
# From Corn to Popcorn?

## Urbanization and food consumption in Sub-Sahara Africa: Evidence from rural-urban migrants in Tanzania

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# Abstract

Sub-Saharan Africa is currently in the midst of an unprecedented wave of urbanization that is expected to have wide-ranging implications for food and nutrition security. Though this spatial transformation of the population is increasingly put forward as one of the main drivers of changes in food consumption patterns, empirical evidence remains scarce and the comparative descriptive design of existing research is prone to selection bias as urban residence is far from random. Based upon unique longitudinal data from the Tanzania National Panel Survey and the Kagera Health and Development Survey, this study will be the first to assess the impact of urbanization on food consumption through comparing individuals' food consumption patterns before and after they have migrated from rural to urban areas. We find that even after controlling for individual fixed heterogeneity, baseline observable characteristics and initial household fixed effects, urbanization is significantly associated with important changes in dietary patterns, including a shift away from traditional staples towards more processed and ready-to-eat foods. While there is some evidence of changes that can be deemed beneficial from a nutritional point of view - including increased consumption of vegetables and animal source foods - the results also largely confirm concerns about the association between urbanization and heightened consumption of sugar and fats. In addition, we find no support for the hypothesis that urbanization is associated with more diverse diets. Finally, the results clearly indicate that rural-urban migration significantly contributes to reducing volatility in food consumption.

# Introduction

Sub-Saharan Africa is currently in the midst of an unprecedented urbanization wave. The region is rapidly shifting from a population dispersed across small rural settlements dominated by agriculture towards one that is concentrated in larger, dense urban settlements characterised by industrial and service activities. Though at present still the least urbanized region in the world, at more than 4 % per year Sub-Sahara Africa is experiencing the strongest urban population growth such that 55 % of its inhabitant are projected to be living in urban areas by 2050 (UN, 2015).

This spatial transformation is widely believed to be one of the driving forces behind the "nutrition transition", giving rise to and accelerating profound shifts in diets, physical activity and the prevalence of the double burden of malnutrition. More specifically, it is hypothesized that though many urban population are still faced with food insecurity, subpopulations suffer from dietary excess and obesity as a consequence of the transition towards diets high in sugar, fats and refined foods, but low in fibre (e.g. Popkin, 1999; 2001; Popkin and Gordon-Larsen, 2004).

Though a substantial literature discusses the impact of urbanization on food consumption, sound empirical evidence remains scarce. To date, the majority of existing research is based on comparative descriptive analysis. This approach has serious limitations, as urban residence is unlikely to be the sole difference between urban and rural population groups. As such, it remains unclear whether the identified differences in food consumption patterns can be attributed to a unique urban residence effect, or whether they merely reflect other socioeconomic disparities between urban and rural residents. In addition, little is understood about the pathways through which urbanization affects food consumption. While some authors put forward potential reasons as to why rural and urban food consumption may differ, the validity of these claims has not been tested.

This paper aims to improve our understanding of the impact of this rural-urban transition from a micro-level perspective. More specifically, we seek to address the issue of selection bias by going beyond simple comparisons of rural and urban residents and elaborating an innovative identification strategy focussing on rural-urban migrants. Based upon unique longitudinal survey data from Tanzania, this study will be the first to investigate the impact of urbanization on food consumption through the comparison of individuals' dietary patterns before and after they relocate from rural to urban areas. This specification allows us to control for individual fixed heterogeneity and initial household fixed effects.

Another contribution relates to food consumption volatility. Seasonal fluctuations in food consumption are widely acknowledged as serious threats to food and nutrition security, especially for farm households (Handa and Mlay, 2006; Hillbruner and Egan, 2008). However, to date surveys rarely capture this aspect of food consumption as they are often based on relatively short recall periods. Thanks to the monthly information in these Tanzanian data, this study is able to provide the first empirical assessment of the association between urbanization and food consumption volatility.

# 1. Urbanization and food consumption: Revisiting the literature

Urbanization interacts with several key determinants of food consumption. The shift away from agriculture for example implies that more people are employed in sectors with lower energy requirements (Popkin 1998, 1999, 2001). Another common assumption is that urbanization raises opportunity costs of time through improved (female) labour market opportunities, thus inducing greater preference for foods with shorter preparation time (Huang and Bouis, 2001; Regmi and Dyck, 2001). Others have pointed to the associated income growth (Stage et al., 2010; Regmi and Dyck, 2001). Urban areas are also characterized by markedly different food environments, which influences the availability and affordability of food. For instance, the ongoing expansion of supermarket and fast food chains in the developing world is still mainly concentrated in urban areas (Hawkes et al., 2009). Another line of thought focuses on the socio-cultural food environment and changes in preferences and habits that arise as a consequence of exposure to more global eating patterns in urban areas (Huang and Bouis, 2001; Regmi and Dyck, 2001) or of improved access to formal or informal nutrition knowledge.

A substantial literature attempts to estimate the impact on food consumption. Cross-country studies demonstrate that higher urbanization rates are associated with increasing consumption of animal source foods (Rae, 1998, Delgado, 2003) and sweeteners and fats (Drenowski and Popkin, 1997; Popkin, 1999; Popkin and Nielsen, 2003). Time series analysis then again shows that urbanization significantly affected cereal consumption patterns in Burkina Faso, Mali (Delgado, 1989) and Asia (Huang and David, 1993).

The majority of existing research is based on comparative descriptive analysis. Studies comparing rural and urban diets in Asia point to elevated levels of meat consumption (Huang and Bouis, 1996; Popkin, 1999; Regmi and Dyck, 2001; Huang and Bouis, 2001; Popkin and Du, 2003; Ma et al., 2004; Zhai et al., 2009), lower grain or rice consumption (Huang and Bouis, 1996; 2001; Popkin and Du, 2003; Zhai et al., 2009) and increased likelihood of eating meals away from home (Zheng and Henneberry, 2009) in urban areas. Other differences include that urban diets are more diverse (Popkin and Du, 2003) and contain more fats and refined carbohydrates (Shetty, 2002; Popkin and Du, 2003; Mendez and Popkin, 2004). The latter is confirmed for Latin American (Arimond and Ruel, 2004; Willaarts et al., 2013)and Sub-Saharan African countries (De Nigris, 1997; Bourne et al., 2002; Abdulai and Aubert, 2004;Smith et al., 2006), where urban diets tend to be less dominated by traditional staples (De Nigris, 1997; Maxwell et al., 2000; Hassen et al., 2016). Multiple studies also indicate increased consumption of processed cereal products including bread (Maxwell et al., 2000; Hassen et al., 2016) and growing reliance on street foods (Maxwell et al., 2000; Maruapula et al., 2011).

Several authors however, discuss the limitations of this approach. Popkin (1999) for example argues that these descriptive studies contribute little to our understanding of the causes for these differences. In particular, there is no clear sense if these can be attributed to a unique urban residence effect or just reflect differences in socioeconomic factors. In addition, we have no knowledge about the timing of these effects. Finally, Huang and Bouis (2001:62) conclude that "an ideal data set for measuring structural shifts in food demand patterns records foods consumed before and after a large number of families migrated from rural to urban areas".

Witcher et al. (1988) adopt a somewhat similar approach to study the effect of rural-urban migration in Ecuador. During an interview, women were asked to report the frequency of consumption of different food items before and after migrating. The lack of actual panel data however, raises concerns about recall bias. To the best of our knowledge, this study will be the first to employ a panel data approach to assess changes in food consumption after migrating from rural to urban areas.

# 2. The setting: Tanzania

As one of the world's most rapidly growing and urbanizing countries in the world, Tanzania – a low-income, low human development country in East Africa – provides an extremely relevant case study to investigate the impact or urbanization on food consumption. Average urban population growth over the past two decades amounted to over 5 %. As a result, close to 31 % of the population is currently living in urban areas, compared to 20.5 % in 1995 (World Bank, 2016). The former capital, Dar es Salaam (DSM) is even expected to hit the ten million mark by 2030 and become one of the 20 largest cities in the world by 2050 (UN, 2015)

Despite considerable progress, food security gains are not matching national economic gains (WFP, 2013). An estimated 34.8 % of children under five – 44.2 and 30.8 % in rural and urban areas respectively – was still affected by stunting in 2010-2011 (WHO, 2014). At the same time, the prevalence of overweight and obesity is rising rapidly especially in urban areas with already 13.3 % of women estimated to be obese (WHO, 2015).

In addition, at an estimated 8.51 % per annum between 2002 and 2012, Tanzania has been faced with strong food price inflation, which has resulted in food prices increasing faster than non-food prices (Adam et al., 2012). More generally, the food environment in Tanzania is undergoing rapid changes. The "supermarket revolution" has arrived in the capital. DSM now hosts various supermarket chains. This transformation is still just taking root in secondary cities, most notably via the increase in small supermarkets (Ijumba et al., 2015). Processed and imported foods are also widely available in urban areas and their share in the budget is expected to increase dramatically in the future (Ijumba et al., 2015; Tschirley et al., 2015).

# 3. Methodology

As mentioned above, the simple comparison of food consumption patterns in rural and urban areas is unlikely to capture the true impact of urbanization as location is far from random, which raises concerns about selection bias. Perhaps the most promising approach to study the impact of urbanization on food consumption is to compare individuals' dietary patterns before and after they migrated from rural to urban areas.

In line with Beegle et al. (2011), we employ a difference-in-difference estimator, comparing changes in food consumption of those who stayed in their baseline rural community with those who moved to other rural areas or urban areas. This specification controls for individual fixed heterogeneity, thus resolving a large number of possible sources of endogeneity, which are likely to affect both migration and food consumption. We distinguish urban areas in DSM from secondary cities as it clearly stands out in terms of population – 4.36 million, accounting for 10 % of the total Tanzania Mainland population according to the 2012 census – and is characterized by a markedly different food (retail) environment (cfr. supra).

It is important to note however, that in the absence of experimental data, heterogeneity affecting both food consumption and the process of migration remains a key concern. These data offer excellent opportunities to control for a wide set of factors in this respect. First, we can control for a set of individual characteristics that may affect food consumption and possibly migration as well. In addition, we can control for initial household fixed effects because we observe baseline households in which some individuals migrate and others do not. This controls for observable and unobservable factors fixed to the family.

In sum, the regression model looks as follows:

$$\Delta C_{i,t+1,t} = \alpha + \beta_1 M_{i,t+1}^{\text{rural-rural}} + \beta_2 M_{i,t+1}^{\text{rural-sec.cit.}} + \beta_3 M_{i,t+1}^{\text{rural-DSM}} + \gamma X_{i,t} + \delta_{i,h} + \epsilon_{i,t}$$

Where $C_{i,t+1,t}$ is change in one of the measures for food consumption discussed above for individual i between period t+1 and t. $M_{i,t+1}^{rural-rural}$, $M_{i,t+1}^{rural-sec.cit.}$ and $M_{i,t+1}^{rural-D.e.S.}$ are dummy variables equal to one when individual i stayed in the baseline rural community, migrated to a different rural area, secondary city or DSM respectively by period t+1. The term $X_{i,t}$ represents a vector of individual level characteristics that that may affect both food consumption and the process of migration; age, sex and years of education[1]in the baseline period. Finally, $\delta_{i,h}$ stands for the initial household fixed effects and $\epsilon_{i,t}$ represents the error term.

Since we include data from all individuals living in rural areas at baseline, those who did not migrate and remained in their original rural community serves as a control group. The impact of urbanization should be reflected in the coefficients of the dummies for migration to urban areas. In addition, we formally assess whether the urban destination rather than migration in general matters by testing whether the coefficients migration to secondary cities and DSM are significantly different from those for rural-rural.

[1] We attribute missing values for the level of education to zero years of schooling and included a dummy variable that equals one when the observation was originally reported as missing.

# 4. Data and results

We use data from two complementary surveys, the Tanzania National Panel Survey (TNPS) and Kagera Health and Development Survey (KHDS), as they offer distinct advantages. In particular, the TNPS provides us with data from a nationally representative sample and includes information on the exact quantity of consumption of a wide variety of food items. The KHDS on the other hand has an extraordinary long time-span (from 1991 to 2010), which provides us with a larger sample of migrants and allows us to get more insight in the long-term impact of migration. In addition, in sharp contrast to the large majority of surveys with recall questionnaires that are limited in time, the KHDS tracks food consumption with monthly data that allows us to capture volatility in food consumption.

## 4.1 Tanzania National Panel Survey

A nationally representative sample of 3,265 households was first interviewed in 2008/09. The second round relocated 3,168 baseline households and had a total sample size of 3,924 households. Finally, the 2012/13 round covered 3,786 of these households, bringing up the total sample size to 5,015.

The survey includes a one-week diet recall questionnaire at household level reporting food consumption in grams, litres or pieces. In addition, each individual reported the monetary value of their consumption of food and beverages outside the home. In order to quantify food consumption all these units were converted to grams and kilocalories, based on the detailed local conversion factors (Deweerdt et al., 2014).

The final sample consists of a balanced panel of 13,844 individuals for which information on food consumption was plausible. These individuals belonged to 1,868 rural and 1,022 urban households in the baseline. In 2012/13, after several household had split and some individuals had migrated, these individuals corresponded to 4,222 households. As can be derived from Table 1, despite the relatively short time span, the TNPS captures considerable migration flows. For our main analysis, we compare individuals who relocated from rural areas with those who remained in their original rural communities, thus focussing on the 9,363 individuals represented in the first row.

Table 2: Migration matrix

| | | *2012/2013* | | | |
|---|---|---|---|---|---|
| | | In same location | In different location | | |
| | | | Rural | Secondary cities | DSM |
| *2008/2009* | Rural | 8,390 | 729 | 151 | 93 |
| | Secondary cities | 2,482 | 139 | 256 | 35 |
| | DSM | 1,172 | 29 | 52 | 316 |

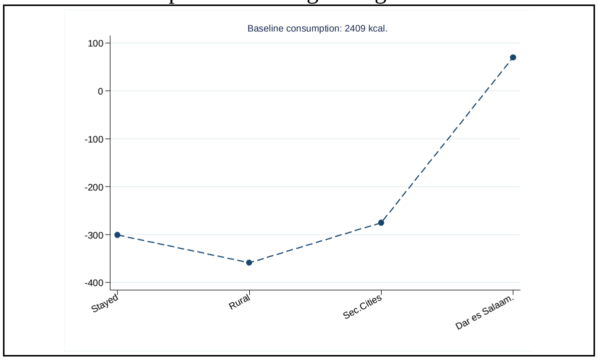
### 4.1.1 Food consumption

For this part of the analysis, we focus on the consumption of 12 food categories, of which 3 are further subdivided into subgroups per specific product type, expressed in kilocalories per capita per day.

#### 4.1.1.1 *Descriptive analysis*

The mean change in total food between 2008/09 and 2012/13 across individuals who stayed in their original rural community and those who moved elsewhere is depicted in Figure 1. On average total food consumption has decreased over time. This could to some extent be explained by the sharply rising food prices during this period. Contrary to prior findings (e.g. Abdulai and Aubert, 2004; Hassen et al., 2016), these data suggest that urbanization has a positive impact on total energy intake.

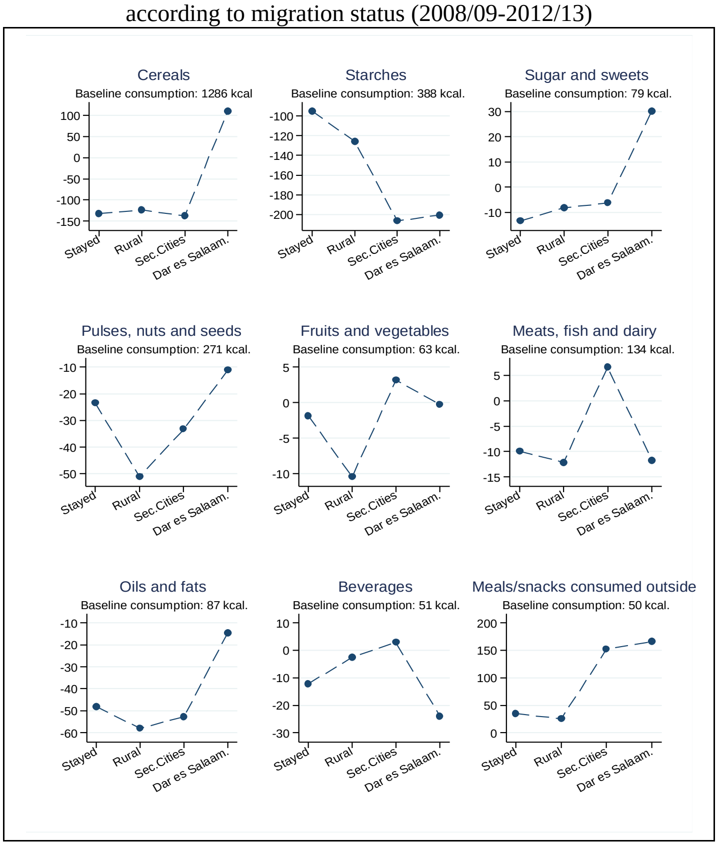
Figure 1: Mean change in total food consumption according to migration status




Food consumption is expressed in kcal. per capita per day.

It line with the hypothesis that urbanization has a greater impact on the composition rather than the level of food consumption (Regmi and Dyck, 2001), we aim to further disentangle changes in dietary patterns associated with rural-urban migration by focusing on mean changes in the consumption of different food (sub) groups.

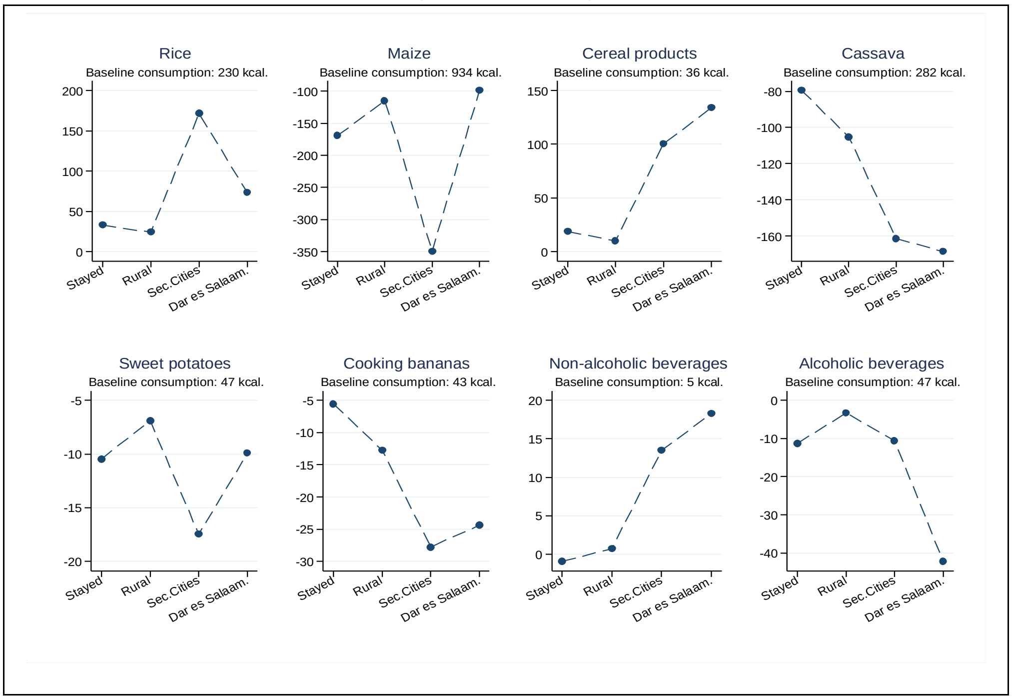
Figure 2: Mean change in consumption of food groups according to migration status (2008/09-2012/13)




Food consumption is expressed in kcal. per capita per day

Figure 2, demonstrates that while increasing for those who moved to DSM, the consumption of cereals decreased over time for non-migrants and for migrants to other rural areas and secondary cities. Further disaggregation (see Figure 3) reveals large increases in the consumption of processed cereal products after moving to more urbanized areas. This is in line with findings from Ghana (Maxwell et al., 2000) and could be related to the hypothesis that higher opportunity costs of time will induce urban consumers to prefer food products with shorter preparation times. Similar to previous studies documenting that urban diets in Sub-Saharan Africa are less dominated by traditional staples (De Nigris, 1997; Maxwell et al., 2000), the descriptive statistics further suggest a shift away from cassava and maize in particular. Interestingly, the latter appears to be particularly pronounced for migrants to secondary cities.

Figure 3: Mean change in consumption of food subgroups according to migration status (2008/09-2012/13)




Food consumption is expressed in kcal. per capita per day.

Another notable difference appears for meals and snacks consumed outside the home. Though there was a general rising trend over time, this increase appears to be much greater for people who moved to more urbanized areas and DSM in particular. On average, the latter consumed an additional 192 kcal. worth of meals and snacks outside the home, compared to a modest increase of 33 kcal. for individuals who remained in their original rural communities.

In keeping with earlier findings (McIntyre, 2002; Abdulai and Aubert, 2004) these data show support for concerns about the health implications of urban diets (Popkin, 1999; 2004; 2012). Compared to those who relocated to DSM, the decline in daily intake of oils and fats was over three times greater for non-migrants. Likewise, though declining for individuals that stayed in their original rural communities, the consumption of sugar and sweets increased for those who moved to the former capital. In addition, there appears to be a much larger increase in the consumption of high-sugar processed cereal products such as buns, cakes and biscuits and sugary non-alcoholic beverages.

### *4.1.1.2 Regression analysis*

Next, we regress the difference in the consumption of the different food (sub) groups between 2008/2009 and 2012/2013 on dummy variables for migration from the baseline rural communities to different rural areas, secondary cities and DSM respectively. As mentioned above, those who did not migrate and remained in their original rural area serve as a control group.

Table 2: Change in the consumption of food groups (2008/09-2012/13)

| | ΔCereals | ΔStarches | ΔSugar, sweets | ΔPulses, nuts, seeds | ΔFruits, veg. | ΔMeat, fish, dairy | ΔOils, fats | ΔBev. | ΔMeals /snacks cons. Outs. |
|---|---|---|---|---|---|---|---|---|---|
| *Baseline cons.* | *1,285.95* | *387.62* | *78.63* | *134* | *17.98* | *99.18* | *86.96* | *51.17* | *50.16* |
| $M^{Rural}$ | 3.270 | 4.318 | 11.19 | -7.724 | -35.43$^{*}$ | -11.47 | -6.019 | 24.85 | 0.549 |
| | (53.83) | (31.65) | (6.150) | (6.627) | (18.01) | (12.92) | (6.388) | (25.88) | (37.65) |
| $M^{Sec.cit.}$ | 106.9 | -168.1$^{***}$ | 11.52 | -13.26 | -28.93 | 18.04 | -8.978 | 8.005 | 236.0$^{**}$ |
| | (120.7) | (45.91) | (11.29) | (10.08) | (33.28) | (24.17) | (18.58) | (26.84) | (78.36) |
| $M^{DSM}$ | -293.8$^{*}$ | -248.2$^{***}$ | 55.58$^{**}$ | 11.25 | -32.07 | 8.821 | 11.50 | 38.36 | 304.4$^{**}$ |
| | (145.5) | (60.30) | (18.62) | (14.65) | (56.84) | (29.07) | (16.70) | (40.88) | (108.3) |
| Const. | -157.6$^{***}$ | -91.91$^{***}$ | -17.32$^{***}$ | -5.067$^{**}$ | -35.57$^{***}$ | -14.57$^{***}$ | -49.81$^{***}$ | -7.563 | 35.74$^{**}$ |
| | (11.58) | (6.627) | (1.312) | (1.750) | (4.092) | (2.701) | (1.591) | (9.777) | (11.56) |
| Contr. | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| IHHFE | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| *N* | 9363 | 9363 | 9363 | 9363 | 9363 | 9363 | 9363 | 9363 | 8932 |
| $R^2$ | 0.916 | 0.919 | 0.890 | 0.912 | 0.912 | 0.890 | 0.909 | 0.368 | 0.475 |
| $M^{Rural} = M^{Sec.cit}$ | 0.646 | 10.02 | 0.001 | 0.229 | 0.031 | 1.048 | 0.023 | 0.236 | 7.429 |
| | 0.421 | 0.002 | 0.979 | 0.632 | 0.861 | 0.306 | 0.879 | 0.627 | 0.006 |
| $M^{Rural} = M^{DSM}$ | 3.866 | 12.57 | 5.442 | 1.512 | 0.003 | 0.439 | 0.950 | 0.089 | 7.543 |
| | 0.049 | 0.000 | 0.020 | 0.219 | 0.955 | 0.507 | 0.330 | 0.765 | 0.006 |
| $M^{Sec.cit.} = M^{DSM}$ | 4.760 | 1.177 | 4.301 | 2.006 | 0.002 | 0.061 | 0.713 | 0.414 | 0.270 |
| | 0.0292 | 0.278 | 0.0381 | 0.157 | 0.961 | 0.805 | 0.398 | 0.520 | 0.604 |

Food consumption is expressed in kcal. per capita per day.
Standard errors in parentheses.
$^{*}$ $p < 0.05$, $^{**}$ $p < 0.01$, $^{***}$ $p < 0.001$

The results of the regressions summarized in Table 2 largely confirm the trends identified in the descriptive analysis. We find a much stronger shift away from starches and towards meals and snacks consumed outside the home for migrants to secondary cities and DSM in that order. The coefficients for both dummies are highly significant and the F-test results further indicate that the impact of rural-urban migration is different from rural-rural migration, suggesting that the urban destination matters. Migration to DSM was also significantly associated with stronger growth in the consumption of sugar and sweets over time.

Compared to those who stayed in their original rural community as well as rural-rural migrants, rural-urban migrants experienced stronger growth in the consumption of processed cereal products over time (see Table 3). Interestingly, though in the descriptive analysis it appeared that the drop in maize consumption was much more pronounced for those who moved to secondary cities, only the coefficient for migration to DSM is significant after controlling for initial household fixed effects. Finally, we note that also the increase in the consumption of (sugary) non-alcoholic beverages was significantly greater for rural-urban migrants – and especially for those who moved to secondary cities.

Table 3: Change in the consumption of food subgroups (2008/09-2012/13)

| | ΔRice | ΔMaize | ΔCereal products | ΔCassava | ΔSweet potatoes | ΔCooking bananas | ΔNon-alc. beverages | ΔAlc. beverages |
|---|---|---|---|---|---|---|---|---|
| *Baseline cons.* | *230.07* | *933.65* | *35.79* | *282.42* | *46.69* | *42.91* | *4.61* | *46.56* |
| $M^{Rural}$ | 32.46 | -48.13 | -5.437 | 15.28 | -4.829 | -8.033 | 2.498 | 22.36 |
| | (28.44) | (46.15) | (8.652) | (29.90) | (7.065) | (5.944) | (2.102) | (25.80) |
| $M^{Sec.cit.}$ | 115.5$^{*}$ | -102.8 | 90.88$^{***}$ | -135.5$^{**}$ | -11.05 | -19.48 | 26.57$^{**}$ | -18.56 |
| | (53.81) | (98.42) | (25.89) | (42.74) | (11.60) | (9.957) | (8.487) | (25.32) |
| $M^{DSM}$ | 57.26 | -303.8$^{**}$ | 105.8$^{**}$ | -191.0$^{**}$ | -6.335 | -45.64$^{***}$ | 21.05$^{**}$ | 17.31 |
| | (74.18) | (98.84) | (33.18) | (59.41) | (6.186) | (13.19) | (6.588) | (39.81) |
| Const. | 8.714 | -157.5$^{***}$ | 9.522$^{***}$ | -75.11$^{***}$ | -9.606$^{***}$ | -6.994$^{***}$ | -0.132 | -7.431 |
| | (5.890) | (10.07) | (2.147) | (6.241) | (1.512) | (1.295) | (0.801) | (9.739) |
| Controls | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| IHHFE | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| *N* | 9363 | 9363 | 9363 | 9363 | 9363 | 9363 | 9363 | 9363 |
| $R^2$ | 0.884 | 0.926 | 0.874 | 0.918 | 0.906 | 0.915 | 0.415 | 0.367 |
| $M^{Rural} = M^{Sec.cit}$ | 1.941 | 0.269 | 12.75$^{***}$ | 8.766$^{**}$ | 0.189 | 0.979 | 7.499$^{**}$ | 1.515 |
| | 0.164 | 0.604 | 0.000 | 0.003 | 0.664$^{*}$ | 0.323 | 0.006 | 0.218 |
| $M^{Rural} = M^{DSM}$ | 0.095 | 5.966$^{*}$ | 10.93$^{**}$ | 8.632$^{**}$ | 0.031 | 7.433$^{**}$ | 7.481$^{**}$ | 0.013 |
| | 0.758 | 0.015 | 0.001 | 0.003 | 0.860 | 0.006 | 0.006 | 0.909 |
| $M^{Sec.cit.} = M^{DSM}$ | 0.425 | 2.203 | 0.127 | 0.606 | 0.136 | 2.634 | 0.257 | 0.627 |
| | 0.515 | 0.138 | 0.722 | 0.436 | 0.713 | 0.105 | 0.612 | 0.429 |

Food consumption is expressed in kcal. per capita per day.
Standard errors in parentheses.
$^{*}$ $p < 0.05$, $^{**}$ $p < 0.01$, $^{***}$ $p < 0.001$

### 4.1.2 Diet diversity

A very straightforward way to measure diet diversity is to count the number of food items or groups consumed. As there is no consensus in the literature as to whether individual food products or broader food groups should be used while assessing diet diversity as a proxy for more nutritious diets (e.g. Torheim et al., 2004), we report both.

The count measure - although easy to interpret - has the disadvantage that it does not consider the distribution of food consumption. There are alternative measures that overcome this problem such as the Berry Index (Berry, 1971), which has gained popularity in the literature (e.g., Thiele and Weiss, 2003; Drescher and Goddard, 2011; Hertzfeld et al., 2014). The Berry Index is calculated using the following formula:

$BI = 1 - \sum s_i^2$ where $s_i$ is the share of the $i^{th}$ food item/group in total food consumption in kcal.

This index ranges from 0, in the case where food consumption is entirely based on one food item or group, to 1-1/n, when n food items or groups are consumed in equal proportions[2].

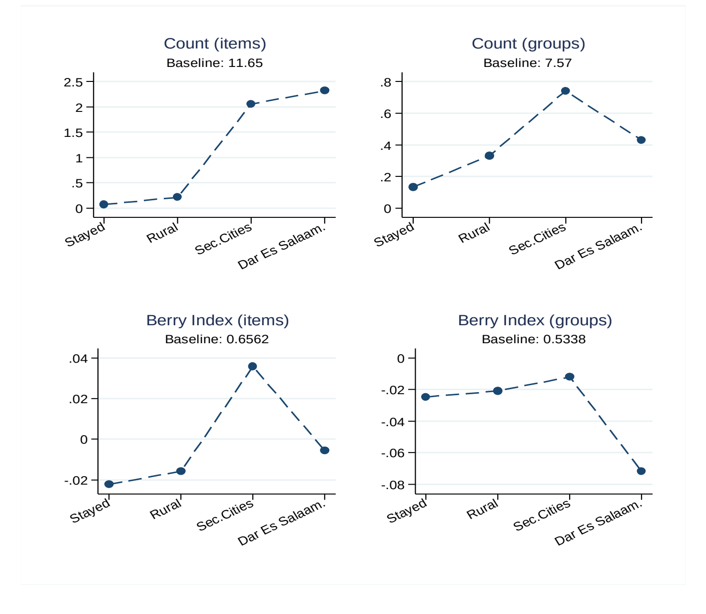
#### *4.1.2.1 Descriptive analysis*

Figure 4 depicts the mean change in the count measures and the Berry Indices based on individual food items and broad food groups between 2008/09 and 2012/13 according to

[2] For this particular dataset n – and thus the maximum value of the count measure – equals 55 or 12 when considering food items or broader food groups respectively. The upper bound of the Berry Index is therefore equal to 0.982 or 0.917 respectively.

migration status. When focussing on the count of food items – the most commonly used measure of diversity in economic studies – our results confirm previous findings and suggest that individuals consume more diverse diets after migrating to urbanized areas, whereas there was virtually no change for non-migrants and those who moved to other rural areas. Interestingly, the increase in the number of food groups consumed is largest for migrants to secondary cities.

Figure 4: Mean change in diet diversity according to migration status




Looking at the Berry Indices, we even find that the sharpest decline in diet diversity has occurred among migrants to DSM. To some extent, this decline can be explained by the increased reliance on foods consumed outside. As we are not able to distinguish between the different components of these meals, we could be underestimating diversity. When focussing only on foods consumed at home[3] however, we find a similar pattern. This could in theory be mitigated by the fact that meals and snacks consumed outside are more diverse. Information from food diaries (Deweerdt et al., 2014) however reveals that these meals consumed outside are mostly starch- or cereal-based and thus unlikely to contribute positively to diet diversity.

### *4.1.2.2 Regression analysis*

Contrary to previous findings on the relationship between urbanization and diet diversity (De Nigris, 1997; Bourne et al., 2002; Abdulai and Aubert, 2004; Smith et al., 2006), the results of our regressions indicate that – regardless of the measurement – rural-urban migration is not associated with significant changes in diet diversity after controlling for initial household fixed effects.

Table 4: Changes in diet diversity

| | ΔCount (items) | ΔBI (items) | ΔCount (groups) | ΔBI (groups) |
|---|---|---|---|---|
| *Baseline* | 11.546 | *0.630* | *7.630* | *0.508* |
| $M^{Rural}$ | -0.276 | 0.010 | -0.001 | -0.002 |
| | (0.345) | (0.015) | (0.171) | (0.015) |

[3] Additional information can be obtained from the corresponding author upon request.

| | | | | |
|---|---|---|---|---|
| $M^{Sec.cit.}$ | 0.968 | 0.038 | 0.033 | -0.032 |
| | (0.818) | (0.029) | (0.350) | (0.027) |
| $M^{DSM}$ | 1.604 | 0.0499 | 0.132 | -0.001 |
| | (0.967) | (0.035) | (0.474) | (0.035) |
| Const. | -0.864*** | -0.053*** | -0.122 | -0.043*** |
| | (0.142) | (0.006) | (0.068) | (0.006) |
| Controls | ✓ | ✓ | ✓ | ✓ |
| IHHFE | ✓ | ✓ | ✓ | ✓ |
| *N* | 9363 | 9363 | 9363 | 9363 |
| $R^2$ | 0.869 | 0.864 | 0.853 | 0.853 |
| $M^{Rural} = M^{Sec.cit}$ | 2.075 | 0.774 | 0.008 | 1.007 |
| | 0.150 | 0.379 | 0.928 | 0.316 |
| $M^{Rural} = M^{DSM}$ | 3.320 | 1.106 | 0.073 | 0.001 |
| | 0.069 | 0.293 | 0.788 | 0.971 |
| $M^{Sec.cit.} = M^{DSM}$ | 0.259 | 0.073 | 0.030 | 0.524 |
| | 0.611 | 0.787 | 0.864 | 0.469 |

Food consumption is expressed in kcal. per capita per day.
Standard errors in parentheses.
$^{*}$ $p < 0.05$, $^{**}$ $p < 0.01$, $^{***}$ $p < 0.001$

### 4.1.3 Pathways

Next, we attempt to capture some of the pathways that could explain the impact of urbanization on food consumption. More specifically, we assess the influence of changes in income – proxied by the difference in the logarithm of per capita total household expenditures over time – and the transition from a household headed by a farmer to a non-farming household.

From the results of the regressions summarized in Table 5 and 6, we can derive that several of the changes in consumption patterns that were captured by the migration variables in the previous regressions, can be explained by income changes or changes in occupational activities.

Table 5: Change in the consumption of food groups (2008/09-2012/13)

| | ΔCereals | ΔStarches | ΔSugar, sweets | ΔPulses, nuts, seeds | ΔFruits, veg. | ΔMeat, fish, dairy | ΔOils, fats | ΔBev. | ΔMeals /snacks cons. Outs. |
|---|---|---|---|---|---|---|---|---|---|
| *Baseline cons.* | *1285.95* | *387.62* | *78.63* | *134* | *17.98* | *99.18* | *86.96* | *51.17* | *50.16* |
| $M^{Rural}$ | -24.56 | 8.058 | 5.421 | -5.490 | -27.66 | -13.98 | -2.487 | 29.77 | 0.962 |
| | (51.54) | (31.47) | (6.003) | (6.514) | (17.55) | (11.85) | (6.567) | (28.17) | (30.36) |
| $M^{Sec.cit.}$ | -23.59 | -111.4* | -16.51 | -21.87* | -30.56 | -32.77 | -18.05 | 20.80 | 86.62 |
| | (124.5) | (43.66) | (10.97) | (11.06) | (35.89) | (24.68) | (20.75) | (31.13) | (72.05) |
| $M^{DSM}$ | -483.4*** | -216.9** | 33.29 | 0.357 | -32.33 | -39.41 | 2.888 | 60.96 | 52.37 |
| | (134.0) | (68.10) | (18.87) | (15.54) | (54.69) | (25.65) | (16.56) | (44.61) | (107.2) |
| Δ Farm | -79.49 | -116.6*** | 8.222 | -31.29*** | -102.4*** | -13.50 | -15.40 | -41.07 | 96.81** |
| | (55.99) | (30.90) | (6.844) | (6.973) | (20.14) | (14.02) | (9.039) | (21.15) | (37.27) |
| Δ Ln(exp.) | 427.7*** | 27.39 | 35.57*** | 42.20*** | 113.0*** | 111.8*** | 23.19*** | 5.633 | 213.1*** |
| | (39.10) | (20.25) | (4.171) | (5.418) | (12.65) | (9.570) | (5.041) | (15.26) | (27.12) |
| Const. | -324.8*** | -94.47*** | -32.43*** | -20.23*** | -73.72*** | -59.49*** | -58.22*** | -9.810 | -68.38*** |
| | (19.21) | (10.01) | (2.205) | (2.845) | (6.897) | (4.735) | (2.562) | (11.68) | (15.72) |
| Contr. | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| IHHFE | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| *N* | 9259 | 9259 | 9259 | 9259 | 9259 | 9259 | 9259 | 9259 | 8859 |
| $R^2$ | 0.933 | 0.924 | 0.904 | 0.922 | 0.925 | 0.915 | 0.914 | 0.369 | 0.469 |
| $M^{Rural} = M^{Sec.cit}$ | 0.000 | 5.351* | 3.175 | 1.734 | 0.00535 | 0.438 | 0.519 | 0.0622 | 1.300 |
| | 0.994 | 0.021 | 0.075 | 0.188 | 0.942** | 0.508 | 0.471 | 0.803 | 0.254 |
| $M^{Rural} = M^{DSM}$ | 11.19** | 8.142** | 2.129 | 0.129 | 0.007 | 0.900 | 0.090 | 0.456 | 0.228 |
| | 0.001 | 0.004 | 0.145 | 0.720 | 0.934 | 0.343 | 0.765 | 0.499 | 0.633 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| $M^{Sec.cit.} = M^{DSM}$ | 6.731** | 1.885 | 5.597* | 1.517 | 0.001 | 0.040 | 0.669 | 0.616 | 0.075 |
| | 0.010 | 0.170 | 0.018 | 0.218 | 0.977 | 0.842 | 0.414 | 0.432 | 0.785 |

Food consumption is expressed in kcal. per capita per day.
Standard errors in parentheses.
$^{*}$ $p < 0.05$, $^{**}$ $p < 0.01$, $^{***}$ $p < 0.001$

In particular, most of the effect on the increase in consumption of meals and snacks outside of the home after migrating to more urbanized areas can be explained by income growth. The coefficients for migration to secondary cities and DSM have been reduced dramatically in terms of magnitude and are no longer statistically significant. The stronger growth in the consumption of processed cereal products and non-alcoholic beverages – arguably luxury products – is clearly linked to changes in income (see Table 6). The coefficients for rural-urban migration and especially for relocation to DSM have declined in terms of magnitude as well as significance. Interestingly, after controlling for income, the coefficient for moving to the former capital in the regression on the growth in the consumption of maize has actually gained significance and magnitude

The results also indicate that moving to a non-farm household accounts for a considerable part of the negative impact of relocation to secondary cities on the growth of the consumption of starches, which are mostly consumed from home production in rural areas

Table 1: Changes in the consumption of food subgroups (2008/09-2012/13) - Pathways

| | ΔRice | ΔMaize | ΔCereal products | ΔCassava | ΔSweet potatoes | ΔCooking bananas | ΔNon-alc. beverages | ΔAlc. beverages |
|---|---|---|---|---|---|---|---|---|
| *Baseline cons.* | *230.07* | *933.65* | *35.79* | *282.42* | *46.69* | *42.91* | *4.61* | *4656* |
| $M^{Rural}$ | 5.600 | -36.76 | -13.46 | 14.63 | -3.522 | -3.026 | 1.366 | 28.41 |
| | (28.59) | (47.10) | (8.849) | (29.51) | (7.468) | (5.804) | (1.974) | (28.09) |
| $M^{Sec.cit.}$ | 15.65 | -103.8 | 56.61* | -63.10 | -14.71 | -26.85* | 22.12** | -1.321 |
| | (54.33) | (107.0) | (27.37) | (39.25) | (12.55) | (11.30) | (8.534) | (29.98) |
| $M^{DSM}$ | -35.83 | -367.1*** | 87.29** | -153.1* | -6.127 | -47.65*** | 14.05* | 46.91 |
| | (65.79) | (105.9) | (32.00) | (66.76) | (7.763) | (14.26) | (6.860) | (43.58) |
| ΔFarm | 67.74** | -162.7*** | 26.94* | -93.68*** | -11.91 | -10.95 | 2.972 | -44.05* |
| | (26.27) | (48.57) | (13.03) | (28.27) | (7.996) | (6.829) | (2.131) | (21.09) |
| ΔLn(exp.) | 174.8*** | 196.3*** | 47.08*** | -11.57 | 13.93*** | 16.58*** | 8.197*** | -2.564 |
| | (20.40) | (31.15) | (7.025) | (18.36) | (4.225) | (3.854) | (1.563) | (15.19) |
| Const. | -68.23*** | -222.3*** | -11.74** | -63.39*** | -14.59*** | -12.99*** | -4.147*** | -5.663 |
| | (10.74) | (15.43) | (3.823) | (9.186) | (2.327) | (2.016) | (0.945) | (11.62) |
| Controls | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| IHHFE | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| *N* | 9259 | 9259 | 9259 | 9259 | 9259 | 9259 | 9259 | 9259 |
| $R^2$ | 0.903 | 0.933 | 0.888 | 0.924 | 0.911 | 0.922 | 0.423 | 0.368 |
| $M^{Rural} = M^{Sec.cit}$ | 0.028 | 0.356 | 6.151* | 2.763 | 0.529 | 3.579* | 5.789* | 0.736 |
| | 0.867 | 0.551 | 0.013 | 0.097 | 0.467 | 0.059 | 0.016 | 0.391 |
| $M^{Rural} = M^{DSM}$ | 0.342 | 8.788** | 9.829** | 4.722* | 0.075 | 9.377** | 3.357 | 0.168 |
| | 0.559 | 0.003 | 0.002 | 0.030 | 0.784 | 0.002 | 0.067 | 0.682 |
| $M^{Sec.cit.} = M^{DSM}$ | 0.414 | 3.337 | 0.568 | 1.483 | 0.377 | 1.441 | 0.558 | 0.952 |
| | 0.520 | 0.068 | 0.451 | 0.223 | 0.539 | 0.230 | 0.455 | 0.329 |

Food consumption is expressed in kcal. per capita per day.
Standard errors in parentheses
$^{*}$ $p < 0.05$, $^{**}$ $p < 0.01$, $^{***}$ $p < 0.001$

Finally, we note that though not significantly affected by rural-urban migration, income growth is associated with significant increases in diet diversity (see Appendix, Table A1). This is in line with previous findings (Moon et al., 2002; Theil and Finke, 1983; Thiele and Weiss, 2003) and could explain to some extent why studies based on the comparison of rural and wealthier urban population groups find that people tend to consume more diverse diets in urban areas.

In sum, our analysis of the TNPS data on changes in food consumption patterns between 2008/09 and 2012/13 reveals that rural-urban migration is associated with a more pronounced shift away from traditional staples such as cassava and maize towards more processed and prepared food items. Whereas the declining consumption of staple foods for those who moved to urban areas appears to be linked to moving out of agriculture, the increasing importance of processed and prepared foods can for the most part be attributed to changes in income. The data further confirm concerns about the healthiness of urban diets. Not only do we find that the consumption of sugar and sweets experienced a stronger growth for those who relocated to DSM, rural-urban migration is associated with a larger increase in the consumption of sugary non-alcoholic beverages and processed cereal products. In addition, the results show that rural-urban migration is not associated with changes in diet diversity, nor do we find evidence of a positive impact on the consumption of healthier food groups.

## 4.2 Kagera Health and Development Survey

The KHDS is a unique 19-year panel survey. Kagera, a region far from the capital and the coast, bordering Lake Victoria, Rwanda, Burundi, and Uganda is characteristic of many landlocked parts of Africa that are largely dependent on agriculture (De Weerdt, 2010).

The survey originally consisted of 915 households from 51 villages interviewed up to four times from fall 1991 to January 1994. Excluding households in which all previous members were deceased, 93 and 92 % of the baseline households were recontacted in the 2004 and 2010 round respectively (De Weerdt et al., 2012). Due to household dynamics and partition, the sample covered over 2,700 and 3,300 households in 2004 and 2010 respectively. Beegle et al. (2012) note that the KHDS panel thus has a remarkably low attrition rate when compared to other well-known panel surveys with most of these surveys covering considerably shorter time periods.

In all three rounds, the KHDS includes detailed information on the households' consumption from home production and food expenditures in the past 12 months. In particular, respondents were asked to indicate for every month whether they had consumed a certain food item as well as the frequency and value of the amount typically consumed during months of the self-defined rainy and dry season. In addition, data on expenditures on food and beverages consumed outside the home in the last two weeks before the interview were collected at the individual level.

This extraordinary long panel survey covers substantial migration flows. Table 8 summarizes the evolution of respondents' location.

Table 8: Migration matrix

| | | *2010* | | | |
|---|---|---|---|---|---|
| | | In same location | In different location | | |
| | | | Rural | Secondary cities | DSM |
| *1991/94* | Rural | 2,089 | 1,009 | 679 | 186 |
| | Secondary cities | 139 | 59 | 91 | 24 |

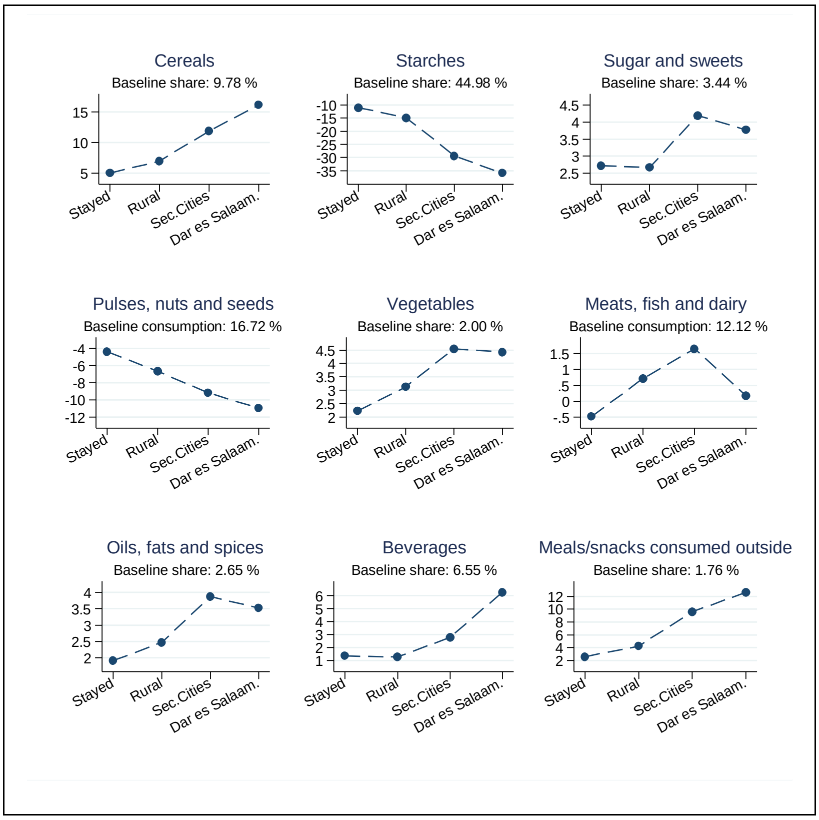
### 4.2.1 Food consumption

Since the KHDS thus does not include information on the exact quantities consumed, but rather the value of the consumption of food items, we focus on the share of 11 food groups in the total value of food consumption to assess changes in food consumption patterns. Differences over time could thus also be affected by changes in relative prices rather than actual food intake.

#### *4.2.1.1 Descriptive analysis*

Figure 5 depicts the mean changes in these shares between 1991/94 and 2010 for individuals that stayed in their original rural community, relocated to different rural and urban areas respectively. Similar to previous studies documenting the abandonment of traditional staples and our earlier findings, we note a distinctive general decline in the share of starches. This change is however much greater for those who migrated to urban areas and DSM in particular, which seems to suggest an adverse effect of urbanization.

Figure 5: Mean change in the share of food groups in the total value of food consumption according to migration status (1991/94-2010)



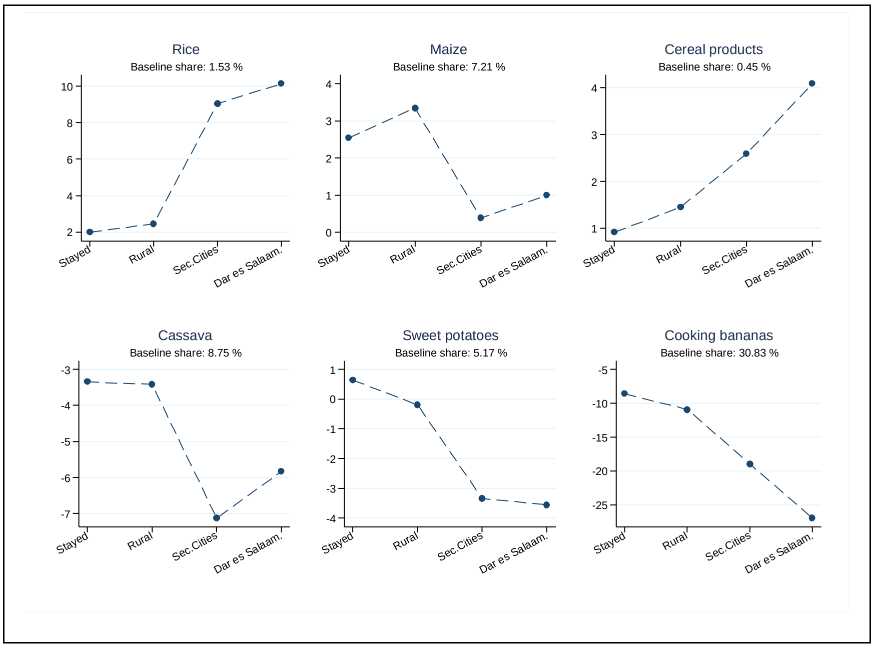

Food consumption is expressed in 2010 TZS per capita per year.

It appears that especially cooking bananas have lost their importance (see Figure 6). This could be related to difficulties in transporting and regional differences in availability. The share of pulses seems to have decreased considerably over time as well, with the change again being much greater for migrants to secondary cities and DSM, in that order. We further note a larger increase in the share of rice and cereal products for those who migrated to urbanized areas.

Another remarkable change has occurred for food consumed outside the home. Whereas the average share was as low as 1.76 % for individuals residing in the original rural communities during the first survey round, this has increased on average by close to 13 percentage points for those who migrated to DSM. This increase was three times greater compared with those who remained in their original community.

Similar to our previous findings, the increase in the share of the consumption of beverages was much more pronounced for migrants to urban areas as well. The data also indicate that those who moved to secondary cities experienced the largest increase in the share of oil and fats, vegetables and sugar and sweets.

Figure 12: Mean change in the share of food subgroups in the total value of food consumption according to migration status (1991/94-2010)




Food consumption is expressed in 2010 TZS per capita per year.

#### *4.2.1.2 Regression analysis*

We now turn to the regressions of the difference in share of the different food (sub) groups in the total value of food consumption between 1991/94 and 2010 on three dummy variables for migration from the baseline rural communities to different rural areas, secondary cities and DSM respectively.

Table 9: Change in the share of food groups in total value of food consumption (1991/94-2010)

| | ΔCereals | ΔStarches | ΔSug, sweets | ΔPulses, nuts, seeds | ΔVeg. | ΔMeat, fish, dairy | ΔOils, Fats | ΔBev. | ΔMeals /snacks cons. outs. |
|---|---|---|---|---|---|---|---|---|---|
| Baseline share | 9.78 % | 44.98 % | 3.44 % | 16.72 % | 2 % | 12.12 % | 2.65 % | 6.55 % | 1.76 % |
| $M^{Rural}$ | 1.556*** | -4.340*** | 0.143 | -1.571*** | 1.196*** | 1.348*** | 0.432** | 0.0521 | 1.489** |
| | (3.54) | (-6.04) | (0.54) | (-5.03) | (3.53) | (3.52) | (2.64) | (0.12) | (2.90) |
| $M^{Sec.cit.}$ | 6.960*** | -17.36*** | 1.067*** | -4.793*** | 2.718*** | 2.540*** | 1.517*** | 1.178* | 6.470*** |
| | (12.57) | (-24.36) | (3.48) | (-14.64) | (6.42) | (5.57) | (7.74) | (2.30) | (8.94) |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| $M^{DSM}$ | 9.426$^{***}$ | -23.39$^{***}$ | 0.549 | -5.766$^{***}$ | 1.456 | 0.528 | 0.597 | 5.594$^{***}$ | 10.28$^{***}$ |
| | (8.92) | (-23.38) | (0.95) | (-12.14) | (1.87) | (0.64) | (1.48) | (4.71) | (8.29) |
| Const. | 5.875$^{***}$ | -18.18$^{***}$ | 2.651$^{***}$ | -6.587$^{***}$ | 0.130 | -0.196 | 2.198$^{***}$ | 4.857$^{***}$ | 6.766$^{***}$ |
| | (9.43) | (-20.16) | (6.89) | (-15.60) | (0.26) | (-0.36) | (9.98) | (7.66) | (9.07) |
| Contr. | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| IHHFE | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| $N$ | 3963 | 3963 | 3963 | 3963 | 3963 | 3963 | 3963 | 3963 | 3958 |
| $R^2$ | 0.558 | 0.718 | 0.553 | 0.779 | 0.532 | 0.627 | 0.517 | 0.532 | 0.373 |
| $M^{Rural} = M^{Sec.cit}$ | 76.29$^{***}$ | 236.8$^{***}$ | 7.320$^{***}$ | 71.34$^{***}$ | 9.808$^{**}$ | 5.084$^{*}$ | 23.27$^{***}$ | 3.774 | 38.08$^{***}$ |
| | 0.000 | 0.000 | 0.007 | 0.000 | 0.002 | 0.024 | 0.000 | 0.052 | 0.000 |
| $M^{Rural} = M^{DSM}$ | 51.93$^{***}$ | 296.7$^{***}$ | 0.469 | 65.42$^{***}$ | 0.102 | 0.900 | 0.150 | 21.11$^{***}$ | 46.98$^{***}$ |
| | 0.000 | 0.000 | 0.494 | 0.000 | 0.749 | 0.343 | 0.698 | 0.000 | 0.000 |
| $M^{Sec.cit.} = M^{DSM}$ | 4.885$^{*}$ | 34.08$^{***}$ | 0.745 | 3.808 | 2.371 | 5.341$^{*}$ | 4.572$^{*}$ | 13.10$^{***}$ | 7.950$^{**}$ |
| | 0.027 | 0.000 | 0.388 | 0.051 | 0.124 | 0.021 | 0.033 | 0.000 | 0.005 |

Food consumption is expressed in 2010 TZS per capita per year.
Standard errors in parentheses
$^{*}$ $p < 0.05$, $^{**}$ $p < 0.01$, $^{***}$ $p < 0.001$

Similar to the results from the descriptive analysis and earlier findings, we observe a large, significantly negative effect of migration on the growth in the share of pulses, nuts and seeds, and starches, especially cooking bananas (see Table 10). Moving out of rural Kagera to relocate in a secondary city or the former capital resulted in an additional decline in the growth of the share of starches of 17 % and 23 % of the total value of food consumption over time.

In line with expectations, rural-urban migration is also significantly associated with a positive effect on the growth of the share of foods with shorter or no preparation time. Keeping all else equal, on average, migration to secondary cities and DSM resulted in an additional increase of the share of meals and snacks consumed outside of 6.5 % and 10 % of the total value of food consumption respectively. In addition, we also find significantly positive effects on the change in the share of rice and processed cereal products over time (see Table 10).

Table 10: Change in the share of food subgroups in the total value of food consumption (1991/94-2010)

| | ΔRice | ΔMaize | ΔCereal products | ΔCassava | ΔSweet potatoes | ΔCooking bananas |
|---|---|---|---|---|---|---|
| Baseline share | 1.53 % | 7.21 % | 0.59 % | 8.75 % | 5.17 % | 30.83 % |
| $M^{Rural}$ | 0.897$^{***}$ | 0.233 | 0.430$^{***}$ | -0.540$^{*}$ | -1.268$^{***}$ | -2.595$^{***}$ |
| | (0.244) | (0.340) | (0.120) | (0.244) | (0.256) | (0.613) |
| $M^{Sec.cit.}$ | 5.790$^{***}$ | -0.672 | 1.824$^{***}$ | -3.191$^{***}$ | -4.142$^{***}$ | -10.42$^{***}$ |
| | (0.357) | (0.387) | (0.172) | (0.232) | (0.244) | (0.584) |
| $M^{DSM}$ | 7.046$^{***}$ | -0.590 | 3.007$^{***}$ | -3.826$^{***}$ | -4.549$^{***}$ | -15.58$^{***}$ |
| | (0.694) | (0.551) | (0.318) | (0.265) | (0.309) | (0.831) |
| Const. | 2.749$^{***}$ | 2.335$^{***}$ | 1.058$^{***}$ | -4.056$^{***}$ | 0.198 | -14.39$^{***}$ |
| | (0.374) | (0.468) | (0.170) | (0.310) | (0.330) | (0.747) |
| Controls | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| IHHFE | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| $N$ | 3963 | 3963 | 3963 | 3963 | 3963 | 3963 |
| $R^2$ | 0.506 | 0.630 | 0.421 | 0.840 | 0.733 | 0.782 |
| $M^{Rural} = M^{Sec.cit}$ | 149.4$^{***}$ | 4.314$^{*}$ | 55.71$^{***}$ | 88.93$^{***}$ | 98.54$^{***}$ | 130.6$^{***}$ |
| | 0.000 | 0.038 | 0.000 | 0.000 | 0.000 | 0.000 |
| $M^{Rural} = M^{DSM}$ | 74.13$^{***}$ | 1.945 | 61.00$^{***}$ | 106.7$^{***}$ | 83.11$^{***}$ | 198.3$^{***}$ |
| | 0.000 | 0.163 | 0.000 | 0.000 | 0.000 | 0.000 |
| $M^{Sec.cit.} = M^{DSM}$ | 2.904 | 0.019 | 12.00$^{***}$ | 5.101$^{*}$ | 1.627 | 36.40$^{***}$ |
| | 0.088 | 0.891 | 0.001 | 0.024 | 0.202 | 0.000 |

Food consumption is expressed in 2010 TZS per capita per year.
Standard errors in parentheses
$^{*}$ $p < 0.05$, $^{**}$ $p < 0.01$, $^{***}$ $p < 0.001$

The regressions further demonstrate that migration to secondary cities potentially contributes to healthier dietary patterns as it results in a more pronounced increase in the share of vegetables and animal source foods. However, at the same time, there is evidence of greater increases in the consumption of beverages –often high in sugar – and the coefficient for migration to secondary cities is significantly positive in the regression on sugar and sweets and oils and fats.

We note that in all but three of the regressions, the coefficient for rural-rural migration is significant as well. However, the results of the F-tests clearly confirm that the effect of migration to secondary cities is significantly different. The same holds for migration to DSM in all the regressions where the coefficient for the dummy is significant. This again strongly suggests that though the process of migration in itself is associated with some changes, urban destination clearly matters.

### 4.2.2 Volatility of food consumption

We hypothesize that besides affecting the level and composition of diets, urbanization could have important implications for the stability of food consumption. In particular, the supply of food products is likely to be less volatile in urban areas due to a larger network of market linkages and improved market integration, access to imports as well as decreased reliance on home production among other things.

Though volatility in food consumption could reflect adaptations to differing seasonal labour requirements, one of the few empirical studies assessing this in the case of Burkina Faso concludes that seasonal consumption and activity levels are in fact countercyclical (Reardon and Matlon, 1989). Moreover, based upon data from the KHDS, Dillon and Christian (2016) demonstrate that volatility in food consumption can have large adverse long-term effects on health and labour outcomes.

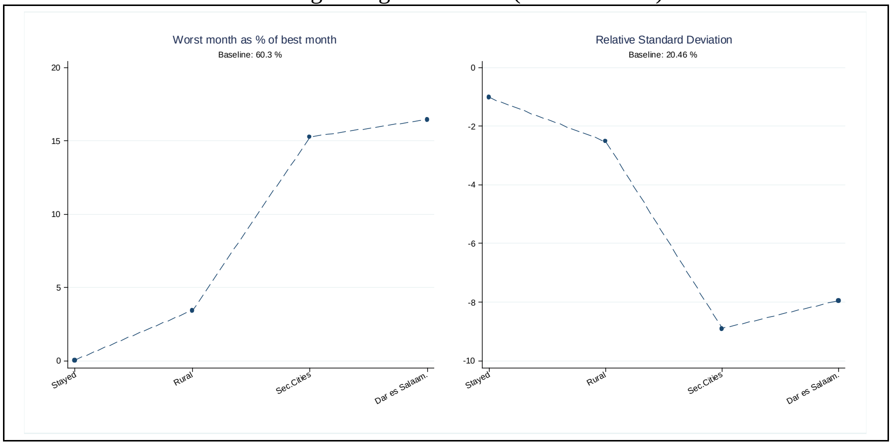
As mentioned above, a unique feature of the KHDS is that it allows us to capture volatility in food consumption, as respondents were asked to report during which months they had consumed each item. Our measures volatility are based on proxies for the monthly value of food consumption at home.

Next, we express the worst month (with the lowest total value of food consumption at home) as a percentage of the best month (with the highest total value of food consumption at home) and calculate the relative standard deviation (the ratio of the standard deviation to the mean, also referred to as the coefficient of variation) of the monthly estimates. It is important to note that volatility as captured by these measures can be driven by changes in the quantities consumed as well as prices.

#### *4.2.2.1 Descriptive analysis*

On average consumption during the “worst” month amounted to only 60.31 % per cent of the “best” month in rural Kagera between 1991 and 1994. The relative standard deviation amounted to 20.45 % of the mean. Figure 12 summarizes the change over time of these two indicators of food consumption volatility according to migration status.

Figure 12: Mean change in volatility of the value food consumption according to migration status (1991/94-2010)




Food consumption is expressed in 2010 TZS per capita per day.

We immediately see that while there was little change for individuals who stayed in rural Kagera, the relative difference between the worst and best month has declined sharply for those who moved to more urbanized areas. In particular, on average after migrating to secondary cities and DSM the estimated value of the worst month was 15.14 and 17.16 % closer to the best month respectively.

Focusing on the relative standard deviation and thus taking into account the complete distribution, we again find that the decline in volatility of the value of food consumption is much larger for those who moved to urban areas, thus confirming our hypothesis that urbanization contributes to more stable food consumption patterns. It appears however, that though the extreme values might be closer together for those that have relocated to DSM, the overall variance is lower for migrants to secondary cities.

#### *4.2.2.2 Regression analysis*

Next, we assess whether the regressions controlling for baseline characteristics and initial household effects confirm the volatility-reducing effect of rural-urban migration. The regression results summarized in Table 11 strongly suggest that the hypothesis that urbanization is associated with reduced volatility in food consumption holds. Keeping all else equal on average compared to those who remained in their rural baseline communities, migrants to secondary cities and DSM experienced an additional reduction of the relative standard deviation of the monthly value of their food consumption of 8.3 % and 8.9 % of the mean respectively. In addition, the difference between the months with the lowest and highest total value of food consumption declined by 16 % and 17 % respectively.

Table 11: Changes in the volatility of the value of food consumption (1991/94-2010)

| | ΔWorst month as % of best month | ΔRSD |
|---|---|---|
| Baseline level | 60.30 % | 20.46 % |
| $M^{Rural}$ | 4.696*** | -2.312*** |
| | (0.938) | (0.673) |
| $M^{Sec.cit.}$ | 16.17*** | -8.243*** |

| | | |
|---|---|---|
| | (1.110) | (0.745) |
| $M^{DSM}$ | 17.18*** | -9.012*** |
| | (1.807) | (1.157) |
| Const. | -0.349 | -1.074 |
| | (1.302) | (0.954) |
| Controls | ✓ | ✓ |
| IHHFE | ✓ | ✓ |
| *N* | 3919 | 3921 |
| $R^2$ | 0.722 | 0.728 |
| $M^{Rural} = M^{Sec.cit}$ | 84.19*** | 50.29*** |
| | 0.000 | 0.000 |
| $M^{Rural} = M^{DSM}$ | 42.39*** | 28.11*** |
| | 0.000 | 0.000 |
| $M^{Sec.cit.} = M^{DSM}$ | 0.268 | 0.394 |
| | 0.605 | 0.530 |

Standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Again, the coefficient for rural-rural migration is significant, though considerably smaller, in both regressions. The F-tests however, reveal that the difference between the change in volatility experienced by rural-rural migrants and rural-urban migrants is highly significant. There is however, no evidence of a significant difference between different types of urban migration destinations.

### 4.2.3 Pathways

Similar to the analysis of the TNPS data, we aim to explore different pathways for explaining the observed changes in the composition and volatility of food consumption. We therefore include the difference in the logarithm of per capita household expenditures and a dummy variable for switching from a farming to a non-farming household.

Table 12: Change in the share of food groups in total value of food consumption (1991/94-2010) – Pathways I

| | ΔCereals | ΔStarches | ΔSugar, sweets | ΔPulses, nuts, seeds | ΔVeg. | ΔMeat, fish, dairy | ΔOils, Fats | ΔBev. | ΔMeals /snacks cons. outs. |
|---|---|---|---|---|---|---|---|---|---|
| Baseline share | 9.78 % | 44.98 % | 3.44 % | 16.72 % | 2 % | 12.12 % | 2.65 % | 6.55 % | 1.76 % |
| $M^{Rural}$ | 1.648*** | -2.639*** | -0.0930 | -1.042*** | 0.735*** | 1.146** | 0.375* | -0.690 | 0.546 |
| | (0.439) | (0.642) | (0.260) | (0.301) | (0.189) | (0.378) | (0.164) | (0.405) | (0.476) |
| $M^{Sec.cit.}$ | 7.565*** | -10.38*** | 0.109 | -2.601*** | 1.859*** | 1.654*** | 1.279*** | -1.993*** | 2.525*** |
| | (0.589) | (0.715) | (0.321) | (0.346) | (0.232) | (0.489) | (0.215) | (0.510) | (0.690) |
| $M^{DSM}$ | 10.93*** | -13.63*** | -0.762 | -2.639*** | 1.416** | -0.887 | 0.252 | 0.805 | 4.504*** |
| | (1.090) | (1.071) | (0.598) | (0.489) | (0.454) | (0.860) | (0.427) | (1.242) | (1.282) |
| Δ Farm | 2.178*** | -5.781*** | 0.906*** | -1.567*** | 0.587** | 0.0169 | 0.147 | 1.175** | 2.324*** |
| | (0.452) | (0.600) | (0.262) | (0.290) | (0.179) | (0.393) | (0.162) | (0.409) | (0.472) |
| Δ Ln(exp.) | -2.755*** | -9.101*** | 1.166*** | -3.042*** | 0.650*** | 1.682*** | 0.347* | 5.199*** | 5.863*** |
| | (0.374) | (0.453) | (0.201) | (0.224) | (0.154) | (0.313) | (0.143) | (0.324) | (0.440) |
| Const. | 6.277*** | -12.17*** | 1.821*** | -4.709*** | 2.124*** | -0.928 | 1.995*** | 2.191*** | 3.396*** |
| | (0.640) | (0.857) | (0.408) | (0.419) | (0.252) | (0.558) | (0.231) | (0.613) | (0.685) |
| Contr. | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| IHHFE | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| *N* | 3963 | 3963 | 3963 | 3963 | 3963 | 3963 | 3963 | 3963 | 3958 |
| $R^2$ | 0.571 | 0.769 | 0.563 | 0.790 | 0.538 | 0.636 | 0.519 | 0.577 | 0.431 |
| $M^{Rural} = M^{Sec.cit}$ | 87.50*** | 98.95*** | 0.338 | 17.73*** | 18.47*** | 0.852 | 14.83*** | 5.332* | 6.347* |
| | 0.000 | 0.000 | 0.561 | 0.000 | 0.000 | 0.356 | 0.000 | 0.021 | 0.012 |
| $M^{Rural} = M^{DSM}$ | 69.75*** | 97.37*** | 1.205 | 10.14** | 2.046 | 5.176* | 0.078 | 1.448 | 8.887** |
| | 0.000 | 0.000 | 0.272 | 0.001 | 0.153 | 0.023 | 0.780 | 0.229 | 0.003 |
| $M^{Sec.cit.} = M^{DSM}$ | 9.373** | 9.774** | 2.108 | 0.007 | 0.924 | 8.442 | 5.611* | 5.215* | 2.149 |
| | 0.002 | 0.002 | 0.147 | 0.935 | 0.337 | 0.004 | 0.018 | 0.023 | 0.143 |

Food consumption is expressed in 2010 TZS per capita per year.
Standard errors in parentheses
$^{*}$ $p < 0.05$, $^{**}$ $p < 0.01$, $^{***}$ $p < 0.001$

The results in Table 12 show that the more pronounced decline in the share of starches and pulses can for a large part be explained by moving out of farming and income growth. The negative coefficients for the dummies for rural-urban migration are considerably smaller though still highly significant. Similar to our previous findings, we note that a large part the of increasing importance of food consumed outside can be explained by rising incomes as well. We further note that both the changes that can be deemed beneficial – vegetables, meat, fish and eggs - and harmful – sugar and sweets, oils and fats - from a nutritional point of view can for a large part be explained by changes in income rather than urbanization.

Surprisingly, after controlling for both pathways, the coefficients for the rural-urban migration dummies in the regression on the share of maize are now significantly positive (see Table 13). Income growth not only seems to explain the larger decline in the share of this staple food in more urbanized areas, it concealed that individuals who migrated to urban areas actually experienced a stronger increase in the share of maize. Similarly, the coefficient for migration to secondary cities in the regression on beverages is now significantly negative, whereas individuals who migrated to the capital experienced no significantly different change. Again, this strongly suggests that income rather than urbanization positively affects the consumption of beverages whereas the former actually has a negative effect that may be due to lower availability of local brews for example.

Table 13: Changes in the share of food subgroups in the total value of food consumption (1991/94-2010) - Pathways I

| | ΔRice | ΔMaize | ΔCereal products | ΔCassava | ΔSweet potatoes | ΔCooking bananas |
|---|---|---|---|---|---|---|
| Baseline share | 1.53 % | 7.21 % | 0.59 % | 8.75 % | 5.17 % | 30.83 % |
| $M^{Rural}$ | 0.687$^{**}$ | 0.651 | 0.304$^{**}$ | -0.151 | -0.882$^{***}$ | -1.668$^{**}$ |
| | (0.240) | (0.334) | (0.118) | (0.233) | (0.248) | (0.596) |
| $M^{Sec.cit.}$ | 4.961$^{***}$ | 1.205$^{**}$ | 1.322$^{***}$ | -1.552$^{***}$ | -2.505$^{***}$ | -6.706$^{***}$ |
| | (0.379) | (0.415) | (0.183) | (0.240) | (0.260) | (0.627) |
| $M^{DSM}$ | 5.994$^{***}$ | 2.513$^{***}$ | 2.345$^{***}$ | -1.418$^{***}$ | -2.105$^{***}$ | -10.67$^{***}$ |
| | (0.722) | (0.593) | (0.330) | (0.304) | (0.328) | (0.892) |
| ΔFarm | 1.124$^{***}$ | 0.395 | 0.584$^{***}$ | -0.887$^{***}$ | -0.727$^{**}$ | -4.183$^{***}$ |
| | (0.269) | (0.326) | (0.128) | (0.223) | (0.244) | (0.534) |
| ΔLn(exp.) | 0.759$^{***}$ | -3.879$^{***}$ | 0.532$^{***}$ | -2.483$^{***}$ | -2.597$^{***}$ | -4.021$^{***}$ |
| | (0.220) | (0.265) | (0.103) | (0.167) | (0.186) | (0.396) |
| Const. | 2.016$^{***}$ | 3.866$^{***}$ | 0.618$^{***}$ | -2.665$^{***}$ | 1.580$^{***}$ | -11.14$^{***}$ |
| | (0.377) | (0.468) | (0.174) | (0.309) | (0.338) | (0.750) |
| Controls | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| IHHFE | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| *N* | 3963 | 3963 | 3963 | 3963 | 3963 | 3963 |
| $R^2$ | 0.513 | 0.662 | 0.434 | 0.854 | 0.756 | 0.796 |
| $M^{Rural} = M^{Sec.cit}$ | 106.5$^{***}$ | 1.661 | 28.12$^{***}$ | 27.37$^{***}$ | 34.06$^{***}$ | 56.49$^{***}$ |
| | 0.000 | 0.198 | 0.000 | 0.000 | 0.000 | 0.000 |
| $M^{Rural} = M^{DSM}$ | 51.92$^{***}$ | 9.622$^{**}$ | 36.57$^{***}$ | 14.49$^{***}$ | 12.23$^{***}$ | 93.15$^{***}$ |
| | 0.000 | 0.002 | 0.000 | 0.000 | 0.000 | 0.000 |
| $M^{Sec.cit.} = M^{DSM}$ | 1.928 | 5.035$^{*}$ | 8.861$^{*}$ | 0.214 | 1.596 | 21.36$^{***}$ |
| | 0.165 | 0.025 | 0.003 | 0.644 | 0.207 | 0.000 |

Food consumption is expressed in 2010 TZS per capita per year.
Standard errors in parentheses
$^{*}$ $p < 0.05$, $^{**}$ $p < 0.01$, $^{***}$ $p < 0.001$

Table 14 summarizes the results of the regressions including the dummy variable for moving out of farming and income growth on both measures of volatility.

Table 14: Changes in the volatility of the value of food consumption (1991/94-2010) – Pathways I

| | ΔWorst month as % of best month | ΔRSD |
|---|---|---|

| | | |
|---|---|---|
| Baseline level | 60.30 % | 20.46 % |
| $M^{Rural}$ | 3.377*** | -1.504* |
| | (0.888) | (0.651) |
| $M^{Sec.cit.}$ | 10.17*** | -4.608*** |
| | (1.170) | (0.834) |
| $M^{DSM}$ | 7.436*** | -3.163* |
| | (2.001) | (1.345) |
| ∆Farm | 1.496 | -1.129 |
| | (0.903) | (0.648) |
| ∆Ln(exp.) | 10.91*** | -6.464*** |
| | (0.760) | (0.592) |
| Const. | -5.268*** | 1.923* |
| | (1.290) | (0.959) |
| Controls | ✓ | ✓ |
| IHHFE | ✓ | ✓ |
| $N$ | 3921 | 3919 |
| $R^2$ | 0.748 | 0.745 |
| $M^{Rural} = M^{Sec.cit}$ | 29.39*** | 12.30*** |
| | 0.000 | 0.000 |
| $M^{Rural} = M^{DSM}$ | 3.850* | 1.372 |
| | 0.050 | 0.241 |
| $M^{Sec.cit.} = M^{DSM}$ | 1.855 | 1.289 |
| | 0.173 | 0.256 |

Standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Though still highly significant, the coefficients for the dummies for rural-urban migration have declined strongly in terms of magnitude. Income growth clearly accounts for a considerable part of the observed impact of rural-urban migration on the volatility of the value of food consumption. This is in line with expectations, as income is a crucial factor in making households resilient to temporary shocks. While moving out of farming can have important implications for the sources of food and their stability and the lower reliance on home-production is likely to reduce vulnerability to seasonal fluctuations in food availability and temporary shocks, the coefficient for the shift away from agriculture is no longer statistically significant after controlling for changes in income.

Finally, we also have information on the exact year of migration, which allows us to assess whether the effect of migration on consumption patterns is gradual or immediate. This could offer some insights on to what extents the effect of urbanization is the result of a slow (socio-cultural) adaptation process or rather an immediate change in response to differing supply of food.

As a first check, we include additional dummy variables that equals one when migration was recent, i.e. when migrants relocated no more than 5 years ago. This dummy variable is interacted with each of the three migration dummies we had before (see Appendix, Tables A2-A4). We specifically focus on this particular timespan, because it allows us to assess the comparability of the analysis of the KHDS data covering almost 19 years with the TNPS covering 5 years.

In addition, when restricting the analysis to the subsample of migrants with rural-rural migrants serving as a control group, we can include a variable capturing the number of years since moving and add interaction effects with the dummies for migration (see Appendix, Tables A5-A7).

Overall, we find no evidence of significant interaction between rural-urban migration and the number of years since relocation. This gives support to the hypothesis that the consumption changes when migrating to urban areas are immediate, which suggests that supply side factors, supply, or changes related to time spending and occupations (which may change immediately upon moving to urban areas) rather than changes in consumption preferences form the explanation for the observed changes related to migration.

In sum, our analysis of the KHDS data on changes in the composition and volatility of the value of food consumption between 1991/94 and 2010 confirms that migration to more urbanized areas is associated with a stronger shift away from traditional staple products such as cassava and cooking bananas, towards more processed and ready-to-eat foods as well as foods with shorter preparation time. Again, the lower consumption of starches appears to be linked to moving out of agriculture, whereas the increasing consumption of rice, processed cereal products and meals and snacks outside the home can be explained by changes in income. The data further demonstrate that rural-urban migrants experience a stronger increase in the share of some healthier food groups; including meat, fish and eggs and vegetables. However, there is also evidence of increased importance of sugar and sweets and oils and fats. Finally, the data reveals urbanization appears to contribute to reducing volatility in food consumption. Individuals who migrated from rural to urban areas experienced a much larger decline in the relative standard deviation of the monthly estimates of the value of total food consumption.

# Conclusion

Although urbanization is increasingly put forward as one of the main determinants of changes in food consumption patterns in the developing world, our understanding of its effects on diets remains limited. Using unique panel data – the Tanzania National Panel Survey for 2008/09 - 2012/13 and the Kagera Health and Development Survey for 1991/94 – 2010, spanning nearly two decades - this paper provides empirical evidence on the impact of rural-urban migration on the consumption of different food groups, their share in the total value of food consumption, diet diversity and volatility. Not only is this focus on rural-urban migrants novel in the literature, it also enables us to more accurately capture the effect of urbanization on food consumption as we are able to observe the same individual in a rural and urban setting. In addition, the panel nature of the data allows us to further improve the identification strategy by controlling for initial household fixed effects.

Overall, the evidence presented in this paper strongly suggests that urbanization is associated with important shifts in dietary patterns. Even after controlling for individual fixed heterogeneity, baseline observable characteristics and initial household fixed effects, we find that individuals who relocated to urbanized areas experience a significantly larger increase in the consumption of processed and ready-to-eat foods. The analysis of both datasets further indicates a general shift away from traditional staples such as pulses, maize, cassava and cooking bananas, which is much more pronounced for those who moved to urban areas.

While there is some evidence of changes that can be deemed beneficial from a nutritional point of view - including increased consumption of vegetables and animal source foods - the results also to some extent confirm concerns about the association between urbanization and heightened consumption of sugar and fats. In addition, contrary to previous findings (e.g. De Nigris, 1997; Smith et al., 2006) we find that after controlling for initial household fixed effects there is no evidence that urbanization is associated with more diverse diets.

In addition, the results indicate that besides affecting the composition, urbanization has important implications for the stability of food consumption. Individuals who migrated from rural to urban areas experienced a much larger decline in the relative standard deviation also known as the coefficient of variation (ratio of the standard deviation to the mean) of the monthly estimates of the value of total food consumption.

Our results further indicate that a large part of the effect of rural-urban migration on dietary patterns can be explained by changes in income. In particular, the increasing importance of meals and snacks consumed outside, processed cereal products and non-alcoholic beverages appears to be largely attributable to income growth. In line with expectations, income growth also plays an important role in explaining the association between urbanization and more stable food consumption. It is important to note however, that even after controlling for income, the coefficients for rural-urban migration remain highly significant in several of the regressions, thus negating the claim made by Stage et al. (2010) that the difference between urban and rural households' patterns of food consumption is caused by income only. Moving out of farming in turn seems to account for a sizeable part of the shift away from starches, such as cassava and cooking bananas, which are mostly consumed from home production in rural areas. Finally, there is little evidence that the effect of migration to more urbanized areas on food consumption patterns evolves over time, thus pointing towards the importance of immediate changes in response to different income-earning opportunities and supply-side determinants rather than more gradual socio-cultural adjustments.

These results clearly demonstrate that food demand analysis done without taking into consideration the underlying structural shifts resulting from urbanization can lead to misleading results and erroneous food demand forecasts. In addition, though also associated with several beneficial changes, our findings again raise concerns about the nutritional quality of diets in an urbanizing world and call for focused policy action in urban areas. Finally, combined with emerging evidence on the profound health implications of fluctuations in dietary intake, our results with regards to food consumption volatility urge further research into what explains this volatility-reducing effect of rural-urban migration and how policies can be targeted to ensure that rural communities are not left behind. In addition, our findings point to a need for improved data collection. Rather than focussing on a short period of time through 1 or 2 week dietary recall modules, surveys should be designed to capture seasonal or monthly variation in food consumption

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# Appendix

Table A1: Changes in diet diversity (2008/09-2012/13) - Pathways

| | ΔCount (items) | ΔBI (items) | ΔCount (groups) | ΔBI (groups) |
|---|---|---|---|---|
| *Baseline level* | 11.546 | *0.630* | *7.630* | *0.508* |
| $M^{Rural}$ | -0.433 | 0.007 | -0.026 | 0.002 |
| | (0.334) | (0.014) | (0.166) | (0.015) |
| $M^{Sec.cit.}$ | -0.151 | 0.007 | -0.227 | -0.040 |
| | (0.857) | (0.030) | (0.345) | (0.027) |
| $M^{DSM}$ | 0.932 | 0.046 | 0.125 | 0.010 |
| | (0.895) | (0.033) | (0.474) | (0.034) |
| ΔFarm | 0.446 | -0.022 | -0.085 | -0.043** |
| | (0.362) | (0.015) | (0.176) | (0.015) |
| ΔLn(exp) | 1.831*** | 0.0594*** | 0.557*** | 0.045*** |
| | (0.273) | (0.012) | (0.128) | (0.011) |
| Const. | -0.864*** | -0.053*** | -0.122 | -0.043*** |
| | (0.142) | (0.007) | (0.068) | (0.006) |
| Controls | ✓ | ✓ | ✓ | ✓ |
| IHHFE | ✓ | ✓ | ✓ | ✓ |
| *N* | 9259 | 9259 | 9259 | 9259 |
| $R^2$ | 0.887 | 0.881 | 0.870 | 0.866 |
| $M^{Rural} = M^{Sec.cit}$ | 0.100 | 0.000 | 0.290 | 2.005 |
| | 0.752 | 0.987 | 0.590 | 0.157 |
| $M^{Rural} = M^{DSM}$ | 2.047 | 1.162 | 0.093 | 0.04 |
| | 0.153 | 0.281 | 0.761 | 0.829 |
| $M^{Sec.cit.} = M^{DSM}$ | 0.803 | 0.853 | 0.382 | 1.460 |
| | 0.370 | 0.356 | 0.536 | 0.227 |

Food consumption is expressed in kcal. per capita per day.
Standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table A2: Change in the share of food groups in total value of food consumption (1991/94-2010) – Pathways II

| | ΔCereals | ΔStarches | ΔSugar, sweets | ΔPulses, nuts, seeds | ΔVeg. | ΔMeat, fish, dairy | ΔOils, Fats | ΔBev. | ΔMeals /snacks cons. outs. |
|---|---|---|---|---|---|---|---|---|---|
| Baseline share | 9.78 % | 44.98 % | 3.44 % | 16.72 % | 2 % | 12.12 % | 2.65 % | 6.55 % | 1.76 % |
| $M^{Rural}$ | 1.461$^{**}$ | -1.758$^{*}$ | -0.247 | -0.901$^{**}$ | 0.499$^{*}$ | 1.049$^{*}$ | 0.208 | -0.727 | 0.403 |
| | (0.472) | (0.696) | (0.271) | (0.331) | (0.197) | (0.413) | (0.180) | (0.441) | (0.524) |
| $M^{Rural} < 5y$ | 0.737 | -3.582$^{**}$ | 0.643 | -0.617 | 0.998$^{*}$ | 0.275 | 0.714$^{*}$ | 0.196 | 0.631 |
| | (0.828) | (1.097) | (0.488) | (0.547) | (0.411) | (0.727) | (0.311) | (0.795) | (0.923) |
| $M^{Sec.cit.}$ | 7.772$^{***}$ | -10.54$^{***}$ | -0.0150 | -2.324$^{***}$ | 1.665$^{***}$ | 2.521$^{***}$ | 1.073$^{***}$ | -2.333$^{***}$ | 2.215$^{**}$ |
| | (0.676) | (0.815) | (0.353) | (0.389) | (0.253) | (0.538) | (0.235) | (0.559) | (0.761) |
| $M^{Sec.cit} < 5y$ | -0.515 | -0.101 | 0.504 | -0.926 | 0.740 | -2.550$^{**}$ | 0.731$^{*}$ | 1.059 | 1.021 |
| | (1.007) | (1.047) | (0.533) | (0.488) | (0.394) | (0.813) | (0.349) | (0.850) | (1.379) |
| $M^{DSM}$ | 11.42$^{***}$ | -13.60$^{***}$ | -1.503$^{*}$ | -2.671$^{***}$ | 1.495$^{**}$ | -0.552 | 0.268 | 0.466 | 4.678$^{***}$ |
| | (1.188) | (1.122) | (0.635) | (0.532) | (0.476) | (0.930) | (0.465) | (1.271) | (1.403) |
| $M^{DSM} < 5y$ | -1.978 | -1.393 | 3.599$^{*}$ | -0.107 | 0.0234 | -1.512 | 0.203 | 1.641 | -0.527 |
| | (2.228) | (2.199) | (1.555) | (0.810) | (1.001) | (1.703) | (0.844) | (2.759) | (2.474) |
| Δ Farm | 2.165$^{***}$ | -5.774$^{***}$ | 0.921$^{***}$ | -1.572$^{***}$ | 0.589$^{**}$ | -0.00775 | 0.150 | 1.188$^{**}$ | 2.327$^{***}$ |
| | (0.452) | (0.600) | (0.261) | (0.290) | (0.179) | (0.393) | (0.162) | (0.409) | (0.472) |
| Δ Ln(exp.) | -2.786$^{***}$ | -8.843$^{***}$ | 1.094$^{***}$ | -2.975$^{***}$ | 0.563$^{***}$ | 1.732$^{***}$ | 0.279 | 5.153$^{***}$ | 5.795$^{***}$ |
| | (0.381) | (0.462) | (0.202) | (0.226) | (0.155) | (0.314) | (0.144) | (0.327) | (0.440) |
| Const. | 6.300$^{***}$ | -12.21$^{***}$ | 1.805$^{***}$ | -4.726$^{***}$ | 2.145$^{***}$ | -0.933 | 2.010$^{***}$ | 2.190$^{***}$ | 3.419$^{***}$ |
| | (0.640) | (0.852) | (0.405) | (0.420) | (0.251) | (0.556) | (0.230) | (0.609) | (0.685) |
| Contr. | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| IHHFE | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| $N$ | 3963 | 3963 | 3963 | 3963 | 3963 | 3963 | 3963 | 3963 | 3958 |
| $R^2$ | 0.571 | 0.770 | 0.565 | 0.791 | 0.540 | 0.638 | 0.521 | 0.578 | 0.432 |
| $M^{Rural} = M^{Sec.cit}$ | 71.61$^{***}$ | 89.04$^{***}$ | 0.353 | 10.34$^{**}$ | 16.25$^{***}$ | 5.638$^{*}$ | 10.43$^{**}$ | 6.330$^{*}$ | 4.145$^{*}$ |
| | 0.000 | 0.000 | 0.552 | 0.001 | 0.000 | 0.018 | 0.001 | 0.012 | 0.042 |
| $M^{Rural} = M^{DSM}$ | 65.56$^{***}$ | 95.76$^{***}$ | 3.681 | 9.683$^{**}$ | 3.939$^{*}$ | 2.653 | 0.015 | 0.861 | 8.450$^{**}$ |
| | 0.000 | 0.000 | 0.055 | 0.002 | 0.047 | 0.103 | 0.902 | 0.354 | 0.004 |
| $M^{Sec.cit.} = M^{DSM}$ | 8.647$^{**}$ | 6.907$^{**}$ | 5.075$^{*}$ | 0.401 | 0.120 | 10.08$^{**}$ | 2.795 | 4.888$^{*}$ | 2.714 |
| | 0.003 | 0.009 | 0.024 | 0.526 | 0.729 | 0.002 | 0.095 | 0.027 | 0.100 |

Food consumption is expressed in 2010 TZS per capita per year.
Standard errors in parentheses
$^{*}$ $p < 0.05$, $^{**}$ $p < 0.01$, $^{***}$ $p < 0.001$

Table A3: Change in the share of food subgroups in total value of food consumption (1991/94-2010) – Pathways II

| | ΔRice | ΔMaize | ΔCereal products | ΔCassava | ΔSweet potatoes | ΔCooking bananas |
|---|---|---|---|---|---|---|
| Baseline share | 1.53 % | 7.21 % | 0.59 % | 8.75 % | 5.17 % | 30.83 % |
| $M^{Rural}$ | 0.338 | 0.857$^{*}$ | 0.243$^{*}$ | -0.0133 | -0.667$^{*}$ | -1.151 |
| | (0.253) | (0.369) | (0.120) | (0.258) | (0.273) | (0.646) |
| $M^{Rural}$ < 5y | 1.408$^{**}$ | -0.832 | 0.220 | -0.549 | -0.835$^{*}$ | -2.149$^{*}$ |
| | (0.496) | (0.580) | (0.207) | (0.410) | (0.419) | (1.009) |
| $M^{Sec.cit.}$ | 5.095$^{***}$ | 1.116$^{*}$ | 1.537$^{***}$ | -1.650$^{***}$ | -2.814$^{***}$ | -6.481$^{***}$ |
| | (0.435) | (0.468) | (0.212) | (0.276) | (0.294) | (0.701) |
| $M^{Sec.cit}$ < 5y | -0.169 | 0.123 | -0.613$^{*}$ | 0.207 | 0.782$^{*}$ | -1.034 |
| | (0.689) | (0.666) | (0.292) | (0.329) | (0.335) | (0.891) |
| $M^{DSM}$ | 6.131$^{***}$ | 2.649$^{***}$ | 2.541$^{***}$ | -1.540$^{***}$ | -2.141$^{***}$ | -10.50$^{***}$ |
| | (0.783) | (0.636) | (0.374) | (0.321) | (0.349) | (0.929) |
| $M^{DSM}$ < 5y | -0.127 | -0.907 | -0.831 | 0.363 | -0.104 | -1.561 |
| | (1.571) | (1.107) | (0.742) | (0.504) | (0.570) | (1.816) |
| Δ Farm | 1.117$^{***}$ | 0.395 | 0.576$^{***}$ | -0.882$^{***}$ | -0.719$^{**}$ | -4.188$^{***}$ |
| | (0.269) | (0.326) | (0.128) | (0.223) | (0.244) | (0.535) |
| Δ Ln(exp.) | 0.666$^{**}$ | -3.821$^{***}$ | 0.535$^{***}$ | -2.451$^{***}$ | -2.557$^{***}$ | -3.840$^{***}$ |
| | (0.225) | (0.271) | (0.103) | (0.171) | (0.189) | (0.401) |
| Const. | 2.037$^{***}$ | 3.862$^{***}$ | 0.623$^{***}$ | -2.674$^{***}$ | 1.575$^{***}$ | -11.17$^{***}$ |
| | (0.376) | (0.468) | (0.173) | (0.309) | (0.337) | (0.749) |
| Contr. | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| IHHFE | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| $N$ | 3963 | 3963 | 3963 | 3963 | 3963 | 3963 |
| $R^2$ | 0.515 | 0.663 | 0.436 | 0.854 | 0.756 | 0.797 |
| $M^{Rural}$ = $M^{Sec.cit}$ | 99.77$^{***}$ | 0.253 | 34.03$^{***}$ | 25.19$^{***}$ | 40.27$^{***}$ | 44.87$^{***}$ |
| | 0.000 | 0.615 | 0.000 | 0.000 | 0.000 | 0.000 |
| $M^{Rural}$ = $M^{DSM}$ | 51.62$^{***}$ | 7.146$^{**}$ | 35.54$^{***}$ | 17.10$^{***}$ | 13.83$^{***}$ | 84.84$^{***}$ |
| | 0.000 | 0.008 | 0.000 | 0.000 | 0.000 | 0.000 |
| $M^{Sec.cit.}$ = $M^{DSM}$ | 1.545 | 5.415$^{*}$ | 6.340$^{*}$ | 0.113 | 3.475 | 17.55$^{***}$ |
| | 0.214 | 0.020 | 0.012 | 0.737 | 0.062 | 0.000 |

Food consumption is expressed in 2010 TZS per capita per year.
Standard errors in parentheses
$^{*}$ $p < 0.05$, $^{**}$ $p < 0.01$, $^{***}$ $p < 0.001$

Table A4: Changes in the volatility of the value of food consumption (1991/94-2010) – Pathways II

| | ΔWorst month as % of best month | ΔRSD |
|---|---|---|
| Baseline level | 60.30 % | 20.46 % |
| $M^{Rural}$ | 2.675** | -1.175 |
| | (0.961) | (0.724) |
| $M^{Rural}$ < 5y | 2.653 | -1.192 |
| | (1.722) | (1.216) |
| $M^{Sec.cit.}$ | 11.87*** | -5.820*** |
| | (1.289) | (0.900) |
| $M^{Sec.cit}$ < 5y | -4.753* | 3.523** |
| | (1.871) | (1.282) |
| $M^{DSM}$ | 9.000*** | -4.162** |
| | (2.074) | (1.393) |
| $M^{DSM}$ < 5y | -6.475 | 4.284 |
| | (4.265) | (2.775) |
| Δ Farm | 1.433 | -1.084 |
| | (0.904) | (0.647) |
| Δ Ln(exp.) | 10.85*** | -6.470*** |
| | (0.771) | (0.605) |
| Const. | -5.220*** | 1.897* |
| | (1.285) | (0.957) |
| Contr. | ✓ | ✓ |
| IHHFE | ✓ | ✓ |
| *N* | 3963 | 3963 |
| $R^2$ | 0.756 | 0.797 |
| $M^{Rural}$ = $M^{Sec.cit}$ | 40.91*** | 20.99*** |
| | 0.000 | 0.000 |
| $M^{Rural}$ = $M^{DSM}$ | 8.268** | 3.784 |
| | 0.004 | 0.052 |
| $M^{Sec.cit.}$ = $M^{DSM}$ | 1.789 | 1.479 |
| | 0.181 | 0.224 |

Food consumption is expressed in 2010 TZS per capita per year.
Standard errors in parentheses
$^{*}$ $p < 0.05$, $^{**}$ $p < 0.01$, $^{***}$ $p < 0.001$

Table A5: Change in the share of food groups in total value of food consumption (1991/94-2010) – Pathways III

| | ΔCereals | ΔStarches | ΔSugar, sweets | ΔPulses, nuts, seeds | ΔVeg. | ΔMeat, fish, dairy | ΔOils, Fats | ΔBev. | ΔMeals /snacks cons. outs. |
|---|---|---|---|---|---|---|---|---|---|
| Baseline share | 9.78 % | 44.98 % | 3.44 % | 16.72 % | 2 % | 12.12 % | 2.65 % | 6.55 % | 1.76 % |
| $M^{Sec.cit.}$ | 5.679$^{***}$ | -7.017$^{***}$ | 0.200 | -1.471$^{***}$ | 1.127$^{**}$ | 0.501 | 1.136$^{***}$ | -1.601$^{*}$ | 1.468 |
| | (0.856) | (0.972) | (0.435) | (0.440) | (0.353) | (0.724) | (0.317) | (0.736) | (1.030) |
| $M^{Sec.cit}$ *Time | -0.001 | -0.001 | -0.002 | -0.000 | -0.003 | 0.002 | -0.002$^{*}$ | 0.002 | 0.004 |
| | (0.002) | (0.003) | (0.001) | (0.002) | (0.002) | (0.002) | (0.001) | (0.002) | (0.003) |
| $M^{DSM}$ | 5.994$^{*}$ | -9.301$^{***}$ | 2.087 | -1.345 | -0.239 | -4.803$^{*}$ | 0.387 | 3.167 | 4.011 |
| | (2.731) | (2.504) | (1.531) | (0.992) | (1.181) | (1.972) | (1.080) | (3.149) | (3.214) |
| $M^{DSM}$ *Time | 0.263 | -0.150 | -0.320$^{**}$ | -0.003 | 0.062 | 0.297 | -0.075 | -0.036 | -0.035 |
| | (0.196) | (0.197) | (0.121) | (0.077) | (0.091) | (0.159) | (0.083) | (0.221) | (0.227) |
| Time | 0.003$^{*}$ | -0.004 | 0.001 | -0.002$^{**}$ | 0.001 | 0.001 | 0.001 | 0.000 | -0.000 |
| | (0.001) | (0.002) | (0.001) | (0.001) | (0.001) | (0.002) | (0.001) | (0.002) | (0.002) |
| ΔFarm | 1.797 | -7.467$^{***}$ | 1.843$^{***}$ | -1.645$^{***}$ | 0.911$^{**}$ | 1.032 | 0.254 | 0.996 | 2.240$^{*}$ |
| | (0.928) | (1.039) | (0.471) | (0.491) | (0.325) | (0.693) | (0.313) | (0.724) | (0.912) |
| ΔLn(exp.) | -3.130$^{***}$ | -8.286$^{***}$ | 1.031$^{***}$ | -3.432$^{***}$ | 0.417 | 1.596$^{**}$ | 0.166 | 5.492$^{***}$ | 6.167$^{***}$ |
| | (0.613) | (0.640) | (0.288) | (0.304) | (0.243) | (0.485) | (0.216) | (0.483) | (0.685) |
| Const. | 8.592$^{***}$ | -14.52$^{***}$ | 1.363 | -5.950$^{***}$ | 2.560$^{***}$ | -0.968 | 2.629$^{***}$ | 1.805 | 4.489$^{**}$ |
| | (1.410) | (1.573) | (0.820) | (0.752) | (0.550) | (1.134) | (0.523) | (1.176) | (1.608) |
| Contr. | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| IHHFE | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| *N* | 1861 | 1861 | 1861 | 1861 | 1861 | 1861 | 1861 | 1861 | 1859 |
| $R^2$ | 0.612 | 0.825 | 0.641 | 0.845 | 0.584 | 0.670 | 0.538 | 0.643 | 0.497 |
| $M^{Sec.cit.} = M^{DSM}$ | 0.0143 | 0.980 | 1.592 | 0.0183 | 1.426 | 7.912$^{**}$ | 0.509 | 2.376 | 0.651 |
| | 0.905 | 0.322 | 0.207 | 0.892 | 0.233 | 0.005 | 0.476 | 0.123 | 0.420 |

Food consumption is expressed in 2010 TZS per capita per year.
Standard errors in parentheses
$^{*}$ $p < 0.05$, $^{**}$ $p < 0.01$, $^{***}$ $p < 0.001$

Table A6 Change in the share of food subgroups in total value of food consumption (1991/94-2010) – Pathways III

| | ΔRice | ΔMaize | ΔCereal products | ΔCassava | ΔSweet potatoes | ΔCooking bananas |
|---|---|---|---|---|---|---|
| Baseline share | 1.53 % | 7.21 % | 0.59 % | 8.75 % | 5.17 % | 30.83 % |
| $M^{Sec.cit.}$ | 4.507*** | 0.319 | 0.896*** | -1.211*** | -1.225*** | -4.855*** |
| | (0.574) | (0.548) | (0.251) | (0.318) | (0.321) | (0.798) |
| $M^{Sec.cit}$ *Time | -0.000 | -0.003 | 0.002* | -0.001* | 0.0002 | 0.000 |
| | (0.002) | (0.002) | (0.001) | (0.000) | (0.001) | (0.002) |
| $M^{DSM}$ | 4.601* | 0.443 | 1.216 | -0.988 | -1.511* | -7.042*** |
| | (1.822) | (1.409) | (0.966) | (0.653) | (0.756) | (2.075) |
| $M^{DSM}$ *Time | 0.0768 | 0.110 | 0.0663 | -0.0351 | -0.0101 | -0.128 |
| | (0.144) | (0.105) | (0.0836) | (0.0459) | (0.0508) | (0.160) |
| Time | 0.002 | 0.002 | -0.000 | 0.000 | -0.000 | -0.009 |
| | (0.001) | (0.001) | (0.000) | (0.000) | (0.000) | (0.029) |
| ΔFarm | 1.388* | -0.461 | 0.836*** | -1.555*** | -1.610*** | -4.310*** |
| | (0.600) | (0.609) | (0.222) | (0.392) | (0.397) | (0.884) |
| ΔLn(exp.) | 0.426 | -3.973*** | 0.482** | -2.380*** | -2.188*** | -3.737*** |
| | (0.375) | (0.417) | (0.150) | (0.229) | (0.250) | (0.531) |
| Const. | 2.933** | 5.330*** | 0.560 | -3.104*** | 0.317 | -11.77*** |
| | (0.902) | (0.956) | (0.388) | (0.506) | (0.558) | (1.284) |
| Contr. | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| IHHFE | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| *N* | 1861 | 1861 | 1861 | 1861 | 1861 | 1861 |
| $R^2$ | 0.558 | 0.706 | 0.511 | 0.900 | 0.821 | 0.858 |
| $M^{Sec.cit.} = M^{DSM}$ | 0.003 | 0.008 | 0.116 | 0.152 | 0.174 | 1.298 |
| | 0.958 | 0.928 | 0.734 | 0.697 | 0.677 | 0.255 |

Food consumption is expressed in 2010 TZS per capita per year.
Standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

TableA7: Changes in the volatility of the value of food consumption (1991/94-2010) – Pathways III

| | ΔWorst month as % of best month | ΔRSD |
|---|---|---|
| Baseline level | 60.30 % | 20.46 % |
| $M^{Sec.cit.}$ | $5.776^{***}$ | $-2.682^{*}$ |
| | (1.648) | (1.165) |
| $M^{Sec.cit}$ *Time | -0.00142 | 0.000654 |
| | (0.00844) | (0.00435) |
| $M^{DSM}$ | -0.696 | -0.976 |
| | (4.785) | (3.296) |
| $M^{DSM}$ *Time | 0.557 | -0.195 |
| | (0.370) | (0.244) |
| Time | -0.00156 | 0.00131 |
| | (0.00222) | (0.000988) |
| ΔFarm | 2.498 | -2.029 |
| | (1.651) | (1.188) |
| ΔLn(exp.) | $9.862^{***}$ | $-5.487^{***}$ |
| | (1.137) | (0.885) |
| Const. | -2.407 | 1.282 |
| | (2.538) | (1.800) |
| Contr. | ✓ | ✓ |
| IHHFE | ✓ | ✓ |
| *N* | 1825 | 1823 |
| $R^2$ | 0.765 | 0.760 |
| $M^{Sec.cit.} = M^{DSM}$ | 2.030 | 0.321 |
| | 0.154 | 0.571 |

Food consumption is expressed in 2010 TZS per capita per year.
Standard errors in parentheses
$^{*}$ $p < 0.05$, $^{**}$ $p < 0.01$, $^{***}$ $p < 0.001$