SEASONALITY IN INCOME, EXPENDITURE AND FOOD DEFICIENCY: THE CASE OF FOUR RURAL VILLAGES IN ETHIOPIA

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Abstract

Income of rural households in Ethiopian has seasonal pattern because they primarily rely on seasonal rain-fed agriculture. This paper explores the implication of income seasonality for household expenditure and daily calorie intakes. It used household-level data from four Ethiopian villages to document seasonal patterns in income, expenditure and calorie consumption, and to test whether income seasonality produces seasonal expenditure and calorie consumption variability. While the findings substantiate seasonal patterns in income and non-food expenditure, there is no well-built seasonal variation in food expenditure. However, mixed results were found in the case of daily calorie consumption. Although food expenditure doesn't necessary tracks seasonal income, I found that at least 5% of households are in food shortage even during main harvesting seasons, January. It was more severe in the "usual" hunger season, July, where up to 70% of household had food shortage.

Due to complete absence of credit market for consumption, rural household in Ethiopia are characterized by preserving output during main harvesting seasons and draw down during the entire year to smooth consumption. However, using net calorie retained for only consumption the paper has also shown that what they preserved is sufficient for a maximum of only nine months and hence households are in transitory food deficient for at least three months.

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1. Introduction

Rural households in many agrarian economies, where rain-dependent crop cultivation is the primary source of household income, have incomes that vary seasonally (Paxson, 1992 and Paxson and Chaunduri, 2001). The seasonal variation in income is quite large. For instance, three of the four rural villages of Ethiopia examined in this paper received, on average, more than 50% of household income in the top three months.

What are the consequences of this pronounced income seasonality for expenditure and consumption? Empirical evidence suggests that although household consumption also varies, leading in many cases to seasonal variation in nutritional status and health (see Chambers et al.,(1981); Sahn (1989) and Walker and Ryan (1990)), income seasonality need not be the sources of consumption seasonality. For instance, Paxson (1992), using rural household in Thailand found little evidence that consumption trucks income seasonality. She indicated that any observed seasonal variations in consumption are the result of seasonal variation in preferences or prices that are common to all households rather than seasonal income. Likewise, Paxson and Chauduri (2001), using rural households in India indicated that while there appears some seasonality in consumption patterns, it was much less pronounced than in the case of income. Moreover, they have shown that the consumption patterns are quite similar for households with very different seasonal income patterns. They observed that borrowing constraints caused by credit market imperfections can indeed combine with income seasonality to produce consumption seasonality.

Seasonal variability in consumption is widely documented in Ethiopia. For instance, Dercon and Krishanen (2001), using three years panel data of Ethiopian Rural Household Survey (ERHS), have shown high seasonal variability in consumption due to common climatic as well as idiosyncratic shocks. Degefa (2000) has also shown seasonal food deficiency, at least for four months, owing to climatic shocks in one of the potential cereals production areas, Arsi zone, Oromia regional state of Ethiopia. Nevertheless, these surveys typically constructed seasonal figures from either short recall periods such as total yearly consumption from own production, or based on questions related to a ‘usual month’. Although the figures were constructed with an adjustment, they were less likely to take into account actual seasonal variability in income and expenditure. For example, they fail to take consumption from own harvest between the period of harvesting and threshing. They also fail to consider ceremonial expenses. Moreover, as Ethiopia is a candidate for a country case study of Millennium Development Goals (MDGs), if we are to attain the MDGs', specifically, MDG1 i.e., reducing extreme poverty and hunger by half between 1990 and 2015, we further need better understanding of seasonality in income, consumption and food insecurity.

The first objective of this paper is, therefore, to investigate tangible seasonal variability in income, expenditure and daily calorie intakes of rural households using data collected at 15 days intervals, unlike that of the recalls of "usual month" or total yearly consumption from own production, and try to bridge the gap. Investigating seasonal variability alone might not quantify the extent of vulnerability of each household, particularly in terms of food insufficiency (calorie consumption). Thus, the second objective of the paper is to explore the proportion of food insecure households using Ethiopian Nutrition Institute standard daily calorie intakes per adult equivalent as a benchmark. The third objective of the paper is to examine the extent of maintaining calorie intakes per adult equivalent via retained output for only consumption.

The rest of the paper is organized as follows: in the next section the theoretical framework and empirical model is presented. While section 3 gives data sources and seasonal pattern in income and consumption, section, 4 and 5 present empirical findings. Section 6 provides concluding remarks.

2. Theoretical Framework and Empirical Model

In order to analyse seasonality in income, consumption and food deficiency, let us assume that preferences are quadratic, separable across periods, that the rate of time preference is equal to a fixed interest rate *r*, and preferences don't vary across time periods. Then, the Permanent Income Hypothesis (PIH) model states that the change in consumption from period to period can be expressed as:

$$\Delta C_{jt} = C_{jt} - C_{jt-1} = \left(\frac{r}{1+r}\right)\sum_{k=0}^{\infty}(1+r)^{-k}\left[E_{jt} - E_{jt-1}\right]Y_{jt+k} \quad \textbf{(1)}$$

Where C_{jt} denotes consumption of household *j* in time *t* and Y_{jt} is non-asset income of household *j* in time *t*. E_{jt} is the expectations operator, conditional on information known at time *t*. i.e., the change in consumption between *t−1* and *t* is equal to the revision in permanent income between the two periods, where permanent income equals the annuity value of discounted future earnings plus the value of current assets. Equation (1) does not explicitly incorporate income seasonality, but since the equation is valid for any income process, it applies equally to situations with seasonal income variation. One can let "*t*" denote a month *m* rather than a year, and allow average income levels (and higher moments of income) to vary systematically across months as:

$$\Delta C_{jm} = C_{jm} - C_{jm-1} = \left(\frac{r}{1+r}\right)\sum_{k=0}^{\infty}(1+r)^{-k}\left[E_{jm} - E_{jm-1}\right]Y_{jm+k} \quad \textbf{(2)}$$

Where C_{jm} denotes consumption of household *j* in month *m* and Y_{jm} is non-asset income of household *j* in month *m*. E_{jm} is the expectations operator, conditional on information known in month *m*. Equation (2) implies that since consumption responds only to unexpected innovations in seasonal income, deterministic seasonal patterns in income should have no effect on consumption. The expected value of the change in consumption between two months, conditional on information known in the earlier month, is zero. Therefore, (2) implies that on average there will be no seasonal consumption variation. More general models of consumption, for instance, those that allow for seasonal variation in preferences, prices or interest rates, or seasonal patterns in the resolution of income uncertainty do yield systematic seasonal patterns in consumption (see Chaudhuri, 1999). However, even in these more general models, seasonality in income levels will not directly translate into consumption seasonality and consumption will still not respond to anticipated income changes.

After applying logarithm and rearranging terms, equation (2) can be expressed as:

$$\ln\left(C_{jm}\right) = \ln(Y_j) + \beta_m + \gamma X_j + \beta_h^m h_j + u_{jm} \quad \textbf{(3)}$$

Where ln(Cjm) is the logarithm of expenditure per adult equivalent of household *j* in month *m* (see Paxson (1992) for details in derivation of equation 3). This variable is regressed on logarithm of average monthly income of household *j* (ln(Y_j)), set of dummy variables for each month (β_m), a set of variables that are constant within a year, including the numbers of males, females, and children in the household at the beginning of the month and constant (X_j) and a set of month dummies interacted with an indictor of households status (h_j), which equal to 1 if the household head is male and 0 otherwise.

Biasness in an econometric estimation results could arise due to factors such as measurement error, missing values, differences in unit of observation, etc. To minimize such errors all possible measures were taken during data collection, verification as well as data entry. However, there may be possible bias due to gender difference of household head. Rural female household heads have triple burden of household chores, childcare and agricultural works as compared to their male counterparts. The inclusion of a set of month dummies interacted with an indictor of household status (h_j) is used to control such bias in specific months. If h_j is 1 for male household head, the parameter β_m measures month effects in expenditure for female household head. The month effects in expenditure for male household heads are measured as $\beta_m + \beta_h^m$ (see Wooldridge, 2003). The parameters β_h^m represent the difference in male and female household heads. An intercept is included in the model, so that first month effect β_1, is normalized to zero[1].

Likewise, seasonality in household's calorie consumption can be given as

$$\ln\left(kcal_{jm}\right) = \ln(Y_j) + \beta_m + \gamma X_j + \beta_h^m h_j + u_{jm} \qquad \textbf{(4)}$$

Where ln(Kcaljm) is the logarithm of calorie consumption per adult equivalent of household *j* in month *m* and the other variables are as specified in equation (3).

[1] For empirical work two variants of equation (3) are estimated i.e., C_{jm} denoting total food and non-food expenditure.

Equation for seasonality in income can also be derived as a function of months and month-head interaction as:

$$A_{jm} = \beta_m + \gamma X_j + \beta_m^h h_j + \varepsilon_m \qquad \textbf{(5)}$$

Where A_{jm} is the ratio of household j's total income in month *m* to the household's average annual income (i.e. annual income divided by 12)[1]. This variable is regressed on a set of dummy variables for each month and a set of month dummies interacted with household head gender status. In the same approach to equation (3 and 4) while β_m measures the average monthly income share of female household head in respective villages, $\beta_m + \beta_m^h$ measures addition to month effects in income share for male household head. And also β_m^h represent the difference in month effects between male and female household heads.

3. Data Source, Seasonal Pattern in Income and Expenditure and Calorie Intakes

The data used come from the 5th round longitudinal monitoring survey for Debrebrehan and Yetmen villages in Amhara, Eteya village in Oromia, and Azedebo (Durame) village in Southern Nations, and Nationalities Peoples (SNNP) regional states. The survey was carried out by Economics Department of Addis Ababa University (AAU) and United States Agency for International Development (USAID). In each village, a sample of sixty-two households[2] was selected; therefore, total sample consists of 247 households[3]. These households were then interviewed frequently, typically every two weeks for a year, from April 2000 to July 2001. It was the first of its kind conducted in the country. Each household was asked questions about socio-demographic characteristics, main activities and labor use, shocks and events, market information, crop output, food and non-food consumption expenditure,

[1] Monthly income is divided by average annual income to remove scale effects.
[2] about 16% of them are female headed
[3] One sample household in Yetmen was excluded due to incomplete information in almost half of the survey period.

etc. In this study, however, information from May 2000 to May 2001 was used where complete information is found for almost all sampled households[1].

The details of the survey allow me to construct income and expenditure aggregate. Monthly expenditure is measured as the sum of expenditure on food (both purchased and value of consumption from own production and gifts) and non-food (clothes/shoes/fabric, household utensils), ceremonial expenses[2] and others. The food bundles were then converted to calorie consumption and scaled to provide 2100 kcal per day per adult equivalent, the minimum energy required for normal life under Ethiopian conditions as estimated by the Ethiopian Nutrition Institute. Monthly income is measured as the sum of value of crop output during the month (crop cultivation), representing the value of food production that is retained for own consumption, monthly gross income from sales of livestock/livestock products and/or cereals and cash crops, monthly gross income from petty trade, off-farm labor for wage and any transfers in the form of remittance and gifts during the specific month. All money variables are expressed in May 2000 Birr.

The villages represent different agro-ecological zones where crop cultivation is the primary source of household income and profoundly depend on *meher* rainfall, usually lasting from June to the beginning of September. Crop cultivation is the dominant activity and source of livelihood. Table 1 presents major crops grown, percent those and quantity produced (in kg/ha)[3]. More than 50% of households have been reporting growing barley, wheat and beans in Debrebrehan, teff and maize in Yetmen and wheat in Eteya. On average 13, 10 and 12qt/ha of barley, wheat and beans in Debrebrehan, 10 and 6qt/ha of teff and maize in Yetmen and 19qt/ha of wheat in Eteya were obtained, respectively. In Azedebo about 9qt/ha of wheat and maize were obtained although less than 40% of the households have been reporting to have grown these crops[4].

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[1] In April 2000 and June and July 2001 only 82, 84 and 36 of 247 households were interviewed.

[2] Most of household studies excluded ceremonial expenses as the data were taken in only "usual month" and difficult to project for all year (see Dercon and Krishanen, 2001). However, this study incorporates these expenses as the information is collected at 15 days interval which would avoid overestimation of ceremonial expenses

[3] It is the actual measured quantity of output. During survey periods land cultivated and crops output was measured rather than depending only on the responses of household heads.

[4] Haricot beans, field peas, *enset*, coffee, oranges, bananas, avocados, sugar cane and chat are among permanent crops growing in the villages rather than the major crops listed in Table 1. Inter-cropping is common in the area as it helps farmers produce more on their land. For instance maize is intercropped with beans, peas with beans, sorghum with maize, maize with haricot beans, and so on. (see Data et al., 1996).

The average yields were very low implying that household net income, mostly derived from these crops (see Table 2), was also low given that prices are most likely unsatisfactory in Ethiopia. For instance, household monthly income is merely greater than 1000.00 Birr in Eteya (the potential wheat producing village) followed by almost Birr 650.00 in Debrebrehan and Birr 400.00 in Azedebo. In Yetmen, average monthly income is limited to nearly 250.00 Birr (see Table 2). These monthly incomes, however, are not often representatives for all households as their standard deviations are very high (almost more than twice of average monthly income) (see Table 2). Thus, there is seasonal variability of income in rural Ethiopia.

Table 1: Percentage of households growing selected crops and average yield produced by those households growing

Crop	Debrebrehan		Yetmen		Eteya		Azedebo	
	% Growing	Quantity produced (in kg/ha)	% Growing	Quantity produced (in kg/ha)	% Growing	Quantity produced (in kg/ha)	% Growing	Quantity produced (in kg/ha)
Teff	0.00	0.00	93.44	921.52 (335.21)	0.00	0.00	30.65	454.24 (322.70)
Barley	100.00	1336.72 (584.68)	0.00	0.00	22.58	1356.89 (950.88)	0.00	0.00
Wheat	83.87	952.62 (535.98)	29.51	782.70 (307.55)	95.16	1836.45 (730.21)	30.65	826.66 (440.39)
Maize	0.00	0.00	47.54	535.54 (329.61)	14.52	840.89 (329.61)	37.10	819.46 (703.11)
Sorghum	8.06	1049.99 (455.66)	0.00	0.00	20.97	1263.07 (567.72)	0.00	0.00
Bean	74.19	1140.81 (816.16)	0.00	0.00	37.10	1157.48 (254.90)	6.45	383.15 (161.29)
Vetch	0.00	0.00	40.98	805.64 (555.75)	0.00	0.00	0.00	0.00

Source: Own computation from survey data

The variability in income is apparent as rural household's income in Ethiopia is derived typically from crops cultivated which have pronounced seasonal patterns. This is not surprising, given that farming in Ethiopia is rain-fed where agricultural cultivation depends heavily on *meher* rains. As indicated in Table 2, crop income accounted for a large share of total annual income ranging from 67% to 85% in three of the four villages under this study. It only accounted for 47% in Debrebrehan. In this village relatively higher income was derived from sales of livestock/livestock products as compared to other villages (see Nigussie, 2006). Although Ethiopia has high water potential, irrigation, which could potentially result in less seasonality in income from crops, is fairly uncommon. Very recently, government has implemented small scale irrigation and water-harvesting scheme. Its impact is not yet analyzed, however.

The combination of *meher* dependent crops and lack of irrigation (water harvesting) results in flows of income from crops that are very unevenly distributed over the year, much more so than flows of income from other sources. Figure 1 trace out monthly averages of income from crops, and income from other sources (trade, off-farm, livestock etc.). The seasonal patterns in crop income are consistent with the timing of main harvesting seasons in each of the four villages. In Debrebrehan, Eteya and Azedebo harvesting on crop fields begins in mid October and usually lasts for about three to four months. In Yetmen harvesting commences a bit earlier, mid of September. During these months, crops income significantly increases and reaches the optimal level in all villages (see Figure 1). Furthermore, the fraction of income received by households in those three highest-income months ranges from 38% in Azedebo to 60% in Eteya (see Table 2). The corresponding fraction of income is 53% in Yetmen and 49% in Debrebrehan. There is a second harvesting season between March and May. In this season Debrebrehan and Azedebo households are merely increasing their crops income.

The pattern of income seasonality in Azedebo is quite unique as compared to other villages due to seasonal migration of household members to off areas for seeking employment and supporting their family members. According to Data et al.,(1996), nearly 50% of the households have members who temporarily migrate often as daily laborers. Places like Harar, Wonji, Wolkite, Negele, Shashamene, Wondo and Alaba Kulito are potential areas of migration. Specifically, migration to Alaba Kulito takes place in April, March, December, January and July to harvest or plant peppers for private farms. These exceptionally favor Azedebo households to merely raise income in these months, particularly June through July (see Fig.1)

The other seasons are either pre-harvest or post-harvest periods known as slack seasons when crops income is either almost stagnant or far below the average annual crops income. For instance, in Yetmen crops income between August and September significantly declines and it is usually the hunger season for most of households (see Tassew et al., 1996).

Table 2: Sample mean of income, consumption expenditure and related variables

	Debrebrehan	Yetmen	Eteya	Azedebo
Monthly income (in Birr)	649.43 (1027.981)	242.21 (437.25)	1092.38 (4353.8)	397.08 (767.95)
%age of annual income from crop cultivation	47.4	75.3	85.2	67.2
%age of income received in top 3 months	49.3	53.4	60.2	38.3
Monthly expenditure on food (in Birr)	60.34 (24.5)	36.91 (25.4)	99.11 (44.2)	60.8 (33.5)
Monthly expenditure on non-food (in Birr)	69.49 (67.10)	35.00 (28.7)	284.49 (872)	36.72 (22.8)
%age of annual expenditure on food	49.6	51.4	37.6	64.1
%age of food expenditure incurred in top 3 months	31.3	29.4	32.6	40.2
%age of non-food expenditure incurred in top 3 months	36.1	37.2	59.4	46.3

Source: Own computation from survey data.

Notes: 1. Average monthly incomes and expenditures are in May 2000 prices. The %age of income/expenditure in top 3 months is calculated as the sum of monthly incomes/expenditures in the 3-highest income/expenditure months of a year, divided by annual income/expenditure.

2. Figures under parentheses are standard deviations.

Fig. 2 shows that higher degree of income seasonality in the household doesn't translate into higher seasonality in consumption expenditure. Total food and non-food expenditures are less erratic among months (seasons) from their respective annual average. In relative terms, consumption expenditure seasonality to some extent is observed in Eteya. In this village, all expenditures decline June through July and September through October; and increase July through September (it is main harvesting season of Onion) and during main harvesting seasons (between October and February). In Azedebo an extraordinary rise in all expenditures is observed in between August and October following seasonal migration of household members which commonly takes places early in the month of September. However, all expenditures seriously decline pursuing the month of October possibly due to low saving behaviors of households or low income commenced from migration. January through May is the hunger season when there is only *enset* for consumption (see

Data et al. 1996). Very slight expenditure seasonality is also observed in Debrebrehan proceeding the main harvesting season and slack season of August through September (this is main harvesting seasons of potato in the village).

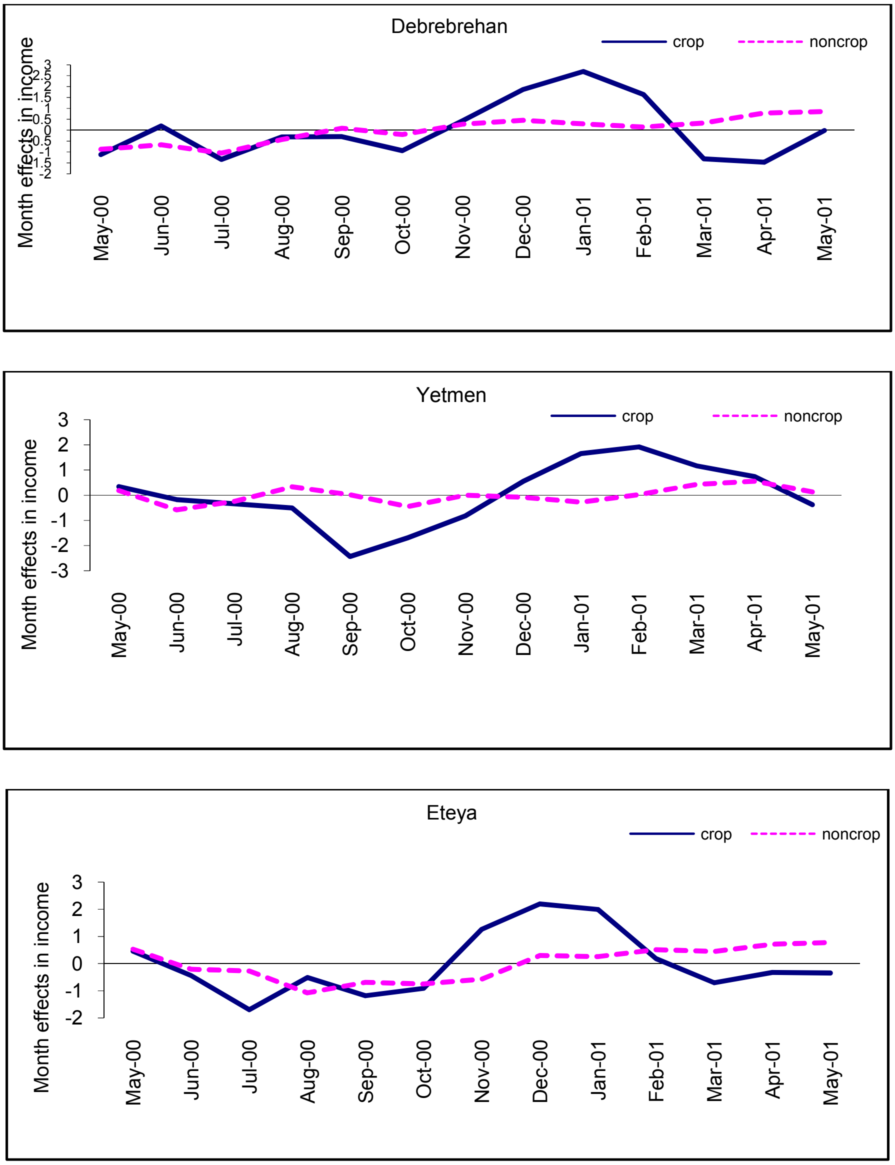
Moreover, close examination of all expenditures shows that the deviation of non-food expenditure is greater than the deviation of total food expenditure. While households spend less on non-food items (clothes/shoes/furniture, unties etc.,) during pre-harvest and post-harvest periods (slack seasons), they spend more on them during

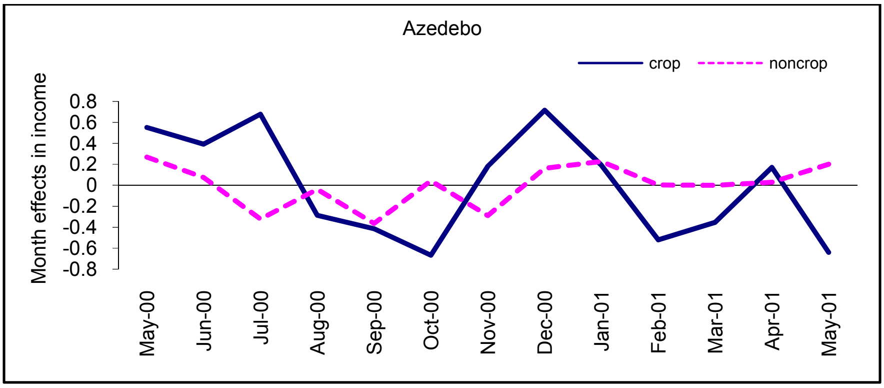
main harvesting seasons. Further exploring the nature of expenditure depicts that total food and non-food expenditures are less concentrated in the top three months as compared to income (see Table 2). Total food expenditure incurred in the top three months ranges from 29% in Yetmen to 32% in Eteya. In Azedebo it accounted up to 40% of the total food expenditure. In this village, food expenditure incurred in the top three months is slightly greater than total agricultural income derived in the top three months (38.2%). This is not surprising, as Data et al., (1996) indicated, the village is a deficit production area and most people buy additional food for consumption or look for food aid. In the village households are more likely looking for additional wage employment including food-for-work program to mitigate income shocks. Nigussie (2006) indicated that more than 90% of households in the village were seeking to engage in additional food-for-work program.

The figure for non-food expenditure incurred in the top three months ranges from 36% in Debrebrehan to 46% in Azedebo. In Eteya it accounted for 59%, which is almost comparable with the total income received in the top three months. This in turn implies that households in Eteya village are self sufficient in production for consumption and hence spend less on food items than non-food items.

Food and non-food expenditures incurred in the top three months, in general, are very low provided that rural households in Ethiopia are mainly characterized by complete absence of credit market for consumption. Recently microfinance institutions are involved in providing rural credit (loan) with only group-based collateral (no need of asset collateral). However, most of them are engaged in provision of credit for investment (productive) purpose as a means of poverty alleviation.

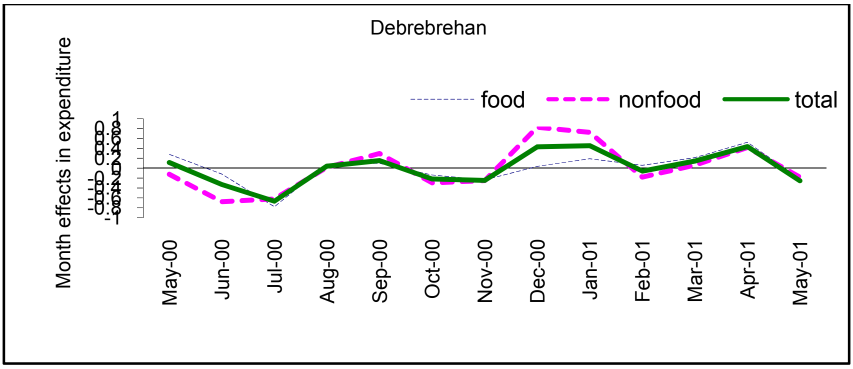
Fig. 1: Income seasonality

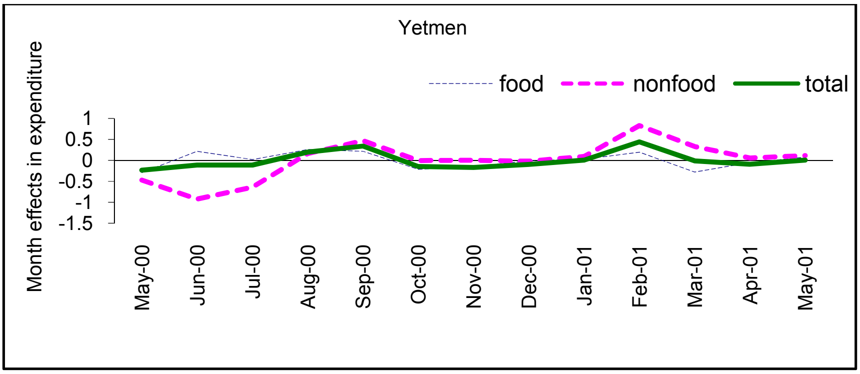




Source: own computation from survey data.

Fig.2: Expenditure seasonality





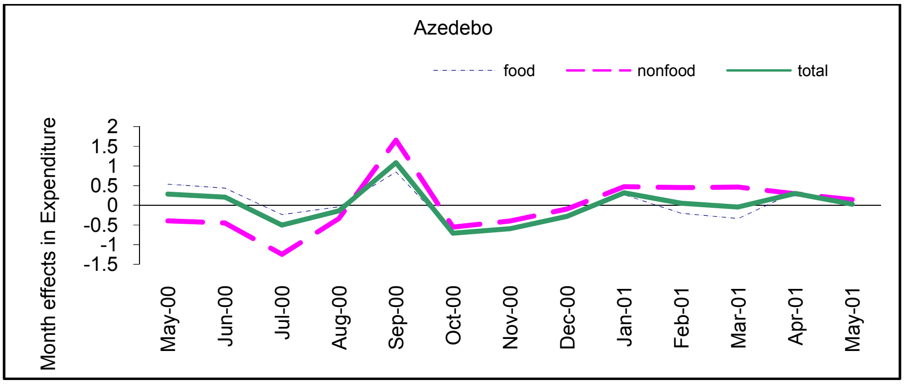


Table 3 presents major sources of calorie intakes. Food retained for consumption from own harvest and drawn down in the entire year is the major sources of calorie intakes accounted for about 94% of households in three of four villages. About 33% of calories sources were purchased food in Azedebo compared with almost less than 5% in other villages. Table 4 depicts net calorie available[1] for consumption per adult equivalent per day by land holding tercile and sample averages[2]. The average net calories retained from own crops output for consumption varies, ranging from 356120 kcal in Azedebo to 1276660 kcal in Eteya. In all villages households of highest tercile have preserved better calories than lowest and medium terciles. While households in the highest tercile preserved 1036070, 898700, 1518010 and 409650 kcal/ae/day, it was only 490660 and 640550, 687990 and 522640, 1346090 and 1518010 and, 399150 and 268600 kcal/ae/day for lowest and medium terciles households in Debrebrehan, Yetmen, Eteya and Azedebo, respectively.

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[1] Net calorie availability is calculated as follows

Ka = KP + KR +KB - (KS + KD +KL)

Where; Ka = Net calories available for consumption (in kcal)

KP = Calories produced (in Kcal)

KR = Calories received in kind for work off-farm (in kcal)

KB = Calories purchased

KS = Calories sold (in Kcal)

KD = Calories used for seed (in kcal)

KL = Calories paid in kind to hired labor in kcal)

Note: Since the majority of the farmers' are subsistent, the calculation does not include changes in food stock from year to year.

[2] Table 4 also contains information on adult equivalent and land per mouth to feed (cultivated land per adult equivalent).

Given large family size of rural households (usually 4 to 6 persons per household), 2100 kcal per day[1] is the recommended dietary intake for the active person and December through February is the main harvesting season[2], retained net calories sufficient for only five months in Deberebrehan, six months in Yetmen and Eteya and two months in Azedebo pursuing the month of February. In the highest tercile of Debrebrehan, Yetmen and Eteya, it is used for a maximum of seven, eight and nine months, respectively. In the lowest and medium terciles preserved calorie can feed household members ranging three to nine months. In Azedebo, however, it couldn't feed household members more than four months in either of tericle due to very small land holding per mouth to feed (cultivated land per adult equivalent) (see Table 4)[3].

Table 3: Sources of calorie intakes (in %)

Source	Debrebrehan	Yetmen	Eteya	Azedebo
Food retained for consumption from own harvest	92.39	94.95	94.03	63.09
Purchased food	3.40	4.51	5.28	32.41
Received as remittance etc	4.21	0.54	0.69	4.50

Source: Own computation

Except in the highest tercile of Eteya, households in other villages, including the lowest and medium terciles of Eteya, don't have access to enough food for at least three months (i.e., households are in transitory food shortage) although the variability in consumption is less seasonal. This indicates that most farmers couldn't produce enough to meet the annual requirements. Thus, they are vulnerable and looking for food aid, remittance, transfers etc, for survival.

[1] See Section 5, why 2100 kcal is used as standard value

[2] Usually households are not expected to consume retained output for consumption in December through February as it is the main harvesting seasons and hence these months are excluded from calculations.

[3] Although the average family size of Azedebo's is comparable with other villages, the land per mouth to feed is very small. For instance, land per mount to feed in the highest tercile of Azedebo is equivalent to land per mouth to feed in the lowest terciles in other villages (see Table 4). The plausible reason for such small land per month to feed is high population settlement per square meter in the village.

Table 4: Household adult equivalent and calorie preserved/ae/day (in kcal) by area of survey and land Tercile

Survey area/ Indicator	Land area per adult equivalent by Tercile			Sample average
	Lowest	Medium	Highest	
▪ Debrebrehan				
Cultivated land in ha/ae	0.09 - 0.31	0.32 - 0.44	0.45 - 1.26	
Adult equivalent	5.02(1.32)	5.46(1.46)	5.12(1.43)	5.19(1.39)
Calorie available/ae/day (in Kcal)	490660(130030)	640550 (313950)	1036070 (1146900)	723750(722540)
On average it can feed for months	4	5	8	5
▪ Yetmen				
Cultivated land in ha/ae	0.15 - 0.34	0.35 - 0.51	0.52 - 1.67	
Adult equivalent	5.01(1.94)	4.63(1.56)	3.46(2.23)	4.37(2.00)
Calorie available/ae/day (in Kcal)	687990 (1154106)	522640(168800)	898700 (394350)	700150 (710480)
On average it can feed for months	5	4	8	6
▪ Eteya				
Cultivated land in ha/ae	0.02 - 0.33	0.34 - 0.44	0.45 - 0.98	
Adult equivalent	8.00(2.86)	6.58 2(2.28)	6.03(2.82)	6.87(2.76)
Calorie available/ae/day (in Kcal)	1346090 (2669420)	950330(286040)	1518010(622430)	1276660(1595450)
On average it can feed for months	6	6	9	6
▪ Azedebo				
Cultivated land in ha/ae	0.01- 0.07	0.08 - 0.14	0.15 - 0.49	
Adult equivalent	6.87(1.97)	5.76(1.68)	5.56(1.71)	6.06(1.85)
Calorie available/ae/day (in Kcal)	399150(572650)	268600(167960)	409650(301140)	356210(380010)
On average it can feed for months	2	4	3	2

Source: Own computation from survey data.

Note: Figures in parenthesis are standard deviation

4. Regression Results

In the descriptive section we have seen that expenditure is relatively more flat across seasons than income. This section then applies econometric approaches to explore seasonality in income, expenditure and calorie consumption. Table 5 presents the results of F-tests of the significance of the month effects and month-household head gender interactions. While Test 1 and Test 2 test the null hypothesis of no seasonal effects in income, expenditure and calorie consumption across male and female household heads, respectively, Test 3 measures whether month-household head gender interaction is jointly significant.

The F-tests presented in Table (5) are consistent with the descriptive results indicated in Figure 1 and Table 2. The null hypothesis of no seasonal effect in income strongly rejected across male and female household head except for female household head in Yetmen i.e., seasonality in income holds for both male and female headed households. Although Figure 2 depicts less erratic patterns of non-food expenditure, the regression result confirms seasonality in non-food expenditure in all villages except for female-headed households in Yetmen. In contrast to income and non-food expenditure, seasonality in food expenditure is rejected at 1% level of significance for both male and female headed households. In order to buffer consumption households in the villages not only draw down crop output retained for consumption but also use different copying strategies (see Nigussie, 2006). This implies that food consumption doesn't track income seasonality. The result for daily calorie consumption per adult equivalent is mixed. While seasonality in calorie consumption was observed for both male and female headed households in Debrebrehan and Durame; and female headed households in Eteya, it is rejected for both male and female headed households in Yetmen and male headed households in Eteya villages (Table 5).

Table 5: F-statistics test for month effects in income, expenditure and calorie intake (P-value in parentheses)

Observation (household- month)	Debrebrehan	Yetmen	Eteya	Durame
	713	781	698	664
Income				
Test 1: no month effect: Female head	7.76(0.000)***	0.38(0.970)	9.73(0.000)***	2.33(0.0063)***
Test 2: no moth effect: Male head	35.02(0.000)***	10.11(0.000)***	19.25(0.000)***	3.05(0.0005)***
Test 3: month effect identical	0.47(0.9317)	0.46(0.939)	0.71(0.745)	0.61(0.834)
R-square	0.442	0.090	0.079	0.144
Food Expenditure				
Test 1: no month effect: Female head	1.56(0.0972)*	1.56(0.0982)*	1.02(0.424)	0.59(0.8491)
Test 2: no moth effect: Male head	1.07(0.3827)	1.54(0.1126)	1.13(0.3322)	2.61(0.0030)***
Test 3: month effect identical	1.09(0.3653)	1.38(0.1687)	0.50(0.9146)	0.56(0.8773)
R-square	0.6520	0.5953	0.4574	0.496
Non-food Expenditure				
Test 1: no month effect: Female head	3.75(0.000)***	1.53(0.109)	2.90(0.0006)***	3.16(0.0002)***
Test 2: no moth effect: Male head	10.35(0.000)***	4.60(0.0000)***	3.41(0.0001)***	11.38(0.000)****
Test 3: month effect identical	0.91(0.5399)	0.71(0.7413)	1.51(0.1175)	0.78(0.6679)
R-square	0.4602	0.5301	0.4614	0.3146
Calorie consumption				
Test 1: no month effect: Female head	3.79 (0.000)***	0.40 (0.9636)	1.54 (1.051)	1.74(0.0546)**
Test 2: no moth effect: Male head	11.67(0.000)***	1.19(0.2927)	5.71(0.000)***	2.83(0.0013)***
Test 3: month effect identical	2.09(0.0156)**	0.28(0.9916)	1.06(0.3885)	0.83(0.6125)
R-square	0.3204	0.1363	0.2319	0.1106

Note: *= significant at 10%,** =significant at 5% and *** =significant at 1%.

The null hypothesis of identical month effects among male and female-headed households can't be rejected in all villages except for daily calorie intakes in Debrebrehan i.e., month-gender of family head interaction is jointly insignificant for food and non-food expenditure, income and calorie consumption. This implies that there is no estimation bias for any attribute resulting from male or female headed household members except for calorie consumption in Debrebrehan.

5. Food Deficiency

Food expenditure smoothing or calorie consumption smoothing alone could be vague when we want to articulate in terms of vulnerability for each household. Consider the case of calorie consumption for instance. If the daily household members' calorie intake is small, even below recommended daily calorie intakes for active person, for each month, the regression compares that small difference and reports no significant variation in daily calorie intake among months and vice versa. If this is so, one can then ask does no seasonality in daily calorie intake, for instance, in Yetmen mean that each household in a village is able to secure food consumption in each month? Or does observable seasonality in daily calorie intakes in Debrebrehan or Durame mean that each household is not able to secure food consumption in each month, etc? To answer such questions, we need to quantify the extent of vulnerability of each household. In this section I am trying to examine such issues using standard daily calorie intakes.

Though the recommended daily calorie intakes vary from person to person, this study used 2100 kcal per day for active person, as recommended by the Ethiopian Nutrition Institute, as yardstick. Table 6 presents the proportion of households whose dietary intake is below standards. Even during the main harvesting season, in January, the daily calorie intakes for at least 5% of the households are below 2100 kcal per day. It becomes worse and worse during pre and post- harvesting season. For instance, in one of "usual" hunger months, July, the proportion of households whose daily calorie intake is below the recommended value accounted for 70% in Debrebrehan, 53% in Yetmen, 64% in Eteya and 75% in Durame. It is followed by month of November in Debrebrehan and Yetmen, October in Eteya and May 2000 in Durame where it accounted for about 33, 47, 37 and 73%, respectively. In other post-harvesting or pre-harvesting seasons it accounted for 10 to 66%.

The proportion of households whose daily calorie consumption is less than Ethiopian's standards varies from village to village. More than a quarter of households had food deficiency for two months in Debrebrehan, six months in Eteya and almost in all months in Yetmen and Durame. Although, in the regression, we didn't reject the null hypothesis of no seasonality of daily calorie intakes per adult equivalent in Yetmen, 30% to 40% of households had food shortages for about eight months. It was more severe in Durame where 60% to 70% of households had food deficiency for about eight months. The regression result also established the variability in daily calorie intakes in Durame village. Thus, these findings indicated the extent of vulnerability of each household even though the regression results come up with ambiguous results as I mentioned before. If we consider two-thirds of 2100 kcal (i.e.1500 kcal) as a benchmark, we obtain similar patterns except decreasing in the proportion of households facing food deficiency (see Table 7).

Table (6): Proportion of household whose daily calorie intake per adult equivalent is <2200 kcal.

Month	Debrebrehan	Yetmen	Eteya	Durame
May-00	0.10(0.30)	0.44(0.50)	0.34(0.48)	0.73(0.45)
Jun-00	0.19(0.40)	0.33(0.47)	0.19(0.40)	0.56(0.50)
Jul-00	0.70(0.46)	0.53(0.50)	0.64(0.49)	0.75(0.44)
Aug-00	0.08(0.27)	0.38(0.49)	0.21(0.41)	0.45(0.50)
Sep-00	0.06(0.25)	0.43(0.50)	0.24(0.43)	0.26(0.44)
Oct-00	0.13(0.34)	0.39(0.49)	0.37(0.49)	0.66(0.48)
Nov-00	0.32(0.47)	0.47(0.50)	0.33(0.47)	0.61(0.49)
Dec-00	0.11(0.32)	0.28(0.45)	0.29(0.46)	0.60(0.49)
Jan-01	0.05(0.22)	0.33(0.47)	0.08(0.27)	0.50(0.50)
Feb-01	0.16(0.37)	0.39(0.49)	0.27(0.45)	0.60(0.49)
Mar-01	0.08(0.27)	0.38(0.49)	0.27(0.45)	0.61(0.49)
Apr-01	0.00(0.00)	0.31(0.47)	0.06(0.25)	0.45(0.50)
May-01	0.15(0.36)	0.38(0.49)	0.10(0.30)	0.37(0.49)

Source: Own computation from survey data.

Note: Figures under parentheses are standard deviation.

Table (7): Proportion of household whose daily calorie intake per adult equivalent is <1500 kcal.

Month	Debrebrehan	Yetmen	Eteya	Durame
May-00	0.00(0.00)	0.13(0.34)	0.11(0.32)	0.27(0.45)
Jun-00	0.02(0.13)	0.11(0.32)	0.05(0.22)	0.19(0.40)
Jul-00	0.33(0.48)	0.19(0.39)	0.27(0.45)	0.60(0.50)
Aug-00	0.02(0.13)	0.15(0.36)	0.06(0.25)	0.08(0.27)
Sep-00	0.02(0.13)	0.11(0.32)	0.06(0.25)	0.06(0.25)
Oct-00	0.02(0.13)	0.11(0.32)	0.08(0.27)	0.21(0.41)
Nov-00	0.15(0.36)	0.13(0.34)	0.10(0.31)	0.37(0.49)
Dec-00	0.00(0.00)	0.05(0.22)	0.04(0.19)	0.23(0.42)
Jan-01	0.02(0.130	0.08(0.28)	0.03(0.18)	0.08(0.27)
Feb-01	0.02(0.13)	0.10(0.30)	0.08(0.27)	0.18(0.39)
Mar-01	0.00(0.00)	0.11(0.32)	0.05(0.22)	0.23(0.42)
Apr-01	0.00(0.00)	0.07(0.25)	0.03(0.18)	0.11(0.32)
May-01	0.00(0.00)	0.05(0.22)	0.02(0.13)	0.08(0.27)

Source: Own computation from survey data.

Note: Figures under parentheses are standard deviation.

6. Conclusion and Recommendation

The paper has explored whether rural households in Ethiopia, who experience seasonal income variation, also experience seasonal expenditure, particularly food expenditure. The major finding of this paper is that, at household level, seasonal expenditure and income patterns are largely unrelated i.e., food expenditure patterns at household level are similar despite dramatic difference in the timing of income flows. Mixed result was found in the case of calorie consumption. Further analysis of daily calorie consumption indicated that at least 5% of households had food shortage even during main harvesting season, January. It was more severe in the “usual” hunger month, July, where up to 70% of households had food shortage. Furthermore, although there is seasonality in income, non-food expenditure and partly for daily calorie consumption, the paper has shown identical income, food and non-food expenditure and daily calorie intakes between male and female household heads.

Although rural households in Ethiopia are usually characterized by complete absence of credit market for consumption, they are then characterized by accumulating crops output for consumption during main harvesting season and draw down the entire year. However, the finding has shown that retained food for consumption (in calories) is insufficient to provide enough food throughout the course of the year. Households in the study villages are in a transitory food shortage at least for three months. It is more severe in Azedebo where households are in food shortage for at least five months.

As retained calorie derived from crops harvesting is insufficient and seasonal variability in calorie consumption is directly or indirectly influenced by seasonal variability in income, new strategies should be designed to boost production. Very recently the government of Ethiopia launched water harvesting scheme to overcome not only rainfall shortage but also to produce more than once even in a year with good rainfall condition in high potential areas. This scheme should be widely practiced provided that it is properly managed. Whenever the land is repeatedly tilled its fertility deteriorates; hence, proper land management for sustainable development is also essential.

Off-farm activities are means of improving income of rural households. However, adequate attention is not yet given to these activities. Therefore, provisions of technical training to enhance these activities are essential particularly during slack seasons.

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