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EFFECTS OF HOUSEHOLD INCOME COMPOSITION ON FOOD CONSUMPTION IN RURAL MALAWI

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ABSTRACT

This analysis uses panel data methods to assess how food consumption and dietary diversity are affected by changes in household income composition, diversity, and liquidity in rural Malawi. Fixed-effects model estimates reveal several results. First, food consumption and dietary diversity increase with overall income, but at a decreasing rate. Second, while no relationship is found between changes in income *per capita* of different sources (composition effects), and food consumption *per capita*, there is a differentiated impact on calorie intake changes and dietary diversity outcomes. Third, overall, there is no statistically significant effect of income diversity on changes in food consumption, but a positive association is found with dietary diversity. As such, income diversity driven by crop diversification leads to greater consumption of *calories* from roots, pulses, and fruits; and a drop in balanced diets, while income diversification away from agriculture yields greater dietary diversity. Finally, household liquidity, incentivized by off-farm diversification through wage labor market participation and self-employment, promotes dietary diversity via higher consumption of calories from non-staple foods, notably those dependent on market acquisitions, such as animal-based proteins, vegetables, and fruits. These results are corroborated with those from the Seemingly Unrelated Regression Model. There are several policy and programmatic implications. First, income composition, diversity and liquidity are important dimensions to consider when focusing beyond household food security. Second, efforts to promote and sustain income growth are critical for food consumption growth and dietary diversity but increases in income alone are not enough. Policies and investments that ensure a diversified portfolio of economic activities are likely to result in better consumption and dietary diversity outcomes. Promoting crop diversification at the farm level coupled with nutrition sensitive programming, including extension and crop support programs is critical to increase and sustain consumption and better dietary quality. Third, as balanced diets in the Malawian context require a combination of staple foods sourced through crop and livestock home production, including goats, poultry and small domestically raised animals and protein-rich foods typically purchased in the market, as well as a degree of liquidity achieved through increased generation of cash income. Finally, programmatic efforts are needed to reduce gender gaps in access to resources, strengthening nutrition education more broadly, and ensure availability of balanced diets in school feeding programs potentially linked through local procurement.

Key words: Dietary diversity, income composition, liquidity, fixed effects, seemingly unrelated regression

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INTRODUCTION

Food and nutrition insecurity in Malawi remain alarming. The prevalence of stunting among children under 5 years has been falling since 2004 – from 53.1% to approximately 37% in 2016, a level still considered relatively high [1]. Almost 50% of the population consumes less than 2,100 calories *per capita* per day. More than 80% of the poor consume less than the recommended calories, compared to only 31% of the non-poor. Urban households have a clear advantage over their rural counterparts [2].

As agriculture accounts for more than 30% of GDP and 80% of employment, policies aimed at boosting rural incomes through agricultural investments can help to reduce rural poverty and improve food and nutrition security. On the one hand, agricultural growth can be relatively more effective at reducing poverty and achieving basic calorie intake thresholds through direct consumption of own agricultural production. On the other hand, cash income from either agricultural sales or off-farm wage and/or self-employment can lead to more diversified diets [1, 2].

While there is a vast and growing literature that tests the validity of Bennet's law [3], relating to the extent to which consumption structure responds to income, there is little evidence that looks at the preeminence of income sources in benefitting diets. Departing from an earlier cross-sectional analysis on the effect of agricultural involvement on food consumption and nutrition in Malawi [4], we broaden the set of questions while exploiting two-wave panel data set for 2010 and 2013 in Malawi. This analysis investigates how food consumption and dietary diversity (DD) are affected by changes in income composition, diversity, and liquidity constraints. The analysis focuses on a rural population sample and applies Fixed Effects (FE) models for consumption and DD outcomes; and a Seemingly Unrelated Regression (SUR) model of food group shares.

Some results stand out. First, crop income growth increases the shares of agricultural-based foods. Second, income diversity dominated by greater crop diversification, implies greater consumption of calories of roots/tubers, nuts/pulses, and fruit crops; and a relative drop in diversified diets (DD). Finally, diversification into non-farm wage and self-employment (greater liquidity) promote DD via the consumption of foods acquired through the market.

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ANALYTICAL FRAMEWORK OF FOOD CONSUMPTION STUDY IN MALAWI

The economics literature on food and nutrition demand focuses on the link between income and calorie intake - how income growth helps households achieve food and nutrition security. Studies often found conflicting results. Some authors found a positive and significant relation between the level of *per capita* income and calories consumed [5, 6, 7, 8]. Others do not find any statistically significant effects [9, 10, 11, 12].

Conventional wisdom predicts that calorie consumption increases as incomes grow. As theorized in the Engel's Law, the growth rate of calorie intake declines (relative to non-food consumption) when income levels increase, and food consumption reach a saturation point. A meta-analysis [13] concludes that the topic of calorie-income elasticities is well scrutinized in the empirical literature. Likewise, Bennett's Law, that states that as income rises the *per capita* consumption of starchy food staples falls [3], better relates to DD regardless of the Engel's Law holding. Evidence suggests that what was observed in Europe and North America in the 18th and 19th centuries with consumers moving from less expensive staples (Irish potato) to more expensive ones (wheat) as incomes grew, is now taking place in Asia, Africa, and Latin America [14]. The products now extend to not only more expensive staples but processed products and animal proteins [14, 15].

This strand of the literature has not focused on the role of different types of income in affecting nutritional status. This paper addresses this gap by looking at income composition and diversity vis-à-vis consumption and DD. It considers that not all foods consumed are home-produced. Access to food through markets is an important aspect in meeting adequate nutrition [16] but this, in turn, is affected by price dynamics and cash availability (liquidity).

In Figure 1, household income (top left) affects consumption and DD (top right of diagram) through demand and the degree of market dependency (top center). It would be reductive to limit the analysis to total income because income affects consumption through the levels of home production and market dependency. Also, the effect on consumption and DD is constrained by liquidity. To unpack these relationships, this paper investigates how the components at the bottom (income structure/composition, diversity, and liquidity status) relate to the outcomes.

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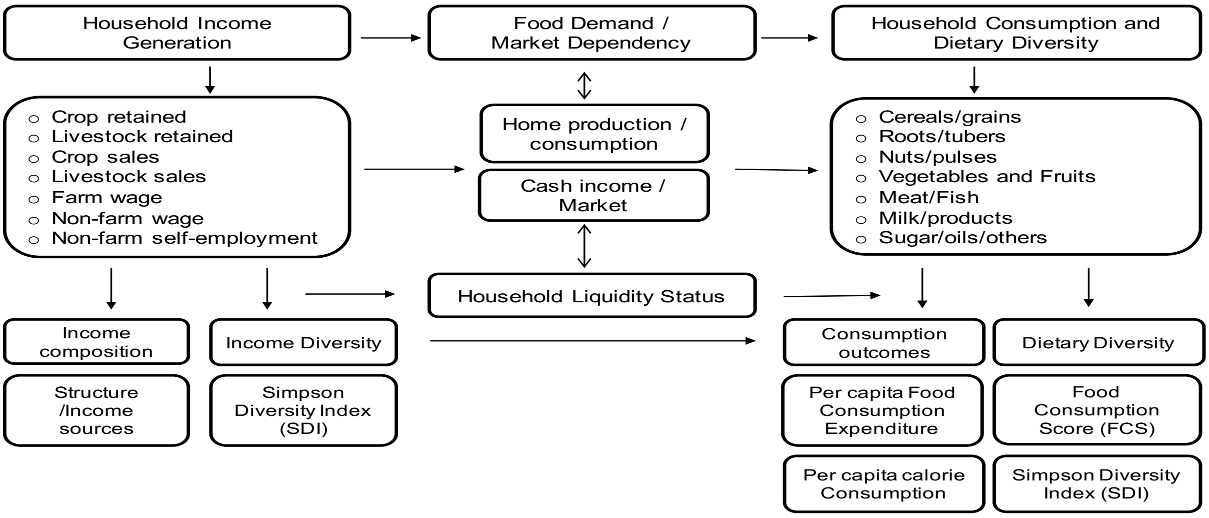

Figure 1: Analytical Framework of Food Consumption study in Malawi
Source: Adapted from Benfica and Kilic (2016)

DATA

This analysis uses data from the Integrated Household Panel Surveys (IHPS) collected by the Malawi National Statistical Office (NSO) with the support of the World Bank Center for Development Data (C4D2) Living Standards Measurement Study – Integrated Surveys in Agriculture (LSMS-ISA) Group.

The sample, originally collected in 2010/2011 (I3), consisted of 12,271 households and is representative at the national, district, urban and rural levels. The I3 sample is divided into two-subsamples: (a) 9,025 cross-sectional households that were interviewed only once and, (b) 3,246 households that have been tracked for a second wave during 2013. Given an overall attrition rate of 3.78%, the panel sample consists of 3,104 baseline households, from which a total of 4,000 have been tracked back, including split-off individuals from the original sample that formed new households. The balanced panel used for our analysis is obtained by considering the first wave (2010) observations of the original households, i.e., independently of their “split-off status” in 2013. Figure 2 shows the Map of Malawi.

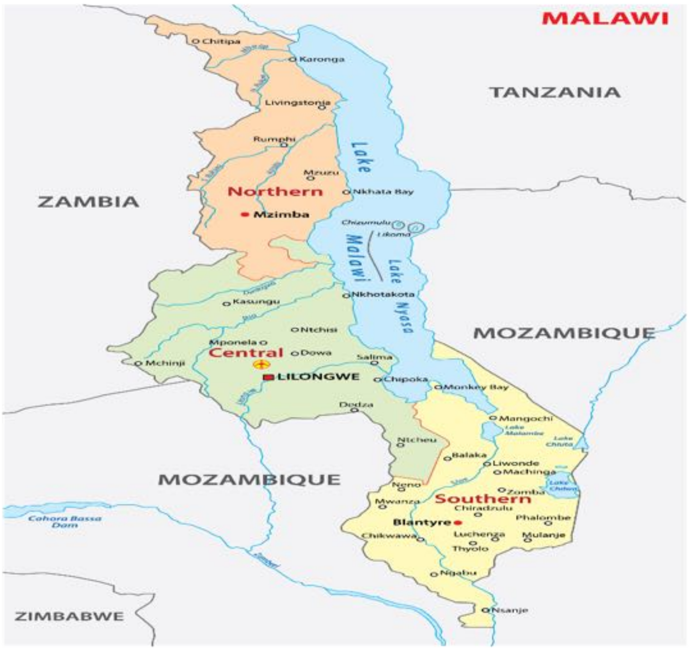

Figure 2: Map of Malawi

The analysis is restricted to rural areas (5,908 households). It uses the consumption aggregate from the LSMS-ISA team, and the income levels and shares developed through the Rural Income Generating Activities (RIGA) methodology.

MEASURES OF FOOD CONSUMPTION OF RESPONDENTS IN MALAWI

This analysis focuses on the relationship between income composition, diversity and liquidity constraints, and food consumption. The measures used are: (a) calories *per capita*, (b) food expenditure *per capita*, (c) Food Consumption Score (FCS), (d) Simpson Diversity Index (SDI) of calorie consumption; and (e) share of consumption of calories from food groups.

Food consumption and calorie intake provide information on the overall level of energy irrespective of the type of food consumed, while the FCS and the SDI shed light on the composition and quality of diets by considering the number and diversity of food groups. Food consumption expenditure and caloric intake data were collected using food consumption modules.

The Simpson Diversity Index (SDI) is a measure of diversity which takes into consideration the importance of each food consumed. It is defined as $\mathrm{SDI_h} = 1 - \sum_{i=1}^{8} \mathrm{ShCal}_{hi}^{2}$, where $\mathrm{ShCal_{hi}}$ is the caloric consumption of food item i divided by the total quantity of calories of household *h*. The measure does not assign weights to food groups based on nutritional importance, but only considers the number and the magnitude of the shares. Given this caveat, we also use the Food Consumption Score (FCS), which is a DD measure that considers the frequency of consumption of 8 food groups weighted by the group-assigned nutrient-based factor [17]. The food groups are: (1) Cereals; (2) Roots/tubers; (3) Nuts/pulses; (4) Vegetables; (5) Meat/fish/animal products; (6) Fruits; (7) Milk/milk products; (8) Sugars/honey/oils/fats/others.

It can be represented as $\mathrm{FCS_h} = \sum_{i=1}^{8} \mathrm{f_{hi}} * \mathrm{w_i}$, where $\mathrm{f_{hi}}$ is the frequency of consumption of group i by household *h* and, $\mathrm{w_i}$ is the weight attributed to each group.[1]

The analysis also employs the Shares of Calorie Consumption of food groups used for the calculation of the FCS.[2]

Between 2010 and 2013, while food expenditures and calorie consumption increased significantly[3], DD outcomes only experienced a modest improvement (Table 1). The share of food groups trends shows that most of the diets in rural Malawi are dominated by cereals. Even though nuts and pulses had a small increase, and vegetables and fruits saw a drop, there were no major shifts in diet composition.

Some differences are present when looking at consumption and DD by sex of household head (Table 2). Gender differences are not significant when it comes to food consumption *per capita* each year. Female headed households experience significantly higher levels of calorie consumption *per capita* per day, while male headed have higher diet diversification.

The shares of consumption by food groups are relatively similar across male and female headed households, except for the shares of cereals which play a bigger role in female-headed households, while meat, fish and animal products are more prominent in households headed by men. These results may be associated with the differences in income levels, with male headed household accessing relatively more cash that allow for diversification beyond home-produced staples.

[1] The indicator ranges from 0 to 35 and allows for the classification of households into one of the following three categories: (a) poor food consumption (0-21), (b) borderline food consumption (21-35); and (c) acceptable food consumption (above 35).
[2] These shares are used in the SUR model discussed in the empirical strategy.
[3] The MWK levels are reported in real terms, at 2010 prices. The reported increase of 10,730 MWK corresponds to an increase of 88 USD *per capita* over the period 2010-2013.

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FOOD AVAILABILITY AND MARKET DEPENDENCY IN MALAWI

Figure 3 illustrates households' sourcing of calories by food groups over the two years, highlighting home production, gifts from others, and market purchases. There are no major differences over time in the structure of consumption. Agricultural-based consumption is mostly originated from own production. Cereals/grains has the greatest reliance on home production and least dependency on gifts and market acquisitions. Roots, tubers, nuts, and pulses have a relatively greater dependency on market acquisitions.

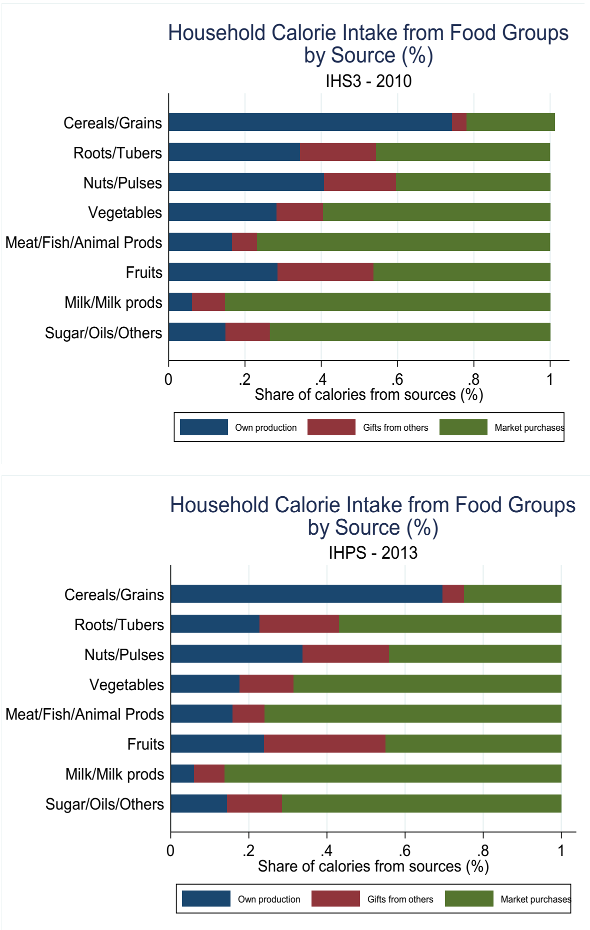

Figure 3: Household calorie intake from food groups by source, 2010 and 2013
Source: Malawi IHPS (2010 and 2013)

The data shows that meat, fish, animal products, milk, vegetables, sugars/oils/fats are mostly sourced through the market. These findings motivate the testable hypothesis of whether greater liquidity will strengthen DD via the increased consumption of non-agricultural staple-based products. Following this line of

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reasoning, in our analysis we try to capture liquidity constraints through the share of cash in household income.

HOUSEHOLD INCOME COMPOSITION, DIVERSIFICATION, AND LIQUIDITY IN MALAWI

The assessment of the linkages between the outcomes of interest and household[4] income composition, diversity, and liquidity considers different income sources: (a) crop income from own production for consumption; (b) crop income from sales; (c) livestock income from own production for consumption; (d) livestock income from sales; (e) farm wage; (f) non-farm wage, and (g) non-farm self-employment. Table 3 provides summary statistics across the two panel waves. Income *per capita* shows a small, not statistically significant, increase. The major sources of income growth over the period 2010-2013 were own food production and self-employment. Despite a slight fall, agricultural wage (ganiyu) remained an important source of income, particularly among the poorest.

Despite all households experiencing growth in income *per capita,* the gender gap remains significant. Some differences are also observed with respect to income sources: male headed households experience higher income from virtually all sources. Men's advantage is more pronounced for non-farm self-employment and crop sales. There are no significant differences in non-farm wage levels, but the gap between agricultural wage and livestock sales decreases.

Regarding income diversity, there is low diversification. Nevertheless, a statistically significant improvement is observed between 2010 and 2013 (Table 3). Despite earning significantly less income overall, female headed households have incomes that are relatively more diversified – the SDIs were about 0.47 (female) and 0.43 (male) in 2010 and 0.50 and 0.47 in 2013, a statistically significant difference each year (Table 3).

Finally, liquidity, measured as the share of cash income from non-agricultural /non-livestock sources, i.e., non-farm income, is estimated at about 20% each year. Female headed household experience stronger liquidity constraints in both waves (Table 3).

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[4] In this study, a household is defined as a unit of production and consumption composed of one or multiple individuals (blood or not-blood related), generally dwelling - for most of the year - under the same roof, sharing common domestic utensils, and consuming the same food

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EMPIRICAL STRATEGY APPLIED TO A FOOD CONSUMPTION STUDY IN MALAWI

The empirical strategy relies on two models: (a) Fixed Effects (FE) model for food consumption and DD outcomes, and (b) Seemingly Unrelated Regression (SUR) model of food group shares. Both models test for income composition, diversity, and liquidity effects.

Fixed Effects model for consumption and dietary diversity
Consider the general unobserved effects/Fixed Effects model:

$$(1) \quad y_{ht} = z_{ht}\beta_1 + x_{ht}\beta_{2,3} + c_h + u_{ht} \qquad , t = 1,2$$

Where
y_{ht} is the dependent variable of interest: consumption and calories intake *per capita* and DD outcomes (FCS and SDI) for household *h* in period *t*.
z_{ht} is the independent variable of interest: income composition, diversity, and liquidity.
x_{ht} are other independent variables, such as demographics, assets, *per capita* expenditure, etc.
c_h captures all unobserved, time invariant factors that affect y_{ht}.
u_{ht} is the idiosyncratic error or time-varying error.

More specifically, exploiting the peculiarities of our panel dataset and the questions in hand, the paper estimates three FE Models. It starts by testing the question on whether growth in income sources matter for food consumption and DD. The FE Model to test this question is specified as follows:

$$(2) \quad Y_{ht} = \beta_0 + \beta_1 \mathrm{IncomePC}_{ht} + \beta_2 \mathrm{ExpenditurePC}_{ht} + \beta_3 \mathbf{X_{ht}} + \epsilon_i \, , \; t = 2010, 2013$$

Where
Y_{ht} is the dependent variable(s) of interest: food consumption *per capita*, calorie consumption *per capita*, FCS and SDI for household *h* in period *t*; $\mathrm{IncomePC}_{ht}$ income levels *per capita* from the different sources for household *h* in period *t*. The vector of characteristics of household *h* in period *t* is indicated as X_{ht}, that includes exogenous variables such as household composition, head's sex and education, and land area owned.

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The second specification aims at verifying whether changes in income diversity influence food consumption and dietary outcomes:

(3) $Y_{ht} = \beta_0 + \beta_1 SimpsonIndex_{ht} + \beta_2 ExpenditurePC_{ht} + \beta_3 X_{ht} + \epsilon_i$, $t = 2010, 2013$

where Y_{ht} the dependent variables of interest are similar to the first specification. Whether diversity of income sources matters is tested using the Simpson Diversity Index for income sources ($SimpsonIndex_{ht}$).

The third specification of the FE model sheds light on the linkages between the dependent variables and liquidity constraints:

(4) $Y_{ht} = \beta_0 + \beta_1 ShCash_{ht} + \beta_2 ExpenditurePC_{ht} + \beta_3 \mathbf{X_{ht}} + \epsilon_i$, $t = 2010, 2013$

where, $ShCash_{ht}$ is the share of cash income from off-farm sources. The estimation also controls for total expenditure *per capita* $ExpenditurePC_{ht}$ and its squared term to test for non-linearity. This variable is included to test the hypothesis of interest, while preventing the omitted variable bias that would result if changes in the levels of the income sources are correlated with the total expenditure.

Seemingly Unrelated Regression model

The second approach is a Seemingly Unrelated Regressions (SUR) model to analyze how income sources influence the allocation of calories across food groups. Given the nature of the decision-making process on consumption choices, a system of linear equations that allows for correlation across the error terms of the different equations, subject to the constraint that all the calories shares have to sum up to unity.

The iterative two-stage Generalized Least Squares Estimator allows the SUR model to provide efficient estimations by combining and optimizing all the available information. The model is specified as follows:

(5) $ShCal_{iht} = \beta_0 + \beta_1 Z_{ht} + \beta_2 ExpenditurePC_{ht} + \beta_3 \mathbf{X_{ht}} + \epsilon_i$, for each food groups i=1 to 8.

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$$(6) \quad \sum_{i=1}^{8} \mathrm{ShCal}_{iht} = 1$$

where ShCal_{iht} is household *h* share of calorie from food group i, Z_{ht} is the independent variable of interest (income sources *per capita*, SDI or Share of cash income), $\mathrm{ExpenditurePC}_{ht}$ is the total level of expenditure *per capita,* and X_{ht} is a vector of household characteristics. ϵ_i is the error term.

RESULTS AND DISCUSSION

Fixed Effects models

Table 4 shows the results for the model on the effects of changes in income components on consumption and DD, controlling for expenditure *per capita* and other factors. Both consumption and DD increase with expenditure at a decreasing rate. On average, a 1% increase in *per capita* expenditure increases food consumption *per capita* by 2.9% corresponding to an average of 2,400 MKW (19.8 USD) at 2010 prices, calorie intake *per capita* by 2.2% (53 KCal), FCS by 35 units and the SDI by 0.48 units.

F-test of the equality of all coefficients associated with growth in income sources indicate that: (a) we fail to reject the null hypothesis for food consumption on whether all components have an equal effect (composition of growth does not matter) on food consumption *per capita*; and (b) reject the null for calorie consumption and both DD measures, for example, growth in individual components have differentiated impact on nutritional outcomes.

First, calorie intake is positively associated with increases in income from consumption of own production of livestock/products, which means that raising and consuming more leads to higher levels of calories more broadly. An increase of 1,000 MKW *per capita* income of livestock/products leads to an increase of 4 Kcal in total caloric intake. The livestock and animals/products in question include especially small ruminants, especially goats, as well as poultry and other small domestically raised animals. Calorie intake is, however, inversely associated with growth in self-employment income (micro and small enterprises), i.e., an increase of 1,000 MKW *per capita* in self-employment income leads to a total drop of 3 Kcal *per capita.* This points to the potential trade-offs that households face and their inability to increase consumption of high calorie items through market purchases (due to lack of liquidity), even though overall diversity is barely impacted.
Second, growth in non-farm wage income and crop sales increase the Simpson Diversity Index (SDI) of calorie intake, for example., an increase of 1000 MKW *per*

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capita income of non-farm wage income results in 2 additional points of the SDI. Similarly crop sales increases it by 1 point. Growth in staple crop production for home consumption reduce the SDI. An increase in SDI implies that households are diversifying diets towards the consumption of more food groups, leaning more away from a dominance of cereals/grains and roots/tubers to diets that include animal and non-animal proteins, fruits and vegetables, and dairy products.

Results for the FCS are consistent in sign with those from the SDI but are statistically less robust. Regarding household characteristics, increases in household size reduce caloric intake but are positively associated with gains in dietary diversity. Moreover, increases in the number of chronically ill adults is associated with worsening of dietary diversity.

Turning to the effect of income diversity (SDI of income sources) on food consumption and dietary diversity, Table 5 shows that there is no effect of income diversity on changes in the levels of both measures of food consumption. A positive and statistically significant association is found, however, with respect to the SDI of calorie intake and a positive, but not statistically significant effect on the FCS. These results suggest, therefore, that income diversification plays a greater role for dietary diversity, not on the actual levels of consumption expenditure and calorie intake. This result reflects the fact that the distinction between farm (crop and livestock production and sales) and off-farm (self-employment and agricultural and farm and non-farm wage) sources of income does not matter to the simple maximization of the levels consumption expenditure and calorie intake that can be made regardless of the way they manifest (home produced or purchased). They do, however affect dietary diversity, as part of it depends on the ability that households have to purchase products, which comes with income earned from the sales of crops and livestock, self-employment earnings, and wages from labor market participation.

Results on whether liquidity (the availability of non-farm cash income) affects consumption and nutritional outcomes are presented in Table 6. Consistent with the previous finding, increases in the share of cash income derived from off-farm labor market participation and non-farm self-employment activities are negatively associated with calorie intake *per capita* [4]. Moreover, a positive and statistically significant association is found with the Food Consumption Score (FCS). Even though with a lower magnitude, liquidity also positively influence the SDI of calorie intake. These results are indicative that, keeping constant the level of overall income, higher income diversification and cash availability leads to better diversity and quality of diets.

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Seemingly Unrelated Regression model

The Seemingly Unrelated Regression (SUR) model confirms that growth of expenditure *per capita* contributes to the increase of each individual food group share, although in different orders of magnitude. The effects of each income component on the changes in the share of calories varies (Table 7). As expected, growth in agricultural crop income increases the share of consumption of agricultural commodities and reduces the share of non-agricultural based foods. One exception is the effect of crop sales on the cereals/grains consumption which is negative. Indeed, crop sales, dominated by maize in rural Malawi, have the potential to reduce current consumption and, due to increases in prices in the hungry season, result in lower overall consumption of the same items.

When compared to agricultural-based calories, income from livestock generally contributes to greater growth in meat, fish, and animal by-products consumption. Cash generating sources such as non-farm self-employment and non-farm wage promote DD via the increased consumption of calories sourced from the market, namely animal-based proteins, fruits, milk, and oils/fats, and sugars. The effect of changes in household characteristics are consistent with expectations - increases in the dependency ratio, female headship, and land area, are generally associated with greater crop-based shares, and negatively correlated with non-farm consumption.

FE model results point to a positive association between diversity of income and DD. Results (Table 8) suggest that the vehicle through which that takes place and confirm the hypothesis put forward that greater income diversity implies relatively greater calorie consumption of roots/tubers, nuts/pulses and fruits and a relative drop in the intake of balanced diets. This result is consistent with the presence of a strong effect of the SDI of income on the SDI of calories, but the absence of a statistically significant effect on the FCS that better reflects diversity across food groups.

As the SDI does not reflect any link between the diversity of sources and the liquidity of households as they become more diversified, we use our measure of liquidity (cash income) to assess how diversity towards cash sources affects the changes in the structure of calorie consumption from different food groups. Results in Table 8 indicate that increased access to cash increases DD via the increased consumption of non-agricultural sources of calories (notably dependent on market acquisitions) such as animal proteins, vegetables, fruits, milk, and others, which bring about more diversified diets. This result is consistent with prior results that show a positive and significant effect of liquidity on DD [4]. It also underscores the importance of promoting income diversification through cash generating opportunities to promote consumption growth and DD.

CONCLUSION, AND RECOMMENDATIONS FOR DEVELOPMENT

This analysis investigates how changes in income composition, diversity and liquidity affect food consumption and dietary diversity (DD) in rural Malawi. It uses Fixed-Effects (FE) models to better understand how income composition, diversity, and liquidity relate to consumption and dietary diversity. A Seemingly Unrelated Regression (SUR) model analyzes how income sources influence the allocation of calories across food groups.

The analysis yields some important results. Fixed Effects estimates show that (a) consumption and DD increase with wealth, but at a decreasing rate; (b) while no relationship is found between changes in income *per capita* of different sources (composition effects), and food consumption per capita, there is a differentiated impact on calorie intake changes and DD outcomes; (c) the increase in the number of chronically ill adults is associated with worsening DD reflecting the inability of those households to increase their activity portfolio and cash income that allows for better access to diversified diets; (d) there is no statistically significant effect of income diversity on changes in food consumption, but a positive association is found with DD, as greater DD depends on the ability that households have to purchase products. Such ability comes as a result of income earned from the sales of crops and livestock, self-employment earnings, and farm and non-farm wages; and (e) Along the same lines, higher liquidity is negatively associated with the changes in calorie consumption, but positively and statistically and significantly associated with diversified diets, i.e., the consumption of more food groups, away from diets dominates by carbohydrates (predominantly cereals/grains and roots/tubers) to those that include proteins, fruits and vegetables, and dairy products.

These results are corroborated with those from the SUR Model. First, growth in crop income increases the shares of agricultural-based consumption. Second, cash generating sources of income promote DD via the increased consumption of calories sourced from the market. Third, greater income diversity implies relatively greater consumption of calories from roots/tubers, nuts/pulses, and fruit crops, and a relative drop in consumption of balanced diets. Finally, greater liquidity increases DD via the increased consumption of non-staples sources of calories, notably

those dependent on market acquisitions, such as animal proteins, fruits and vegetables, dairy products, and sugars, oils, and fats.
Some policy implications are derived. First, income composition, diversity and liquidity are important dimensions to consider when focusing beyond food security to account for the composition and quality of diets. Second, efforts to promote and sustain income growth are critical for food consumption growth and DD in rural Malawi. However, increases in income alone are not enough. Policies and investments that ensure a diversified portfolio of economic activities are likely to result in better DD. Promoting crop diversification at the farm level through nutrition sensitive programming, including extension and crop support programs is critical to increase and sustain consumption and better dietary quality.

Third, since, in the context of Malawi, balanced diets require a combination of foods that are not limited to agricultural products sourced through own production, but also protein-rich foods typically purchased in the market, a degree of liquidity achieved through increased generation of cash income is required. The diversification of livelihoods needs to include sources that increase liquidity, such as wage and self-employment income, and the ability for households to access market sourced food items that relate to diversified diets. Finally, programmatic efforts to reduce gender gaps in access to resources, strengthening nutrition education more broadly, and ensuring availability of balanced diets in school feeding programs through local procurement linked to production support programs are also important.

Conflict of interest

The authors declared no conflict of interest.

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Table 1: Food Consumption Outcomes, Rural Areas, 2010-2013

	Survey Years		Difference	p-value
	2010	2013		
Consumption outcomes				
Food Consumption *per capita* (MWK)	83,258	93,988	10,730	0.000
Calorie consumption *per capita* (Kcal)	2,397	2,600	203	0.000
Dietary diversity outcomes				
Food Consumption Score (FCS)	54.1	55.6	1.5	0.027
Simpson Diversity Index (SDI)	0.450	0.456	0.006	0.368
Share of food groups (% of total calories consumed)				
Cereals	68.1	67.8	-0.2	0.742
Roots and tubers	6.3	5.2	-1.1	0.001
Nuts and pulses	6.4	10.0	3.5	0.000
Vegetables	1.3	0.8	-0.5	0.000
Meat, fish and animal products	3.1	3.0	-0.1	0.298
Milk and milk products	0.4	0.4	0.0	0.480
Fruits	0.9	0.7	-0.3	0.023
Sugars, oil and fats	13.5	12.1	-1.4	0.000

Source: Malawi IHPS (2010 and 2013)

Table 2: Food Consumption, by sex of household head, 2010-2013

	Survey Years							
	2010				2013			
	Male	Female	Difference	p-value	Male	Female	Difference	p-value
Consumption outcomes								
Food Consumption pc (MWK)	77,796	73,463	4,333	0.306	88,615	89,914	-1,299	0.747
Calorie consumption pc (Kcal)	2,339	2,480	-141	0.105	2,500	2,646	-146	0.068
Dietary diversity outcomes								
Food Consumption Score	52.9	46.7	6.2	0.000	53.9	49. 6	4.3	0.000
Simpson index of calorie consumption	0.441	0.403	0.038	0.001	0.445	0.422	0.023	0.011
Share of food groups (% of total calories consumed)								
Cereals	68.9	70.9	-2.0	0.081	68.4	70.4	-2.0	0.017
Roots and tubers	6.2	6.5	-0.2	0.702	5.2	4.8	0.3	0.264
Nuts and pulses	6.5	6.6	0.0	0.956	10.5	10.0	0.5	0.241
Vegetables	1.4	1.2	0.2	0.238	0.7	0.8	0.0	0.397
Meat/fish/animal products	3.1	1.8	1.3	0.000	2.7	2.3	0.4	0.007
Milk and milk products	0.2	0.3	0.0	0.639	0.2	0.2	0.0	0.802
Fruits	0.8	1.0	-0.1	0.000	0.6	0.7	-0.1	0.337
Sugars, oil and fats	12.8	11.8	1.0	0.737	11.6	10.8	0.8	0.110

Source: Malawi IHPS (2010 and 2013)

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Table 3: Income Composition, Diversity and Liquidity, by sex of the head, 2010-2013

	Survey years				Gender Differences							
					2010				2013			
	2010	2013	Diff.	p-value	Male	Female	Diff.	p-value	Male	Female	Diff.	p-value
Activity income (MWK pc)	**29,045**	**32,832**	**3,787**	**0.179**	**32,310**	**18,224**	**14,087**	**0.001**	**36,058**	**23,646**	**12,413**	**0.000**
Composition of income: *per capita* by source (MWK)												
Crop - own consumption	4,687	6,829	2,142	0.000	5,052	3,475	1,577	0.004	7,079	6,115	964	0.136
Crop sales	3,279	3,191	-88	0.867	3,962	1,017	2,944	0.000	3,702	1,737	1,965	0.000
Livestock - own consumption	140	247	107	0.137	147	118	28	0.482	293	116	177	0.082
Livestock sales	382	555	173	0.127	402	314	88	0.294	597	436	161	0.351
Agricultural wage	3,403	3,895	492	0.317	3,886	1,801	2,085	0.000	3,958	3,715	243	0.733
Non-Farm wage income	4,762	4,176	-586	0.402	4,445	5,811	-1,366	0.536	4,183	4,155	28	0.982
Non-farm self-employment	5,706	8,833	3,127	0.016	6,775	2,160	4,616	0.001	10,679	3,575	7,104	0.000
Income diversity												
Simpson Diversity Index	0.44	0.48	0.03	0.000	0.43	0.47	-0.04	0.010	0.47	0.50	-0.04	0.000
Liquidity												
Share of cash income (%)	19.0	20.0	1.0	0.362	21.0	14.0	7.0	0.000	22.0	15.0	7.0	0.000

Source: Malawi IHPS (2010 and 2013)

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Table 4: Effect of Growth in Sources of Income on Food Consumption, FE

	Dependent Variables, Fixed Effects Model			
	Food Consumption		Dietary Diversity	
	Log of Food consumption pc	Log of Calorie Intake pc	Food Consumption Score (FCS)	Simpson Diversity Index (SDI) of Calorie intake pc
Income Composition				
Log [Crop income - own Consumption pc]	-0.001	-0.004	-0.024	-0.001*
	(0.001)	(0.003)	(0.078)	(0.001)
Log [Livestock income - own pc]	0.000	0.004**	0.021	0.001
	(0.001)	(0.002)	(0.074)	(0.001)
Log [Crop sales income pc]	0.001	-0.002	-0.092	0.001**
	(0.001)	(0.002)	(0.057)	(0.001)
Log [Livestock sales income pc]	0.001	-0.000	-0.046	-0.001
	(0.001)	(0.002)	(0.062)	(0.001)
Log [Agricultural Wage income pc]	0.000	0.001	-0.083*	-0.000
	(0.001)	(0.001)	(0.043)	(0.001)
Log [Non-Farm Wage income pc]	-0.000	-0.003	0.152**	0.002***
	(0.001)	(0.002)	(0.064)	(0.001)
Log [Self Employment income pc]	-0.001	-0.003**	0.001	0.000
	(0.001)	(0.001)	(0.051)	(0.001)
Log [Consumption expenditure pc]	2.878***	2.159***	34.676***	0.478***
	(0.263)	(0.464)	(11.853)	(0.128)
Log [Cons. expenditure pc squared]	-0.079***	-0.068***	-0.786	-0.016***
	(0.011)	(0.019)	(0.508)	(0.005)
Household size	0.001	-0.039***	1.842***	0.007***
	(0.004)	(0.006)	(0.219)	(0.003)
Female household head (§)	0.025	0.016	-0.743	-0.013
	(0.016)	(0.029)	(1.098)	(0.012)
Dependency ratio	0.014**	0.002	0.399	0.003
	(0.006)	(0.011)	(0.404)	(0.004)
Head's years of school	0.005***	0.000	0.123	0.000
	(0.001)	(0.002)	(0.089)	(0.001)
Share of adults chronically sick	-0.016	-0.020	-4.484**	-0.045**
	(0.035)	(0.056)	(2.150)	(0.022)
Land owned (Ha)	-0.009	0.020	0.462	0.014*
	(0.011)	(0.020)	(0.714)	(0.007)
Tests of "Equality of income sources"				
F-Test	0.708	2.578	1.935	2.446
2-Sided p-value	0.644	0.020	0.077	0.026
Marginal Effects of "Consumption Expenditure pc" on outcomes				
Per capita expenditure - p25	1.109	0.647	17.105	0.130
Per capita expenditure - p50	1.043	0.590	16.465	0.117
Per capita expenditure - mean	1.038	0.586	16.418	0.116
Per capita expenditure - p75	0.975	0.531	15.806	0.104
Per capita expenditure - p95	0.861	0.434	14.711	0.082
Number of observations	5,907	5,906	5,908	5,906
R-squared	0.840	0.413	0.239	0.133
Adjusted R-squared	0.839	0.412	0.237	0.131

Notes: ***denotes statistical significance at the 1% level, ** at the 5% level, * at the 10% level. § denotes dummy variable
Numbers in parenthesis are standard errors corrected for heteroscedasticity and clustering of the residuals at the EA level
Source: Malawi IHPS (2010 and 2013)

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Table 5: Effect of income diversity on food consumption, FE

	Dependent Variables, Fixed Effects Model			
	Food Consumption		Dietary Diversity	
	Log of Food consumption pc	Log of Calorie Intake pc	Food Consumption Score (FCS)	Simpson Diversity Index (SDI) of Calorie intake pc
Income Diversity				
Simpson Diversity Index (SDI) of Income sources	0.001	-0.027	0.331	0.023*
	(0.019)	(0.032)	(1.256)	(0.014)
Log [Consumption expenditure pc]	2.885***	2.127***	32.065***	0.466***
	(0.264)	(0.467)	(11.789)	(0.127)
Log [Consumption pc squared]	-0.079***	-0.067***	-0.664	-0.015***
	(0.011)	(0.020)	(0.506)	(0.005)
Household size	0.001	-0.041***	1.854***	0.007***
	(0.004)	(0.006)	(0.223)	(0.003)
Female household head (§)	0.025	0.021	-1.090	-0.019
	(0.016)	(0.028)	(1.114)	(0.012)
Dependency ratio	0.014**	0.004	0.446	0.003
	(0.006)	(0.011)	(0.403)	(0.004)
Head's years of school	0.004***	0.000	0.107	0.000
	(0.001)	(0.002)	(0.089)	(0.001)
Share of adults chronically sick	-0.015	-0.010	-4.479**	-0.045**
	(0.035)	(0.057)	(2.144)	(0.021)
Land owned (Ha)	-0.005	0.015	-0.117	0.012
	(0.012)	(0.020)	(0.702)	(0.007)
Number of observations	5,907	5,906	5,908	5,906
R-Squared	0.839	0.409	0.234	0.129
Adjusted R-Squared	0.839	0.408	0.233	0.128

Notes: ***denotes statistical significance at the 1% level, ** at the 5% level, * at the 10% level. § denotes dummy variable. Numbers in parenthesis are standard errors corrected for heteroscedasticity and clustering of the residuals at the EA level.
Source: Malawi IHPS (2010 and 2013)

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Table 6: Effect of Liquidity on food consumption, FE Model

	Dependent Variables, Fixed Effects Model			
	Food Consumption		Dietary Diversity	
	Log of Food consumption pc	**Log of Calorie Intake pc**	**Food Consumption Score (FCS)**	**Simpson Diversity Index (SDI) of Calorie intake pc**
Liquidity				
Share of cash income (Non-Agricultural wage, self-employment)	-0.030	-0.061**	3.282***	0.027**
	(0.018)	(0.028)	(1.121)	(0.011)
Log [Consumption expenditure pc]	2.907***	2.132***	33.364***	0.484***
	(0.260)	(0.471)	(11.839)	(0.129)
Log [Consumption pc squared]	-0.080***	-0.067***	-0.730	-0.016***
	(0.011)	(0.020)	(0.507)	(0.005)
Household size	0.002	-0.040***	1.819***	0.007***
	(0.004)	(0.006)	(0.219)	(0.003)
Female household head (§)	0.024	0.014	-0.748	-0.015
	(0.017)	(0.028)	(1.115)	(0.012)
Dependency ratio	0.013**	0.002	0.436	0.003
	(0.006)	(0.010)	(0.405)	(0.005)
Head's years of school	0.005***	0.000	0.100	0.000
	(0.001)	(0.002)	(0.090)	(0.001)
Share of adults chronically sick	-0.012	-0.021	-4.147*	-0.042*
	(0.037)	(0.057)	(2.145)	(0.022)
Land owned (Ha)	-0.009	0.008	0.177	0.016**
	(0.011)	(0.020)	(0.699)	(0.007)
Number of observations	5,885	5,884	5,886	5,884
R squared	0.839	0.410	0.240	0.129
Adjusted R squared	0.839	0.409	0.239	0.128

Notes: ***denotes statistical significance at the 1% level, ** at the 5% level, * at the 10% level. § denotes dummy variable. Numbers in parenthesis are standard errors corrected for heteroscedasticity and clustering of the residuals at the EA level.
Source: Malawi IHPS (2010 and 2013)

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Table 7: Effect of income sources on food consumption, SUR Model

	Share of calories from food groups:							
	Cereals/Grains	Roots	Nuts/Pulses	Vegetables	Meat/fish	Fruits	Milk/milk products	Sugars/oils and fats
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Log [Consumption expenditure pc]	4.603***	0.682***	0.531***	0.086***	0.479***	0.088***	0.081***	1.330***
	(0.010)	(0.035)	(0.024)	(0.019)	(0.004)	(0.010)	(0.004)	(0.004)
Income composition								
Log [Crop income - own Consumption pc]	0.334***	-0.041*	0.035**	0.013	-0.083***	-0.011	-0.025***	-0.079***
	(0.006)	(0.024)	(0.016)	(0.013)	(0.003)	(0.007)	(0.003)	(0.003)
Log [Livestock income - own pc]	-0.264***	-0.066**	0.050***	-0.030*	0.070***	0.009	0.024***	0.051***
	(0.007)	(0.028)	(0.019)	(0.015)	(0.003)	(0.008)	(0.003)	(0.003)
Log [Crop sales income pc]	-0.101***	0.132***	0.120***	0.006	-0.068***	-0.017***	-0.017***	-0.022***
	(0.005)	(0.023)	(0.015)	(0.012)	(0.003)	(0.006)	(0.002)	(0.002)
Log [Livestock sales income pc]	-0.133***	0.031	-0.028	0.018	0.022***	0.012	0.002	0.028***
	(0.006)	(0.026)	(0.017)	(0.014)	(0.003)	(0.007)	(0.003)	(0.003)
Log [Agricultural Wage income pc]	0.154***	0.096***	0.034***	0.001	-0.065***	-0.004	-0.018***	-0.103***
	(0.004)	(0.018)	(0.012)	(0.010)	(0.002)	(0.005)	(0.002)	(0.002)
Log [Non-Farm Wage income pc]	-0.267***	-0.176***	-0.040***	0.015	0.056***	0.012**	0.042***	0.141***
	(0.005)	(0.019)	(0.013)	(0.010)	(0.002)	(0.006)	(0.002)	(0.002)
Log [Self Employment income pc]	-0.159***	-0.121***	-0.013	0.010	0.030***	0.009*	0.022***	0.104***
	(0.004)	(0.017)	(0.012)	(0.009)	(0.002)	(0.005)	(0.002)	(0.002)
Number of observations	7,997							

Notes: ***denotes statistical significance at the 1% level, ** at the 5% level, * at the 10% level. Numbers in parenthesis are standard errors corrected for heteroscedasticity and clustering of the residuals at the EA level.
Source: Malawi IHPS (2010 and 2013)

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Table 8: Effect of income diversity and household liquidity on food consumption, SUR Model

	Share of calories from food groups							
	Cereals/Grains	**Roots**	**Nuts/Pulses**	**Vegetables**	**Meat/fish**	**Fruits**	**Milk/milk products**	**Sugars/oils and fats**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
Effect of income diversity on food consumption								
Simpson Index of Income sources	-1.203***	2.691***	2.937***	-0.134	-0.117**	0.267**	-0.639***	-1.732***
	(0.114)	(0.471)	(0.319)	(0.253)	(0.057)	(0.135)	(0.049)	(0.050)
Effect liquidity on food consumption								
Share of cash income (Non-Agricultural wage, self-employment)	-6.874***	-1.672***	-1.873***	0.436***	1.842***	0.455***	1.322***	0.490***
	(0.191)	(0.178)	(0.046)	(0.092)	(0.037)	(0.044)	(0.188)	(0.106)

Notes: ***denotes statistical significance at the 1% level, ** at the 5% level, * at the 10% level. Numbers in parenthesis are standard errors corrected for heteroscedasticity and clustering of the residuals at the EA level. Source: Malawi IHPS (2010 and 2013)

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