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Effect of Food and Cash Transfers on Food Consumption in Ethiopia: Evidence Based on a Food Demand System Analysis

Jun Takada[1] **and Hisato Shuto**[2*]

This study introduces the inverse probability weighted regression adjustment (IPWRA) approach to examine the impact of food or cash transfer programs in Ethiopia. The average treatment effects from the IPWRA food demand system estimation show a significantly lower expenditure share of fruits and vegetables and a higher share of animal-based products among assistance beneficiaries than non-beneficiaries. However, the positive, insignificant treatment effect on expenditure share of food away from home is estimated. These findings propose that our concerns should be redefined to elucidate changes in beneficiaries' menu choice and time allocation by transfers within a workfare program.

Key words: Ethiopia, FFW/CFW, IPWRA demand system

1. Introduction

Ethiopia experiences frequent famines and droughts, and recently introduced direct cash or food support, and food-for-work (FFW) or cash-for-work (CFW) via several programs, including a productive safety net programme (PSNP). Transfer programs can have a varied impact dietary diversity and/or child nutrition (Berhane *et al*., 2014; Berhane *et al*., 2017; Gebrehiwot and Castilla, 2019; Bahru *et al*., 2020; Debela *et al*., 2021). Some studies hypothesize that such programs do not change dietary (calorie) diversity scores directly since they only change the intake of less calorific foods such as vegetables, fruit, and meat. Moreover, when consumption shifts toward food-away-from-home (FAFH), the consumption diversification effects become ambiguous, because nutrition from this category is not properly captured. However, as Burney (2018) showed the effect of USA's food transfer (SNAP) on FAFH's share of total food expenditure, it would be another research concern in the case of Ethiopia.

This paper adopts a food demand system estimation approach, including FAFH, and employs the inverse probability weighted regression adjustment (IPWRA) approach to deal with the non-randomness (endogeneity) of receiving benefits from transfer programs. The combined use of demand system estimation and IPWRA allows us to estimate household expenditure on food consumption away from home while adjusting for selection bias.

In Ethiopian studies, the food demand system is examined to address concerns related to the transfer effect. Wang and Çakır (2021) focus on cereal demand system estimation by introducing beneficiary status to the PSNP. They examine the marginal effects of PSNP enrolment and the involvement of free food programs in cereal demand-system estimation by the data for previous waves prior to the data which we use. However, because beneficiary status is not assigned randomly but in a targeted manner based on food insecurity status, their setting of exogenous beneficiary status needs to be validated. Although studies have applied IPWRA to examine the transfer impact on nutritional status (Berhane *et al*., 2017) in Ethiopia, no Ethiopian transfer study has applied IPWRA to the food demand system to examine the food consumption diversification effect on cereals, vegetables/fruits, animal-based food, and FAFH. The contribution of this paper is the estimation of the impact of transfer programs such as the PSNP on FAFH in a statistically rigorous manner.

2. Food and Cash Assistance in Ethiopia

The PSNP, which is currently implemented as PSNP5 (Ministry of Agriculture, 2021), aims to reduce vulnerability in food security by providing productive assets or cash/in-kind transfers. In PSNP5, food or cash assistance is implemented via direct support and FFW/CFW or both. Direct support focuses on households whose members are not laborable, and food or cash is mainly transferred via

[1] Graduate School of Science and Technology, University of Tsukuba
[2] Faculty of Life and Environmental Sciences, University of Tsukuba
Corresponding author*: shuto.hisato.ke@u.tsukuba.ac.jp

public programs (Ministry of Agriculture, 2021). PSNP beneficiaries are nominated and selected non-randomly by targeting food-insecure households and promoting women's empowerment. It is community-based and targets the most vulnerable drought-prone areas to provide a buffer against shocks.

3. Estimation Framework

1) IPWRA demand system

Numerous studies have adopted a single outcome equation for calorie intake, diversification, total food expenditure, or respondents' subjective evaluation of their food security status. Some studies are not concerned with the price effects; however, food demand in Ethiopia, with its high price volatility, is contingent on prices. Any evaluation of nutrition status has difficulty capturing calorie or other nutrition content when consumption is diversified. A food demand system based on expenditure share could help to evaluate food consumption behavior from different angles in conjunction with the findings of previous studies.

And in addition to the targeting criteria, other causes for potential selection bias should be considered. First, the consumer's preference or food security situation could affect their program participation decision. As FFW is known as a self-targeting program (FAO, 2001: Ch. 5), food needs are likely to affect a consumer's participation decision. Second, the CFW/FFW requires the beneficiary's labor supply for public work. This opportunity is offered in the lean season to avoid conflict with other income-generating activities; however it could be in conflict with the labor supply for (unpaid) domestic work, including meal preparation. If the household prefers food at home to FAFH or has time/labor constraints related to nursing a family member, they would be hesitant to join the program.

This study applies the IPWRA to examine the food or cash transfer effect on the expenditure share of food items on the demand system. The IPWRA is an approach for estimating potential outcomes under non-random treatment/untreatment assignment. It is known as a doubly robust estimator, which means a consistent estimator for the potential outcome can be derived, if we can appropriately specify the functional form for either the outcome or the selection equation (Wooldridge, 2010: Ch. 21).

In the literature on Ethiopia's assistance programs, Belete (2020) introduced an IPWRA-demand system approach to examine the children resource allocation effect of food/cash assistance. This demand system constituted four commodity groups: food and beverages, clothing, utilities and energy, and other non-durable goods (Belete, 2020). However, no study has applied this IPWRA-demand system to a food demand analysis with several food groups.

2) Data

This study uses Wave 4 of the Ethiopian Socioeconomic Survey (ESS4) or Living Standards Measurement Study-Integrated Surveys on Agriculture (LSMS-ISA) (CSA of Ethiopia, 2021). The survey was conducted in 2018–2019 by the Central Statistical Agency (CSA) of Ethiopia and the World Bank. The ESS was a panel survey covering three waves (ESS1-ESS3), where ESS4 adopted a new questionnaire and included more food commodities. The ESS4 asked respondent households to provide their consumption of food items by source within a recall period of seven days: purchase, home-grown, and gift. Consumption by a gift source could not include food from assistance programs. The data included food-at-home and FAFH consumption. Consumption or expenditure on non-food, education, and utilities were collected based on a 30-day or 12-month recall survey.

The World Bank's LSMS team estimated annual household expenditure by food, FAFH, non-food, education, and utilities; however, their estimation for expenditure by food items are not available. This study estimates household expenditure by food items by referring to the procedures for food expenditure estimation used by the CSA and World Bank (2021). Due to space limitations, estimation details are not provided. Our estimation of the unit value was modified from the procedures by the World Bank LSMS+ team in consideration of the survey's timing or seasonality in consumption. In spite of this difference, our household food expenditure ($\hat{Y}$) is a well-replicated estimate of the original aggregate food expenditure in ESS4 (Y_{ESS4}) as the single regression equation (1) shows.

$$\hat{Y} = 0.916 \times Y_{ESS4} \ (\mathrm{N} = 6160) \quad (1)$$

3) Demand system and grouping of food

Currently, we have several demand systems that are consistent with the properties required for demand functions under utility maximization or expenditure minimization behavior. This study adopts the linear approximate almost ideal demand system (LAAIDS) developed by Deaton and Muellbauer (1980), which has an advantage in its tractability of empirical estimation.

This study constructs the demand system on the four groups by the food at home (1. grains/cereals, 2. pulses, 3. fruits and vegetables, 4. meat, fish, egg, and dairy foods), 5. drinks, 6. prepared food and FAFH, and the non-food group. Food consumption by household in a recall period of seven days by items was collected from the ESS4. We estimate the unit values for each enumerate unit and weekly household total food expenditure. To derive the food group price, we aggregate unit value by items into a food group as a Laspeyres index using the average share of regional food items in a group.

However, we cannot capture the relevant price data for the FAFH and non-food items from the ESS4 data. To address this problem, we impose the following two assumptions. First, we assume the price of group 6 (FAFH) is a composite price of groups 1–5, and thus exclude the price of FAFH from the system. However, this assumption excludes the validity of symmetric restriction on price parameter in the LAAIDS for estimation. Second, we assume the homogeneity of degree zero in expenditure share with respect to prices and expenditure. However, the CSA estimates and issues the monthly consumer price indices (CPI) for several consumption item groups by region. We deflate prices by the five food groups and expenditure by the monthly CPI of non-food items by region.

The system for estimation is proposed as follows:

$$w_{ih} = \alpha_i + \boldsymbol{ln\,p}^* \boldsymbol{\gamma_i} + \beta_i \, ln\left(\frac{y_h^*}{PL^*}\right) + \boldsymbol{X\delta_i}, \quad i = 1, \ldots, 6 \tag{2}$$

w_{ih} $(i = 1, \ldots, 6)$ refers to food group $i's$ share (four for food at home, drinks, and prepared food and FAFH) of total household expenditure of household h. p^* is the deflated price of each food group by non-food CPI. $\boldsymbol{lnp}^*$ is a vector of the log of relative prices. y_h^* represents the seven days' total per capita expenditure deflated by non-food CPI. The vector of these household attributes $\boldsymbol{X}$ contains the household size, the head of the household's age and sex, number of household members, age–sex structure of the household (specified by the household members' share of the age–sex group), household head literate dummy, and the household's share of literate members. $\alpha, \beta, \gamma s$ and δs are parameters to be estimated. Urban and region dummies are introduced in the actual estimation. From the adding up constraint, non-food items expenditure share equation is excluded from the system for estimation. PL^* is the revised Laspeyres index.

$$\ln PL^* = \sum_k \overline{w}_k \ln p_k^* \tag{3}$$

$\overline{w}_k$ is the regional average expenditure share of group k.

4) Treatment variable and selection equation

This study introduces the treatment variable T of food or cash assistance on beneficiary status in the ESS4. $T = 1$ if the household received food or cash assistance via direct support or public work during the 12 months preceding the survey, otherwise $T = 0$. The covariates in the selection equation are selected based on the beneficiary targeting criteria. The PSNP focuses on improving vulnerable households' food security status. This implies that household endowments include family structure, educational attainment of members, household and productive assets, and their experiences of several types of risk, including the climate shock, asset loss, and threat of safety in daily life.

The selection equation is specified as follows:

$$T = \begin{cases} 1 \; if \; \beta_0^S + \boldsymbol{X\gamma_X^S} + \boldsymbol{Z\gamma_Z^S} + \varepsilon \geq 0 \\ 0 \;\; \text{Otherwise} \end{cases} \tag{4}$$

$\boldsymbol{Z}$ is a vector of covariates that affect the treatment. This study prepares the assets for income generation or production, household goods as their wealth, and experience of previous risk events. In our estimation, $\boldsymbol{Z}$ includes household asset dummies (bed, sofa, clock, telephone, mobile phone, radio, TV, and bicycle), the number of rooms, land use size, livestock holding in tropical livestock units (TLU), shock dummy for climate (including shocks from drought), flood and heavy rains, experience dummy for significant livestock loss, and subject evaluation dummy for social unrest. To consider differences in public work and labor market situations between rural and urban regions, the interaction terms of these variables with the urban dummy are included in $\boldsymbol{X}$ and $\boldsymbol{Z}$. Here, land use and TLU are only available for the rural sample. Furthermore, the regional dummies are introduced in the estimation. ε is an error term. β and γs are the parameters to be estimated.

5) Total expenditure endogeneity

Some studies were concerned about total expenditure endogeneity in their estimation of consumption equations (Dhar *et al*., 2003). In this study, we introduce the control function approach to address this expenditure endogeneity problem. This approach was applied in the Quadratic Almost Ideal Demand System estimation of Tafere *et al*. (2010) and the IPWRA demand system estimation of Belete (2020) in their studies of consumption behavior in Ethiopia. We construct the total expenditure equation as follows for this control function approach.

$$ln\left(\frac{y_h^*}{PL^*}\right) = \beta_0^y + \boldsymbol{ln\,p}^* \boldsymbol{\gamma_p^y} + \boldsymbol{X\gamma_X^y} + \boldsymbol{Z\gamma_Z^y} + \nu \tag{5}$$

Here, $\boldsymbol{X}, \boldsymbol{Z}$ are the same as those in the treatment equation (4). As this equation is estimated for controlling endogeneity in total expenditure, it includes the exogenous variables ($\boldsymbol{ln\,p}^*, \boldsymbol{X}$) in the outcome equation and instrumental variables $\boldsymbol{Z}$. $\boldsymbol{Z}$ is correlated to expenditure but not relevant to the food consumption outcome in the context of exclusion restriction. Therefore, the assets introduced equation (4) are valid. Furthermore, the interaction terms of urban dummy with $\boldsymbol{X}, \boldsymbol{Z}$ and regional dummies are introduced when considering labor market conditions. ν is the error term. Thus, we begin with the estimation of this equation. The control function approach uses the residuals $\hat{\nu}$ of this first step estimation as an additional regressor in the outcome equation, here the demand system using equations (2).

6) Estimation steps

The estimation strategy uses the following steps. Step 1: The probit estimation is applied to equation (4), where the propensity score from this estimation derives the inverse probability weights. Step 2: Total expenditure function (5) is estimated by OLS and its residuals is derived. Step 3: The demand system of the equations for beneficiaries and non-beneficiaries are jointly estimated by including the residuals of (5) and applying the inverse probability weighting. Table 1 summarizes the statistics. Zero consumptions of pulses and FAFH are observed for a remarkable number of households; the censored regression estimation is applied for this group-share equation. We apply the Stata module cmp (Roodman, 2011) for this demand system estimation. Step 4: The estimation of demand system derives the prediction of food item share for both beneficiary statuses as their potential outcome. The mean of the difference between these predictions can be derived as the average treatment effect (ATE) on the food item share. The standard errors of the demand system parameters and ATEs are derived by 1000 replication trials of cluster bootstrap by enumerated areas as the first sampling unit, and sampling weights applied for all steps of estimation. However, the estimation suffers from a convergence problem for the system of 6 equations including 2 left-censored equations. Therefore, we estimate the following two models separately; Model 1 includes the equations for groups 1. cereals, 2. pulses (censored), 3. vegetable and fruits, 4. Egg, meat, and dairy, and 5. drink. Model 2 includes the equations for 1. cereals, 3. vegetable and fruits, 4. egg, meat, and dairy, 6. prepared food and FAFH (censored).

Table 1. Summary statistics

(Outcomes)

	Non-beneficiary			Beneficiary		
	Obs. = 4948			Obs. = 1146		
	No. of zero value	mean	sd	No. of zero value	mean	sd
Share of cereals	152	0.277	0.173	12	0.341	0.170
Share of pulses and seed	925	0.067	0.068	373	0.076	0.092
Share of fruits and vegetables	209	0.171	0.157	108	0.122	0.121
Share of egg, fish, meat and dairy	215	0.123	0.115	21	0.132	0.139
Share of drink	477	0.106	0.132	112	0.122	0.145
Share of prepared food and FAFH	2,795	0.056	0.126	686	0.051	0.097

(Regressors in outcome equations)

	Non-beneficiary		Beneficiary	
	mean	sd	mean	sd
ln(y/PL*)*	2.482	0.914	1.933	0.806
*lnp** (cereals)	2.622	0.246	2.563	0.251
*lnp** (pulses)	3.249	0.280	3.135	0.229
*lnp** (fruits and vegetables)	2.958	0.345	3.136	0.432
*lnp** (egg, fish, meat, dairy)	3.930	0.332	3.780	0.348
*lnp** (drink)	3.857	0.323	3.877	0.368
Household head age	41.867	15.070	46.235	15.500
Male headed household	0.740	0.439	0.676	0.468
Household size	4.330	2.172	4.833	2.280
Member share of male, age – 13 yrs.	0.159	0.179	0.194	0.190
Member share of female, age – 13 yrs.	0.166	0.182	0.179	0.179
Member share of male, age 14– 64 yrs.	0.296	0.239	0.246	0.192
Member share of female, age 14– 64 yrs.	0.333	0.229	0.307	0.200
Member share of male, age 65– yrs.	0.023	0.094	0.032	0.119
Member share of female, age 65– yrs.	0.022	0.113	0.042	0.153
Household head literate dummy	0.572	0.495	0.367	0.482
Member share of literate	0.503	0.329	0.377	0.289
Land use size	0.586	1.075	0.640	3.677
Tropical livestock units	1.904	3.608	1.901	3.233
Shock due to Climate	0.076	0.266	0.228	0.420
Loss of Livestock	0.032	0.175	0.089	0.285
Unrest of Society	0.036	0.187	0.038	0.191
Urban dummy	0.401	0.490	0.163	0.369

Source: Authors' estimation.

4. Results

1) Treatment equation

Due to space limitations, we are unable to show the estimation results table of the treatment equation. Since the Programme Implementation Manual of PSNP (Ministry of Agriculture, 2021) enhances women's empowerment, households headed by women are likely to be targeted as beneficiaries; the negative and significant parameter of the male-headed household dummy in urban area is estimated. TLU, which reflects an accumulation of a type of productive asset, has a negative and significant parameter estimate. This is also consistent with the purpose of the PSNP. The positive and significant parameter of the climate shock variable is likewise a reasonable result. In addition, some household asset variables indicating household wealth (bed, telephone, radio, TV, and the number of rooms) are significantly negative, which implies less wealthy households are likely beneficiaries. Although not directly tested, we assume that conditional independence, an important assumption in IPWRA, is satisfied since some covariates in the selection equation are significant. Although not shown in this manuscript, some instrumental variables are significant in the estimation of the expenditure function.

2) Demand system estimation

Table 2 presents the results of the non-beneficiaries' demand system estimation for Model 2. Some estimated parameters for unit values are significant. Among the household attribute variables, household size has a significant negative effect on the share of FAFH. Notably, family structure significantly affects food consumption structure. Households with more elderly or female adults show a negative and significantly lower share of FAFH. Households with more female adults or elderly female adults show a significantly higher share of fruits and vegetables, egg, fish, meat, and dairy products. This implies that women play a significant role in balancing food-at-home consumption between food groups.

3) Average treatment effects

Table 3 presents ATE results for food group share from Model 1 and 2. No significant ATEs for expenditure share of cereals, pulses, and drinks are estimated. The ATEs from the IPWRA demand system estimation show a significantly lower expenditure share of fruits and vegetables for assistance beneficiaries than non-beneficiaries. The positive and significant ATE on expenditure share of animal-based products. Even though the ATE on unconditional prediction for expenditure share of FAFH is not significant, this ATE is positive and the simple difference shown in Table 1 is negative. This would be due to the correction of the selection bias. Of course, the estimation cannot explain the mechanism of these ATE results. However, if we can understand that household-member structure affects food consumption patterns, and if a public work program targets women as beneficiaries to improve women's empowerment, we could conclude that workfare programs involving women changes the time allocation of women's home production activities, increases the availability of cereals, and changes household members' commitment to menu choices at home.

5. Conclusion

Ethiopia's assistance program is a large scale food/cash transfer based on the FFW/CFW. Previous studies have examined the effects of these programs on both food security and food consumption. Our finding contributes to the debate

Table 2. Linear approximate almost ideal demand system (LAAIDS) estimation result (Model2, non-beneficiaries only)

	Cereals		Fruits and vegetables		Egg, fish, meat and diary		Prepared food, and FAFH	
*lnp** (cereals)	0.039	(0.078)	0.144	(0.100)	-0.088 **	(0.042)	-0.002	(0.077)
*lnp** (pulses)	0.139 *	(0.083)	-0.274 ***	(0.089)	0.075 *	(0.044)	0.075	(0.075)
*lnp** (fruits and vegetables)	0.027	(0.037)	-0.024	(0.028)	0.000	(0.020)	-0.028	(0.037)
*lnp** (egg, fish, meat, dairy)	-0.067 **	(0.029)	-0.040	(0.032)	0.043 **	(0.017)	0.037	(0.037)
*lnp** (drink)	-0.068 **	(0.027)	0.044	(0.035)	0.009	(0.015)	-0.029	(0.031)
Household head age	0.000	(0.000)	0.000	(0.000)	0.000	(0.000)	0.000	(0.000)
Male headed household	0.007	(0.010)	-0.006	(0.011)	-0.011	(0.010)	-0.017	(0.013)
Household size	-0.002	(0.005)	-0.003	(0.003)	0.011 ***	(0.002)	-0.005	(0.005)
Member share of								
male age –13 yrs.	-0.073 **	(0.035)	0.086 ***	(0.026)	0.091 ***	(0.020)	-0.127 ***	(0.038)
female age –13 yrs.	-0.094 **	(0.037)	0.068 **	(0.027)	0.074 ***	(0.021)	-0.103 ***	(0.039)
female age 14–64 yrs.	-0.010	(0.023)	0.082 ***	(0.017)	0.066 ***	(0.017)	-0.231 ***	(0.037)
male age 65– yrs.	0.051	(0.048)	0.069 **	(0.034)	0.006	(0.030)	-0.198 ***	(0.060)
female age 65– yrs.	-0.046	(0.034)	0.089 ***	(0.032)	0.050 **	(0.024)	-0.174 ***	(0.051)
Honholt head literate dummy	-0.016	(0.012)	-0.005	(0.011)	0.009	(0.008)	0.008	(0.013)
Literate member share	-0.006	(0.028)	-0.010	(0.019)	-0.037 ***	(0.014)	-0.002	(0.025)
Urban dummy	-0.017	(0.048)	0.056	(0.048)	-0.064 **	(0.026)	-0.116 **	(0.053)
Region dummy	Yes		Yes		Yes		Yes	
ln(y/PL*)*	-0.109 ***	(0.033)	0.008	(0.023)	0.089 ***	(0.017)	0.085 ***	(0.032)
Residual from eq. (5)	0.056	(0.035)	-0.003	(0.025)	-0.063 ***	(0.017)	-0.023	(0.033)
Constant	0.548 *	(0.315)	0.646 *	(0.332)	-0.412 **	(0.166)	-0.266	(0.319)

Source: Authors' estimation.

Note: Variances and correlations of errors are not reported. Cluster bootstrap standard error in parenthesis. * $p < 0.1$ ** $p < 0.05$ *** $p < 0.01$.

Table 3. Average treatment effect (ATE)

Outcome	Model1		Model2	
Share of cereals	-0.009	(0.015)	-0.009	(0.016)
Share of pulses and seed	-0.007	(0.007)		
Share of fruits and vegetables	-0.029 **	(0.013)	-0.029 **	(0.013)
Share of egg, fish, meat and dairy	0.030 **	(0.015)	0.030 *	(0.016)
Share of drink	0.011	(0.014)		
Share of prepared food and FAFH			0.044	(0.079)

Source: Authors' estimation
Cluster bootstrap standard error in parenthesis.
* $p < 0.1$ ** $p < 0.05$ *** $p < 0.01$

on the impact of cash/food transfers on nutrition outcomes. If a program changes a beneficiary's food consumption behavior from eating at home to eating outside, the nutritional intake estimation for food at home cannot capture actual nutrition intake. This study investigates the impact of PSNP on FAFH and food at home. We find that transfer programs insignificantly increase the expenditure share on FAFH, but the significantly decrease that on vegetable and fruits and increase that on animal-based products. The estimation results of this study indicate that further research is required to examine actual labor allocation among households, including the home food/meal production behavior of those in assistance programs and change the bargaining power of members controlling the food menu choice by involving them in the workfare program.

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