mean of all time-variant variables in the estimation, but they are not reported here to save space.

TABLE 3 | REIV estimation result of HFC and HDDS.

Independent variables	Dependent variables	
	lnHFC	**HDDS**
PSNP	3.523***	−4.394***
	(0.829)	(1.560)
HHsex	0.260***	−0.329**
	(0.076)	(0.127)
HHage	−0.007***	0.002
	(0.002)	(0.004)
HHeduc	0.127***	0.784***
	(0.045)	(0.087)
HHsize	0.127***	0.040**
	(0.012)	(0.020)
Lvstock	0.006***	0.004**
	(0.001)	(0.002)
Nfarm	−0.061	0.598***
	(0.053)	(0.105)
Land	0.001	0.002
	(0.001)	(0.002)
Drought	−0.113	0.057
	(0.078)	(0.131)
Distroad	0.001	0.000
	(0.001)	(0.002)
Distmkt	−0.002***	−0.001
	(0.000)	(0.001)
Constant	8.825***	4.300***
	(0.127)	(0.213)
No. of observations	2,656	2,745
No. of households	1,004	1,005
Wald test p-value	0.000	0.000
J-test p-value	0.319	0.738
Sargan-Hansen test p-value	0.275	0.721
Hausman test p-value	0.665	0.041**

Values in the parentheses are robust standard errors. *, ** and *** represent significance at 10, 5, and 1%, respectively.

CRE probit regression. The result of the regression is reported in **Table 2** below.

Table 2 reveals that the household participation in non-farm activity significantly influences membership in PSNP. Households who engage 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 which are often practiced by informal self-employed workers. The mean annual income of households engaged in non-farm activities is 4103.5 Birr lower than that of those engaged in farm activities. Therefore, households participating in non-farm activities are one of the most vulnerable groups and have higher likelihood to be included in the social protection programs, like 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 who faced shortage of rainfall and precipitation are more likely to be included in the PSNP than those who were not, which is consistent with the standard expectation.

The regression result that demonstrates how PSNP membership and other factors impact HFC and HDDS is presented in **Table 3**. The last two rows in **Table 3** show that both Sargan-Hansen and traditional Hausman tests support the REIV in the estimation of lnFC model. However, the two tests provide different conclusions in the estimation of HDDS wherein the traditional Hausman test affirms fixed effects with instrumental variable (FEIV), but the Sargan-Hansen test supports REIV. This study chooses to depend on the result of Sargan-Hansen test and, therefore, reported 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. The J-test for overidentifying restrictions also fails to the reject the null hypothesis, confirming that the exclusion restriction condition is satisfied (see **Table 3**).

A closer look at **Table 3** indicates that the coefficient on PSNP is statistically significant for both lnHFC and HDDS. The coefficient is positive for lnHFC, but it is negative for HDDS implying that though PSNP membership improves households' consumption of food, it reduces the diversity of food items consumed by the households included in the program. This result is consistent with Berlie's (2014) findings, which demonstrated that users of the safety net program 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 sex, age and education status of household head, household size, livestock ownership and household residence distance from the nearest market. Likewise, HDDS is significantly influenced by sex and education status of household head, household size, livestock ownership and household participation in non-farm activities.

As presented in **Table 3**, male-headed households consume more amounts of food than female-headed households, but the female-headed households have higher dietary diversity score than that of male-headed households. This implies that female-headed households are more attentive to the benefits of consumption of variety of food groups. This result is contrary to finding of study done by Misker et al. (2016) in which they found that being male sex for the household head increases dietary diversity by nearly four times.

Household size, household head education status and livestock ownership have positive impacts on both HFC and HDDS. The positive effect of household size on HFC seems sensible. The reason is that households with large family size need more amount of food than those with few family sizes, keeping other factors unchanged. This result contradicts the finding obtained by Siman et al. (2020) where it was indicated that the number of household members did not affect the household food expenditure. On the other hand, the positive effect of household size on HDDS revealed by this study appears soundless since large household size is often associated with poverty, especially in rural areas of Ethiopia (Muhammedhussen, 2015; Demissie, 2016), which can deplete the dietary diversity consumption of households. Similar study done by (Olayemi, 2012) concluded that large family size has negative impact on house food security.

The positive relationship between education status of household head and HFC as well as HDDS implies that educated household leaders empower their family to consume larger amount and diversity of food groups. This might be due to the reason that education helps individuals to be conscious about health benefits associated with consumption of balanced diet foods. This result is consistent with Moreira and Padrão (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 the educational intervention had the major role in preventing the consumption of junk food among school Adolescents in Nepal.

Fundamentally, the positive impact of livestock ownership on both HFC and HDDS seems robust evidence because households' ownership of more livestock units, especially cattle, is associated with higher agricultural outputs production and earning of large income and, hence, higher food consumption and variety of food items. According to Christian et al. (2019), having more livestock may improve household food security by increasing 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.

Age of household head influences HFC negatively implying that elder-headed households have lower food consumption expenditure. On the contrary, (Mao and Xu, 2013) found that the shares of food expenditure in the total household consumption tend to rise along with population aging. Household residence distance to the nearest market also influences HFC negatively, which confirms that longer distance to 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 is found to be statistically insignificant in HFC regression, but it is significant and positive in HDDS regression implying that household participation in non-farm activities enables households to consume more variety of food rudiments. This finding is also verified by (Rahman and Mishra, 2018; Pritchard et al., 2019; Kissoly et al., 2020) where they showed that engagement in non-farm activities leads to greater household dietary diversity.

CONCLUSION AND POLICY IMPLICATIONS

Social protection interventions, like PSNP, play an important role to improve and sustain household food consumption and security in Ethiopia. The objective of this study is to analyse the effect of PSNP on household food consumption and dietary diversity. The study applied control function approach to test the endogeneity of PSNP membership. The study confirmed that PSNP membership is found to be endogenous and is significantly affected by household's exposure to rainfall and precipitation shortages which were assumed as instrumental variables in 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 PSNP influences HFC positively, it impacts HDDS negatively. Furthermore, both HFC and HDDS are significantly affected by factors, such as sex and educational status of household head, household size and livestock ownership. Except the sex of household head (being male), which has positive effect on HFC and negative effect on HDDS, all these factors influence both the dependent variables positively. There are also other determinants which significantly influence either HFC or HDDS, but not both. Age of household head and distance to the nearest market affect HFC negatively. On the other side,

HDDS is positively affected by household engagement in non-farm activities.

The results of this study have important policy implications. First, PSNP membership should be complemented with building households' awareness about benefits associated with consumption of variety of food items to improve both household food consumption and food security. Second, the result of the study shows that ownership of more livestock, which have multipurpose, increases both HFC and HDDS. This implies that PSNP should be designed not only to provide the urgent social protection services but also to endow the households to accumulate essential assets, especially livestock. Third, local governments need to prioritize the provision of infrastructures to help household easily access markets, and as a result, they can purchase cheap food products at local level. Finally, non-farm employment opportunities in rural areas need be created to generate supplementary income to boost household dietary diversity.

Need for Further Research

More research, using more rigorous impact evaluation methods, is needed to analyse how participation in PSNP affects the dietary diversity and health outcomes of different groups of people in a household.

DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/**Supplementary Materials**, further inquiries can be directed to the corresponding author/s'.

AUTHOR CONTRIBUTIONS

The author confirms being the sole contributor of this work and has approved it for publication.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fsufs.2022.714001/full#supplementary-material

REFERENCES

Ahmed, U. I., Ying, L., Wilson, M., Bashir, M. K., Abid, M., and Zulfiqar, F. (2017). Status and determinants of small farming households' food security and role of market access in enhancing food security in rural Pakistan. *PLoS ONE* 12, 1–15.

Araya, G., and Holden, S. (2018). "The impact of Ethiopia's productive safety net program on fertilizer adoption by small holder farmers in tigray, Northern Ethiopia," in: *30th International Conference of Agricultural Economists*, 1–29.

Araya, G. B. (2020). Impact of Ethiopia's productive safety net program on manure use by rural households: evidence from tigrai,northern Ethiopia. *Agricult. Econ.* 51, 725–742. doi: 10.1111/agec.12588

Ayenew, H. Y., Biadgilign, S., Schickramm, L., and Kassa, G. A. (2018). Production diversification, dietary diversity and consumption seasonality: panel data evidence from Nigeria. *BMC Public Health* 18, 1–9. doi: 10.1186/s12889-018-5887-6

Bahru, B. A., Jebena, M., Birner, R., and Zeller, M. (2020). Impact of Ethiopia's productive safety net program on household food security and child nutrition: a marginal structural modeling approach. *SSM—Populat. Health* 12, 1–9. doi: 10.1016/j.ssmph.2020.100660

Bailey, S., and Hedlund, K. (2012). The impact of cash transfers on nutrition in emergency and transitional contexts: a review of evidence. *Humanita. Policy Group Overseas Develop. Instit.* 12, 1–47. doi: 10.1371/journal.pone.0185466

Baum, C. (2007). *Instrumental Variables Estimation in Stata*. Boston: Faculty Micro Resource Center, Boston College, pp. 1–31.

Baum, C., Schaffer, M., and Stillman, S. (2003). Instrumental variables and GMM: estimation and testing. *Stata J.* 3, 1–31. doi: 10.1177/1536867X0300300101

Berhane, G., Devereux, S., Hoddinott, J., Hoel, J., Roelen, K., Abay, K., et al. (2015). Evaluation of the social cash transfer pilot programme,tigray region, Ethiopia, Endline Report. *Int. Food Policy Res. Instit.* 15, 1–194. Available online at: http://ebrary.ifpri.org/cdm/ref/collection/p15738coll5/id/4934

Berhane, G., Golan, J., Hirvonen, K., Hoddinott, J., Kim, S., Taffesse, A. S., et al. (2020). "Evaluation of the nutrition-sensitive features of the fourth phase of ethiopia's productive safety net programme," in *Strategy Support Program|Working Paper 140, International Food Policy Research Institute*, (Addis Ababa), 11–39.

Berhane, G., Hoddinott, J., and Kumar, N. (2017). The Impact of Ethiopia's productive safety net programme on the nutritional status of children: 2008–2012. *Ethiopia Strategy Support Program, ESSP Working Paper* 99, IFPRI, 1–22.

Berlie, A. B. (2014). The Role of Productive Safety Nets in Improving Household Food Dietary Diversity in the Amhara Region of Ethiopia: A Case Study on Lay Gayint District. *Ethiopian Journal of Health Development* 28, 191–201.

Christian, A. K., Wilson, M., Aryeetey, R., and Jones, A. (2019). Livestock ownership, household food security and childhood anaemia in rural Ghana. *PLoS ONE* 14, 1–14. doi: 10.1371/journal.pone.0219310

Cochrane, L., and Tamiru, Y. (2016). Ethiopia's productive safety net program: power, politics and practice. *J. Int. Develop.* 28, 649–665. doi: 10.1002/jid.3234

Coll-Black, S., Gilligan, D., Hoddinott, J., Kumar, N., Taffesse, A. S., and Wiseman, W. (2011). "Targeting food security interventions when "everyone is poor": the case of Ethiopia's productive safety net programme," in *Ethiopia Strategy Support Program II (ESSP II), ESSP II Working Paper*, pp. 1–35.

Demissie, B. S. (2016). The issue and determinants of rural poverty in Ethiopia. *Ethiopian e-J. Res. Innovat. Foresight* 7, 1–18.

Devereux, S., Vaitla, B., and Swan, S. H. (2008). *Seasons of Hunger Fighting Cycles of Quiet Starvation Among the World's Rural Poor*. Northampton: Chase Publishing Services Ltd, Sidmouth, EX10 9QG.

Dicks, H. (2012). *Assessing the Productive Safety Net Programme (PSNP) In Ethiopia. 1-52*. Available online at: https://ruor.uottawa.ca/bitstream/10393/23766/1/Dicks_Heather_2012_researchpaper.pdf

ESSP. (2014). The impact of research on the productive safety net programme (PSNP). *ESSP Outcome Note* 05, 1–2.

Gebrehiwot, T., and Castilla, C. (2017). Do safety net transfers improve household diets and reduce undernutrition? evidence from rural Ethiopia. *Pep Policy Brief Partnership for Econ. Policy* 170, 1–3. doi: 10.2139/ssrn.3159323

Graham, B., Hahn, J., and Powell, J. (2009). The incidental parameter problem in a non-differentiable panel data model. *Econ. Lett.* 105, 181–182. doi: 10.1016/j.econlet.2009.07.015

Gupta, S., Sunder, N., and Pingali, P. (2020). Market access, production diversity, and diet diversity: evidence from India. *Food Nutri. Bull.* 41, 167–185. doi: 10.1177/0379572120920061

Hagos, F., Jayasinghe, G., Awulachew, S. B., Loulseged, M., and Yilma, A. D. (2011). "Poverty impacts of agricultural water management technologies in Ethiopia," in *IWMI Conference Proceedings 210891, International Water Management Institute,* 184–212.

HLPE (2012). Social protection for food security: a report by the high level panel of experts on food security and nutrition of the committee on world food security. *Rome.* 12, 1–96.

Holmes, R., and Bhuvanendra, D. (2013). "Social protection and resilient food systems: the role of cash transfers," in *Federal Ministry for Economic Cooperation and Development,* 1–21.

Hsiao, C., and Yanan, W. (2006). Panel data analysis—advantages and challenges, wise working paper series, WISEWP0602. *Wang Yanan Instit. Stud. Econ.* 12, 1–32. doi: 10.2139/ssrn.902657

INDDEP (2018). *Data4Diets: Building Blocks for Diet-related Food Security Analysis.* Boston, MA: Tufts University. Available online at:https://inddex.nutrition.tufts.edu/data4diets (accessed December 1, 2020).

Janvry, A., and Sadoulet, E. (2011). Subsistence farming as a safety net for food-price shocks. *Develop. Pract.* 21, 472–480. doi: 10.1080/09614524.2011.561292

Kennedy, G., Ballard, T., and Dop, M. (2011). "Guidelines for measuring household and individual dietary diversity," in *Nutrition and Consumer Protection Division, Food and Agriculture Organization of the United Nations,* pp. 1–53.

Kissoly, L. D., Karki, S. K., and Grote, U. (2020). Diversity in farm production and household diets: comparing evidence from smallholders in Kenya and Tanzania. *Front. Sustain. Food Syst.* 4, 1–13. doi: 10.3389/fsufs.2020.00077

Knippenberg, E., and Hoddinott, J. (2017). "Shocks, social protection, and resilience: evidence from Ethiopia," in *Ethiopian Strategy Support Program, Working Paper 109, IFPRI,* 1–30.

Koppmair, S., Kassie, M., and Qaim, M. (2016). Farm production, market access and dietary diversity in Malawi. *Public Health Nutri.* 20, 325–335. doi: 10.1017/S1368980016002135

Lewis, K. (2017). Understanding climate as a driver of food insecurity in Ethiopia. *Climatic Change* 144, 317–328. doi: 10.1007/s10584-017-2036-7

Mao, R., and Xu, J. (2013). Population aging, consumption budget allocation and sectoral growth. *China Econ. Rev.* 30, 44–65. doi: 10.1016/j.chieco.2014.05.004

Mekuria, G., Wubneh, Y., and Tewabe, T. (2017). Household dietary diversity and associated factors among residents of finote selam town, North West Ethiopia: a cross sectional study. *BMC Nutri.* 3, 1–6. doi: 10.1186/s40795-017-0148-0

Ministry of Agriculture (MOA). (2014). *Productive Safety Net Programme Phase IV Programme Implementation Manual. Addis Ababa.*

Misker, D., Misker, B., and Ayele, G. (2016). Household dietary diversity and associated factors in mirab abaya wereda Southern Ethiopia 2016; community based cross sectional study. *Diversit. Equal. Health Care* 13, 293–296. doi: 10.21767/2049-5471.100065

Mohamed, A. A. (2017). Impact of Ethiopia's productive safety net programme (psnp) on the household livelihood: the case of Babile District in somali regional state, Ethiopia. *Int. J. Econ. Energy Environ.* 2, 25–31. doi: 10.11648/j.ijeee.20170202.12

Moreira, P., and Padrão, P. (2004). Educational and economic determinants of food intake in portuguese adults: a cross-sectional survey. *BMC Public Health* 4, 1–11. doi: 10.1186/1471-2458-4-58

Muhammedhussen, M. (2015). Determinants of rural income poverty in Ethiopia: case study of villages in Dodola District. *Global J. Manage. Bus. Res. Econ. Commer.* 15, 25–32.

Ochieng, J., Sefa, V. A., Lukumay, P. J., and Dubois, T. (2017). Determinants of dietary diversity and the potential role of men in improving household nutrition in Tanzania. *PLoS ONE* 12, 1–18. doi: 10.1371/journal.pone.0189022

Olayemi, A. O. (2012). Effects of Family size on household food security in Osun State, Nigeria. *Asian J. Agricult. Rural Develop.* 2, 136–141. doi: 10.22004/ag.econ.197951

Pritchard, B., Rammohan, A., and Vicol, M. (2019). The importance of non-farm livelihoods for household food security and dietary diversity in rural Myanmar. *J.Rural Stud.* 67, 89–100. doi: 10.1016/j.jrurstud.2019.02.017

Rahman, A., and Mishra, S. (2018). "Does non-farm income affect food security? evidence from India," in *30th International Conference of Agricultural Economists,* 1–35.

Schaffer, M., and Stillman, S. (2006). *XTOVERID: Stata Module to Calculate Tests of Overidentifying Restrictions after xtreg, xtivreg, xtivreg2, xthtaylor.* Boston, MA: Statistical Software Components S456779, Boston College Department of Economics.

Sen, A. (1981). *Poverty and Famines: An Essay on Entitlement and Deprevation.* Mew York : Clarendon Press Oxford.

Siman, S., Tawakal, M. A., Risamasu, P. I., and Kadir, R. (2020). Effect of household size, working hours, health and income on consumption expenditure of poor household. *Enfermería Clínica* 30, 512–515. doi: 10.1016/j.enfcli.2019.10.131

Singh, U. K., Gautam, N., Bhandari, T. R., and Sapkota, N. (2020). Educational intervention of intention change for consumption of junk food among school adolescents in Birgunj metropolitan city, Nepal, based on theory of planned behaviors. *J. Nutri. Metabol.* 2020, 1–7. doi: 10.1155/2020/7932324

SPRING (2015). *Factors Affecting the Family Diet. SPRING/Kyrgyz Republic Formative Research Report,* 1–63.

Swindale, A., and Bilinsky, P. (2011). Household dietary diversity score (HDDS) for measurement of household food access: indicator guide, Version 2. *Food Nutri. Technic. Assist. III Project (FANTA)* 11, 1–11.

Welteji, D., Mohammed, K., and Hussein, K. (2017). The contribution of productive safety net program for food security of the rural households in the case of bale zone, Southeast Ethiopia. *Agricult. Food Secur.* 6, 1–11. doi: 10.1186/s40066-017-0126-4

Wooldridge, J. (2010). *Econometric Analysis of Cross Section and Panel Data: Second Edition.* London, England: The MIT Press Cambridge, Massachusetts.