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From corn to popcorn?

Urbanization and dietary change: Evidence from rural-urban migrants in Tanzania

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Abstract

There is rising concern that the ongoing wave of urbanization will have profound effects on eating patterns and increase the risk of nutrition-related non-communicable diseases. Yet, our understanding of urbanization as a driver of changes in food consumption remains limited. Data from the Tanzania National Panel Survey, which tracked out-migrating respondents, allow us to compare individuals' dietary patterns before and after they relocated from rural to urban areas and assess whether those changes differ from household members who stayed behind or moved to a different rural area. Our study shows that moving to an urban area does not have any significant effect on the intake of fats, animal-source foods, and dietary diversity. However, individuals who moved to urban areas do experience a more pronounced shift away from the consumption of traditional staples, and towards high-sugar, more conveniently consumed and prepared foods. These effects occur across the whole spectrum of urban locations, ranging from smaller secondary towns to large cities. Further exploring the factors underlying these changes in dietary patterns upon moving, we demonstrate that – depending on the food category considered – a substantial part of the impact of relocating to an urban area is related to the transition out of farming, differences in food prices, and especially income changes. The latter appears to explain the more pronounced growth of unhealthy food consumption after rural-urban migration. As such, health concerns over diets can be expected to spread to less-urbanized areas as soon as income growth takes off there. Our findings call for more in-depth research on the extent and consequences of changes in diets related to living in more urbanized areas that may contribute to improved projections on food demand and help to improve health and food and nutrition security policies as well as agricultural and trade strategies.

1. Introduction

Until recently, researchers and policy makers mainly focused on the problem of food insecurity and undernutrition in rural areas (e.g. Bloem and de Pee, 2017; Crush and Frayne, 2010; Mohiddin et al., 2012). Yet, the rising awareness that developing countries are now increasingly suffering from the "double burden of malnutrition", with under- and overnutrition occurring simultaneously, and the fact that the prevalence of overweight appears to be higher and rising more rapidly in urban areas warrants adding an urban focus (Ruel et al., 2017).

Urbanization – the shift from a population that is dispersed across small rural settlements in which agriculture is the dominant economic activity towards one where the population is concentrated in larger, dense urban settlements (Montgomery et al., 2004) – is increasingly put forward as a crucial determinant of changing dietary patterns. It is considered as one of the driving forces behind the "nutrition transition", giving rise to and accelerating profound shifts in diets, physical activity and the prevalence of several nutrition-related non-communicable diseases. More specifically, while part of the urban population faces food insecurity, other subpopulations are hypothesized to suffer from dietary excess and obesity as a consequence of more sedentary lifestyles and the transition towards diets high in sugar, fats and refined foods, but low in fibre (e.g. Doak et al., 2005; Hawkes, 2006; Popkin, 1999; 2001). However, whether and how these patterns are linked to urbanization remains poorly understood. With sub-Saharan Africa currently in the midst of a wave of rapid urbanization and more than 55 % of its inhabitants projected to be living in urban areas by 2020 (UN, 2015), a better understanding of how this may change diets is necessary to develop appropriate policies for agriculture, trade and for improving health and food and nutrition security.

This growing urban population is the result of natural urban population growth, the reclassification of previously rural areas into urban ones and rural-urban migration (McGranahan and Satterthwaite, 2014). While there is substantial geographical variation, on average, migration accounts for about a quarter of total urban growth in Africa (World Bank, 2008). Rural-urban migrants, however, constitute a particularly interesting group to study as, with the right data, we can observe the diet of the same individual in two different environments. Using data from the Tanzania National Panel Survey (TNPS) for 2008/09 and 2012/13 that traced household members who migrated throughout this period, we aim to study the extent to which changes in the structure of diets may be attributable to moving to an urban environment and explore what this could imply for the wider debate on urbanization and dietary change.

This paper makes several contributions to the literature. First, the majority of research on urbanization and dietary change is based on cross-sectional comparisons of rural and urban diets. This approach has limitations, as urban and rural populations may differ in many more respects than only the environment they reside in. The panel nature of the data we use, and the tracking of individuals that moved to new locations allow us to go much further in addressing selection than earlier studies. More specifically, we are able to compare migrants' dietary patterns before and after they relocate from rural to urban areas and assess how this differs from those who did not move over the same period. Since we observe households in which some individuals migrate and others do not, we can restrict the difference-in-differences comparison to those originating from the same rural baseline household, thus obtaining estimates that are purged of observed or unobserved heterogeneity across migrant and non-migrant families.

Secondly, while there is a growing recognition that urban areas form a continuum ranging from small towns to major cities (e.g. Christiaensen and Kanbur, 2017; Satterthwaite, 2006), little attention has been paid to the role these different types of urban environments play in stimulating dietary change. We extend existing analyses by moving beyond the (administrative) rural-urban dichotomy and explore the heterogeneity of our results by type of urban destination and population density.

Finally, the literature has put forward potential reasons as to why rural and urban food consumption may differ, ranging from increases in income and changes in relative prices, to different lifestyles and exposure to more global eating patterns (e.g. Crush et al., 2011; Hawkes, 2008; Popkin, 1999). Yet, the validity of these hypotheses and the relative importance of the different mechanisms has not been tested empirically. We aim to contribute to explaining *how* urbanization may affect dietary patterns by exploring the role of the transition from a farming to a non-farming household and changes in income and food prices as underlying mechanisms through which moving to an urban area affects food consumption.

Overall, the evidence presented in this paper confirms that, for the same individual, eating patterns depend on whether one resides in an urban or a rural area. The results demonstrate that in comparison to household members who remained in their original rural villages, those relocating to urban areas experience a stronger shift away from traditional staples and towards more conveniently consumed, high-sugar or prepared foods. However, several other trends that are commonly associated with urbanization are not reflected in our results. In particular, there is no evidence of a significantly different change in the consumption of oils and fats. Also, moving to an urban area does not appear to contribute to higher intake of more nutritious food groups, such as animal-source foods and fruits and vegetables, nor to improved dietary diversity. We find similar, though smaller, changes when migrating to secondary towns versus larger cities. In addition, most of the differences appear to be independent of the administrative classification into rural or urban and are confirmed when focusing upon population density estimates instead. Further exploring the factors underlying these changing dietary patterns, we demonstrate that – depending on the food category considered – a substantial part of the impact of relocating to an urban area is related to no longer residing in a farming household, differences in food prices, and especially income changes.

The remainder of this paper is organized as follows. The second section briefly discusses how urbanization may interact with different determinants of food consumption and reviews the available empirical evidence. Next, we discuss the food environment in Tanzania and the country's relevance as a case study for this particular topic. The data and methodology are described in Section 4 and Section 5 respectively. The main results are discussed in Section 6. Section 7 explores the heterogeneity of the results across the urban landscape. In Section 8, we present the results of our analysis of the importance of different mechanisms and Section 9 concludes.

2. Urbanization and food consumption

Urbanization interacts with several key determinants of food consumption. As it tends to coincide with a movement out of agriculture, it is likely that more people become employed in sectors with lower energy requirements (Deaton and Dreze, 2009; Ntandou et al., 2008; Sobngwi et al., 2001). This transition out of (smallholder) farming would also imply that own-production and food consumption choices become less closely linked (Huang and Bouis, 2001). Moreover, the more distinct separation of living and work location, combined with improved (female) labour market opportunities and longer commuting distances in urban areas are assumed to raise the opportunity costs of time spent on acquiring and preparing food and induce greater preferences for more conveniently consumed and (pre-)prepared foods (Bourne et al., 2002; Huang and Bouis, 2001; Huang and David, 1992; Regmi and Dyck, 2001). In addition, smaller living spaces and lack of storage and cooking facilities could contribute to increased reliance on foods requiring less or no preparation (Gollin and Goyal, 2017).

Changes in food consumption may be further facilitated by the fact that urban areas are characterized by markedly different food supply environments, affecting the availability and price of food items. Options for eating outside of the house or buying processed or prepared food are, for example, likely to be more abundant and more varied in urban areas, where minimarkets, supermarkets and fast food chains are more present and food-manufacturing sectors are often based nearby (Hawkes, 2008; Nickanor et al., 2017). Rural markets also tend to be less integrated with national and international markets and characterized by imperfect competition, ultimately leading to higher marketing margins (Bergquist, 2017; Moser et al., 2009; Osborne, 2005). Urban prices of imported or processed food items are therefore likely to be lower. Domestically produced food items on the other hand, could be less widely available and more expensive in cities that are located farther from production areas. Overall, it is assumed that the relative prices of traditional food items will differ in urban areas and that new items will be added to the mix.

In addition, urbanization is commonly associated with increases in wealth, which in turn can be expected to significantly change dietary patterns (Regmi and Dyck, 2001; Kearney, 2010). Stage et al. (2010: 204) even hypothesize that "*the difference between urban and rural households' patterns of food consumption is not caused by urbanization and cultural change but income differences*".

Finally, urbanization is believed to have profound effects on the socio-cultural food environment. Several authors argue that changes in preferences and habits arise in urban areas as a consequence of greater exposure to more global eating patterns, modern mass media or of improved access to formal or informal nutrition knowledge in urban areas (Bosu, 2014; Dapi et al., 2007; Huang and Bouis, 2001; Kearney, 2010; Regmi and Dyck, 2001).

A substantial literature has looked into the relation between urbanization and food consumption, applying different approaches. At cross-country level, Huang and David (1993) and Rae (1998) estimate demand system models on aggregate time series data for Asia and find that urbanization decreases the consumption of coarse grains and raises the consumption of wheat and animal source foods. Drenowksi and Popkin (1997) and Popkin (1999) regress the share of energy derived from different types of food on the proportion of the population living in urban areas and find that urbanization is positively related to the consumption of sweeteners and fats. Studies based on within-country time series data similarly show that rising levels of urbanization were associated with changes in cereal consumption patterns in Burkina Faso, Mali (Delgado, 1989) and a number of Asian countries (Huang and David, 1993).

Complementing these, there are several micro-studies, giving insight into these patterns at lower levels of granularity. They mostly refer to cross-sectional comparisons of rural and urban diets, based on detailed survey data on household or individual food consumption. Research from Asia points to elevated levels of meat consumption, lower grain consumption, more fats and refined carbohydrates (e.g. Popkin, 1999; Huang and Bouis, 2001; Shetty, 2002; Mendez and Popkin, 2004; Zhai et al. 2009) and increased likelihood of eating meals away from home (Zheng and Henneberry, 2009) in urban areas. Urban diets are also found to be more diverse (Popkin and Du, 2003; Arimond and Ruel, 2004). Comparable patterns were documented for countries in Latin America and the Caribbean (Arimond and Ruel, 2004; Willaarts et al., 2013).

Studies comparing rural and urban patterns of food consumption in sub-Saharan Africa similarly suggest that urban diets are more diversified (De Nigris, 1997; Ruel and Garrett, 2004; Smith et al., 2006; Steyn et al., 2012 Vorster et al., 2005) and depend less on traditional, coarse grains and starchy staples (Bourne et al., 2002; De Nigris, 1997; Kennedy and Reardon, 1994; Smith et al., 2006; Worku et al., 2017).

Available evidence also points to increased consumption of rice and processed cereal products including bread (Kennedy and Reardon, 1994; Maxwell et al., 2000; Reardon, 1993), higher intakes of sugar (Steyn et al., 2000; Steyn et al., 2012) and fats (MacIntyre et al., 2002; Peer et al., 2013; Steyn et al., 2012; Vorster et al., 2011; Worku et al., 2017) among urban residents, as well as a stronger reliance on street foods (Maxwell et al., 2000; Maruapula et al., 2011). While there is some evidence of higher fruit and vegetable consumption in urban areas in sub-Saharan Africa, the differences appear to be modest (Ruel et al., 2004; Okpechi et al., 2013; Worku et al., 2017). Findings with regards to the consumption of animal source foods are mixed (De Nigris, 1997; MacIntyre et al., 2002; Steyn et al., 2012; Worku et al., 2017). De Brauw et al. (2017), for example, find that while moving from a rural to an urban area in Ethiopia was associated with an increased likelihood of eating meat, there was no significant difference for animal products as a whole.

Specifically for Tanzania, Mazengo et al. (1997) find that the consumption of sugar and animal source foods of urban residents in the Ilala district in Dar es Salaam, markedly exceeds that of their rural counterparts. Based on a QUAIDS analysis of survey data from Dar es Salaam and Mbeya, Abdulai and Aubert (2004) demonstrate that households in urban areas consume less meat, fish and eggs, cereals and pulses, milk and milk products but more fat and oil and fruit and vegetables. Unwin et al. (2010) also document that migrants consumed fruit and vegetables and saturated fat more frequently after moving from rural Morogoro to Dar es Salaam.

While these studies have helped our understanding of existing variation in food consumption across urban and rural households, it is more difficult to draw from them strong conclusions about how living in an urban environment contributes to these differences in dietary patterns. Seto and Ramankuti (2016:943), for example, argue that *"many studies conflate urbanization, rises in income, and westernization"* and call for more research that goes beyond the comparison of urban diets to rural ones. In particular, it remains unclear whether the observed differences are linked to individuals' physical location or whether they merely reflect other socioeconomic disparities between the urban and rural dwellers in the surveys. This line of research is faced with the typical evaluation problem that we cannot observe the same person residing in both a rural and an urban area. Lacking experimental or quasiexperimental data, this can, however, be approximated by studying migrants who move from rural areas to urban areas. Huang and Bouis (2001:62) therefore 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*". To the best of our knowledge this paper will be the first to use this identification strategy, applied to nationally representative panel data, to study the relation between urbanization and changes in diets.[2]

3. The setting: Tanzania

As one of the world's most rapidly growing and urbanizing countries, The United Republic of Tanzania – a low-income, low human development country in East Africa – provides a relevant case study to investigate the impact of urbanization on food consumption. Average annual urban population growth over the past two decades amounted to over 5 %. As a result, nearly one third of the population is now living in urban areas and the country is projected to contribute more than 50 million people to the global urban increment by 2050 (UN, 2015; World Bank, 2016). The commercial capital, Dar es Salaam, currently home to more than 4 million people, is expected to hit the ten million mark by 2030 and become one of the 20 largest cities in the world by mid-century (UN, 2016). The growth of the urban population, however, goes beyond the expansion of Dar es Salaam. Other cities and towns have constituted a stable two thirds of the expanding urban population in Tanzania for the past 50 years (Ambroz and Wenban-Smith, 2014).

Although a substantial part of urbanization is the result of the natural increase of the urban population and the reclassification of previously rural areas into urban areas, Tanzania is also characterized by large internal migration movements. According to the 2012 census, about 7.8 million Tanzanians were living

[2] De Brauw et al. (2017) use the same methodology to assess whether migration for employment was associated with different changes in the likelihood and frequency of eating meat and other animal source foods in Ethiopia. Unwin et al. (2010) also document dietary changes among migrants from rural Morogoro to Dar es Salaam. Their analysis, however, does not allow for a comparison with those who remained in rural areas and was restricted to the frequency rather than the quantity of consumption of different food categories. Witcher et al. (1988) and Stern et al. (2010) collect a retrospective panel among rural-urban migrants, raising the usual concerns about recall bias. Ebrahim et al. (2010) and Bowen et al. (2010) cross-sectionally compare food intake for rural-urban migrants with same-sex siblings still residing in their rural place of origin in India.

outside their place of birth and over 1.5 million people moved to a different region between 2011 and 2012 (NBS, 2015). For most regions, migration actually accounted for around half of the total urban population growth between 1978 and 2012 (Wenban-Smith, 2014a).

Overall, this swift process of urbanization has coincided with a period of relatively rapid macroeconomic growth, with an average annual GDP per capita growth rate close to 3 % between 1995 and 2014 (World Bank, 2016). While according to the 2011/12 National Household Budget Survey, poverty declined dramatically in the prime city, Dar es Salaam, progress was much less pronounced in other urban areas and lacking in rural areas (NBS, 2014). Moreover, food security improvements did not match average national economic gains (WFP, 2013). An estimated 34.4 % of children under five was still affected by stunting in 2015/16 (UNICEF-WHO-WB, 2016). This again hides an important rural-urban divide with stunting rates averaging 44.2 % in rural areas compared to 30.8 % in urban areas and 15 % in Dar es Salaam (WHO, 2016; THDS-MIS, 2016). At the same time, the prevalence of overweight and obesity is rising. While an estimated 18 % of women in Tanzania was overweight in 2004/05, this number had gone up to 28 % by 2015/16 (THDS-MIS, 2016). Once more, there is a marked spatial divide, with the total prevalence of female overweight and obesity in urban areas (42 %) being twice as high as in rural areas (21 %). With 26 % of the female population overweight and an additional 21% obese, Dar es Salaam has the highest prevalence of overnutrition (THDS-MIS, 2016).

The food environment in Tanzania is evolving rapidly as well. In recent years, the structure of food retail has changed substantially. While this transformation is still just taking root in other regional capitals, Dar es Salaam already hosts various supermarket chains. Most notably, however, there has been a proliferation of small mini-markets and clustered food shops (Ijumba et al., 2015). Processed and imported foods are becoming 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). Tschirley et al. (2017) further identify food consumed away from home as a major area of growth. The country has, however, also been faced with strong food price inflation of an estimated 8.51 % per year between 2002 and 2012, faster than the increase of non-food prices (Adam et al., 2012). As a result, the average share of food in the total household consumption basket increased over the past years and the majority of households report to have been negatively affected by the large food price increases (NBS, 2014).

4. Data

4.1 Tanzania National Panel Survey (TNPS)

We use data from the first (2008/09) and third (2012/13) round of the Tanzania National Panel Survey (TNPS) that was conducted as part of the World Bank Living Standards Measurement Study-Integrated Surveys on Agriculture (LSMS-ISA) project. The sample for the first round of data collection covered 3,265 households and was designed to represent the nation as a whole as well as rural, urban and major agro-ecological zones.[3] All sample households were administered questionnaires asking detailed information on a wide range of topics including agricultural and non-agricultural activities, consumption, expenditures and other household and individual socio-economic characteristics. In total, 16,701 individuals were interviewed. We limit our sample to the 16,058 individuals from 3,284 households for whom complete and plausible data on their consumption of food (and non-alcoholic beverages) at home and away from home were recorded (see Section 4.2).[4] Approximately one third of this sample is urban and two thirds is rural.

In the second (2010/11) and third (2012/13) rounds, the survey team attempted to locate and revisit all baseline household members aged 15 years and above, including those who had moved away from their original location. In our regression analysis, we concentrate on members of households that were located in rural areas at the baseline. As shown in Figure 1, out of these 10,581 individuals, 9,639 were re-interviewed in 2012/13. Over this 4-year period, the initial 2,051 rural households had split into 2,883 households. The majority of "new" households (68 %) have arisen as a result of unmarried children or

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[3] The rural-urban classification is defined by the 2002 Census for which all localities identified as urban by the district authority were classified as urban (NBS, 2006). More detailed information on the sample design, the survey instruments, implementation, resulting datasets and basic information documents for each of the survey rounds can be found at www.worldbank.org/lsms.

[4] In line with Smith and Subandoro (2007), we exclude those for whom total food consumption per adult equivalent per day was below 400 kcal or above 12,000 kcal. Applying a more strict upper-limit of 6,500 kcal per adult equivalent per day does not alter our findings.

grandchildren of the baseline household head moving out. After excluding those having incomplete or implausible food consumption data in 2012/13, the final sample for our regression analysis consists of 9,417 individuals, living in 2,580 households in 2012/13. Around 10 %, corresponding to 913 individuals, migrated within the 4-year window of the survey.[5] The majority (710) moved to another rural area, whereas 238 moved into an urban area.

Figure 1: Evolution of the sample between survey rounds

Table 1 provides descriptive statistics of some of the baseline characteristics of migrant and non-migrants in our sample. It is clear that the process of migration is not random. Most (56 %) migrants leaving their rural villages in our sample are female. This is not surprising given the relatively higher female employment opportunities in urban areas (NBS, 2014) and the fact that marriage in Tanzania is primarily characterized by patrilocal residence, where a woman leaves her kin to live with her husband (Kudo, 2015). The summary statistics in Table 1 further reveal that more educated people from smaller, wealthier, non-farming families were more likely to migrate. These differences are particularly pronounced for those moving to urban areas. We discuss how we address this key concern of heterogeneity affecting both the process of migration and food consumption in Section 5.

Table 1: Baseline (2008/09) summary statistics according to 2012/13 migration status

4.2 Food consumption and dietary diversity

Information on food consumption in the TNPS data was derived from an extensive one-week consumption recall questionnaire[6] on home food consumption administered at the household level, combined with a questionnaire on expenditures on eating away from home at the individual level. For the former, respondents were asked to report the physical quantity of household consumption of 59 different items in grams, litres or pieces.[7] All these units were converted to grams per capita, from which their calorie content could be calculated based on detailed local conversion tables (De Weerdt et al.,

[5] Only individuals whose place of residence was more than a one-hour drive away from their original location, were considered as migrants.
[6] De Weerdt et al. (2016) analyse a survey experiment from Tanzania that compares a 7-day recall module (nearly identical to the one used in the TNPS) to a benchmark estimate, which, they argue, reflects the “truth”. They find that while the 7-day recall module underreports kcal per capita compared to the benchmark, the magnitude of the error does not vary with urban residency. If a similar error pattern holds in our data we should be careful interpreting absolute kcal per capita values, but the error would wash out in the difference-in-differences estimations Friedman et al. (2017), however, find that there is a greater tendency to underreport the incidence of consumption in rural areas. Though likely to be tempered in difference-in-differences estimations, this may lead to an underestimation of rural dietary diversity scores.
[7] We exclude alcoholic beverages as well as items for which calorie contents were not available.

2016). The latter part of the survey captured the monetary value of individual consumption of 7 different types of food and drinks away from home[8], which were subsequently converted into physical values using information on the price and content of typical items within these categories. Based on these data, we calculate total food consumption in kilocalories (kcal) per capita per day.[9]

In order to disentangle changes in dietary patterns, we also construct 12 different categories of food (and non-alcoholic beverages) and look at daily per capita consumption of each of these categories, as well as the share of each category in total calorie consumption. This categorization was influenced by the structure of the questionnaire and adjusted to distinguish traditional staples from types of foods typically associated with the nutrition transition (see Appendix A, Table A1).

We further assess whether living in an urban environment is associated with more diverse eating patterns by constructing a dietary diversity score.[10] This score is a simple count of the number of different food groups consumed over the past 7 days (see Appendix, Table A2). It is important to acknowledge that the absence of detailed compositional data on meals and snacks consumed away from home represents a caveat to our analysis of dietary diversity. While information from detailed food diaries from a survey experiment in Tanzania (described in De Weerdt et al., 2016) suggests that purchased full meals tend to be largely starch-based – "ugali" (maize porridge); rice; fried cassava and cooking bananas are most commonly mentioned – we cannot exclude the possibility that we may be underestimating their contribution to dietary diversity by considering them as part of only one food group.

Table 2 summarizes descriptive statistics on the daily energy obtained in total and from the 12 different food categories as well as the values for the dietary diversity index. For each of these variables, we first compare the average value in rural and urban areas in 2008/09.

Table 2: Summary statistics of food consumption (in kcal. per capita per day) by category and diversity score

This comparison of rural and urban food consumption patterns summarized in the left panel of Table 2, highlights large differences in the composition of diets. On average, urban dwellers derive considerably

[8] Full meals; barbecued meat, chips, roast bananas, and other snacks prepared on charcoal; local brews (not included); wine, commercial beer and spirits (not included); sodas and other non-alcoholic drinks; sweets and ice-cream; tea, coffee, samosa, cake and other snacks.

[9] As mentioned above, food consumption at home was reported at the household level. Using food consumption per adult equivalent rather than per capita to approximate individual at home food consumption does not alter our findings.

[10] Using alternative indices, such as the count of individual food items or a Berry Index based on the share of each food item or each food group in total caloric intake (see Thiele and Weiss, 2003) does not alter our findings. These results are available upon request.

less energy from (home) consumption of traditional staple foods such as maize, cassava and other starchy foods (including sweet potatoes and cooking bananas). They, however, consume almost double the amount of rice and almost 7 times more bread, pasta and other cereal products. Besides the elevated levels of urban consumption of oils and fats and high-sugar foods in urban areas, one of the most striking differences is the much higher consumption of meals and snacks away from home. The summary statistics also reveal that urban residents consume more diverse diets. It is worth noting that except for the level of total food consumption, these differences between rural and urban diets are very much in line with the findings from earlier cross-sectional studies from Tanzania (Abdulai and Aubert, 2004) and other sub-Saharan African countries (De Nigris, 1997; Garrett and Ruel, 1999; Smith et al., 2006; Maxwell et al., 2000; Vorster et al., 2005).

Making use of the panel nature of the data combined with the tracking of individuals who moved to different locations, we can also describe the extent to which these variables change between the two rounds and how these trends differ for those who stayed in (or nearby) their original rural villages as compared to individuals who migrated to different rural or urban areas respectively. From the right panel of Table 2, we can discern some notable patterns. Whereas the consumption of traditional staples is declining, the consumption of rice and cereal products as well as meals and snacks away from home is on the rise for those who were living in rural areas at the baseline. Interestingly, there are significant differences in these changes between subsamples based on their location in 2012/13. It is clear that those who moved to an urban area experienced a more pronounced increase in their consumption of rice, bread, pasta and other cereal products, meals and snacks consumed away from home as well as overall dietary diversity. In addition, whereas total food consumption and the intake of high-sugar foods and drinks declined for those who stayed in their original rural village or moved to a different rural area, the change over time for rural-urban migrants is positive.

As mentioned above, the cross-sectional comparison of rural and urban diets is unlikely to capture the true impact of living in an urban environment. Indeed, rural and urban residents tend to differ in many respects, affecting both their choice of residence and their diets. In addition, whereas rural-urban migrants allow us to observe the same individual in both settings, it is important to note that migrant selectivity, rather than living in an urban environment, could explain some, if not all, of these differences in dietary changes. The next section describes our methodology to investigate this further.

5. Methodology

Similar to Beegle et al. (2011), we employ a difference-in-differences estimator that compares dietary patterns before and after an individual has relocated and we assess whether those changes across a four-year period differ systematically from individuals who stayed in their baseline rural community. This specification thus controls for individual fixed heterogeneity, resolving a large number of possible sources of endogeneity, which may influence food consumption in both periods. In addition, because we observe households in which some individuals migrate and others do not, we can include initial household fixed effects (IHHFE), thereby restricting the comparison to people originating from the same household and addressing all time-invariant observed and unobserved heterogeneity across families of origin. As for the heterogeneity within families, we control for a number of personal attributes that are likely to influence migration as well as the change in eating patterns over time. More specifically, we include age, sex, relation to the household head, education and marital status at baseline (for details see Appendix A, Table A3). Yet, unobserved individual characteristics or household time-variant differences may still influence migration as well as eating patterns. To mitigate against this possibility to some extent, we include comparisons between urban and rural migrants, which resolves heterogeneity problems related to the decision to migrate or not. Any remaining potential bias related to unobserved heterogeneity influencing the choice of destination (rural vs. urban) while at the same time (and separate from that destination channel) affecting dietary changes, however, remains unaddressed.

In sum, the difference-in-differences regression model looks as follows:

$$\Delta C_{ij,t+1,t} = \alpha + \beta_1 M_{i,t+1}^{Rural} + \beta_2 M_{i,t+1}^{Urban} + \gamma X_{i,t} + \delta_{i,h} + \epsilon_{i,t}$$

where $\Delta C_{ij,t+1,t}$ represents the absolute change in the daily caloric intake, that person *i* obtains from food category *j* between 2008/09 (*t*) and 2012/13 (*t+1*). In other regression specifications, the left hand side variable will be the change in the *share* of food category *j* in total calories consumed, or the dietary diversity score. $M_{i,t+1}^{Rural}$ and $M_{i,t+1}^{Urban}$ are dummy variables that equal one when individual *i* migrated from their baseline rural community to a different rural or urban area respectively by period *t*+1. The term $X_{i,t}$ represents the vector of individual level baseline characteristics: age, sex, relation to the household head, education and marital status. Finally, $\delta_{i,h}$ stands for the initial household fixed effects (IHHFE) and $\epsilon_{i,t}$ represents the error term. Our main interest lies in establishing the sign, size and statistical significance of β_2, comparing rural-urban migrants to those who stayed in or nearby their baseline rural villages. Finally, we also perform an F-test comparing β_1 and β_2, which informs us whether our results hold when rural-rural migrants rather than rural stayers make up the comparison group. [11] The results of the analysis set out above are described and discussed in section 6.

6. Results and discussion

Table 3 summarizes the results of the difference-in-differences estimations of the effect of rural-urban migration on the absolute changes in total calorie intake per capita per day between 2008/09 and 2012/13 (column 1) and energy obtained from each of the 12 food categories considered (columns 2-13) as well as the change in the dietary diversity score (column 14). Table 4 repeats that analysis, but now using the change in the share of energy derived from each of the 12 categories as the left hand side variable, which allows us to assess the relative importance of these changes. It is important to keep in mind that the coefficient of interest (M^{Urban}) reflects the difference in the change of consumption of (certain) foods or the dietary diversity score over time between rural-urban migrants and their initial household members who remained in their baseline rural villages. This should not be confused with the change in consumption upon migrating nor with the difference in the levels between migrants and those who stayed behind.

[11] The F-statistic for the equality of the coefficients for rural-rural and rural-urban migration in our main specification is equal to the square of the T-statistic testing whether the coefficient for rural-urban migration is significantly different from zero in the regression $\Delta C_{ij,t+1,t} = \alpha + \beta_1 M_{i,t+1}^{Stayed} + \beta_2 M_{i,t+1}^{Urban} + \gamma X_{i,t} + \delta_{i,h} + \epsilon_{i,t}$.

Table 3: Results of the regressions of changes in food consumption (in kcal. per capita per day) by category and diversity score (2008/09-2012/13)

Table 4: Results of the regressions of changes in the share of each food category (in kcal. per capita per day) in total energy intake (2008/09-2012/13)

First, the results in Table 3 and 4 demonstrate that while rural-urban migration is not associated with a significant difference in the change in total energy intake (column 1), the composition of diets, undergoes significantly different changes. While there is a general declining trend in the (home) consumption of traditional staples, our results reveal that this shift is much more pronounced for those who moved to urban areas. Compared to household members who remained in their original rural villages, rural-urban migrants experienced an additional decline of 180 and 155 kcal per day for maize and cassava respectively (columns 2 and 3). From Table 4, we see that this results in a greater decline in their relative importance in total food consumption as well. Whereas maize and cassava accounted for 39 % and 12 % of total energy intake among rural residents at the baseline, urban migration is associated with an additional decline in the importance of these staples of 6.5 and 6.9 percentage points respectively. We find a similar trend in the consumption of other starchy foods (column 4).

The analysis further reveals a large positive effect on the growth of consumption of rice, bread, pasta and other cereal products. The increase in the share of rice in total food intake is 3.5 percentage points higher for rural-urban migrants (column 5). Though the difference in the increase in consumption of bread, pasta and other cereal products appears to be small in absolute value (71 kcal per day), this corresponds to more than four times the average rural intake at the baseline. From these results, it can also be derived that in spite of a mildly decreasing general trend, the consumption of sugary foods increases strongly with urban relocation, resulting in a highly significant difference in the change in energy derived from sugar, sweets and pastries and sodas, tea and coffee amounting to 60 and 25 kcal per day respectively (columns 11 and 12). Finally, there is a large and highly significant divergence in the consumption of meals and snacks away from home (column 13) between rural-urban migrants and their former household members who remained in their original rural areas. Keeping in mind that the average intake of this food category was relatively low at baseline (63 kcal per day) and increased only modestly for those who stayed in their original rural community, moving to urban areas was found to generate an average additional increase of 346 kcal per day. This corresponds to a remarkable difference of 9.7 percentage points in terms of the increase of its share in total energy intake.

Relocating to an urban area does not seem to induce a significantly different trend in the consumption of oils and fats at home (column 10). It is worth noting, however, that the potentially higher fat-content of meals and snacks consumed outside, may still lead to a stronger increase in total fat intake. Rural-urban migration also does not appear to be significantly associated with greater intake of pulses, nuts and seeds, animal source foods or fruits and vegetables (columns 7-9). Similarly, the change in the dietary diversity score over time appears to be unaffected (Table 2, column 14).

In order to assess whether moving to an urban area affects men and women differently, we run the regressions separate by gender (see Appendix B, Table B1 for women and B2 for men). The effects on the changes in the consumption of different food categories over time appear to be rather similar, except for meals and snacks consumed away from home. The more pronounced increase in the latter food category seems to be driven by male migrants. The coefficient for rural-urban migration becomes insignificant when we restrict the analysis to women. A potential explanation lies in the fact that women tend to migrate for marriage and other family-related reasons. Male migrants on the contrary, are more likely to be unmarried and to live alone or in smaller households and therefore perhaps less likely to cook or have someone else preparing food at home. Also, with respect to dietary diversity, the effects appear to be different for men and women. We find that, whereas women experience a significantly stronger increase in their dietary diversity score upon migration to urban areas, the coefficient for rural-urban migration is significantly negative when restricting the analysis to men. This comparison is, however, complicated by the fact that men consume more full meals away from home for which we do not have accurate compositional data.

So far we have compared urban migrants to those who remained in the rural areas, but it is also instructive to assess the differences among migrants according to the rural or urban nature of their destination. The last rows of Table 2 and Table 3 do so by presenting an F-test for the equality of the urban and rural migration dummies. Except for rice, comparing those who moved to urban areas to those who moved to rural areas produces differences of similar magnitudes and significance levels. This suggests that the dietary shifts we have identified relate indeed to living in an urban environment and not to migrant selection.

Because we lose close to 18 % of our sample between base- and endline, it is also important to consider the potential bias related to unit and item non-response. To test the robustness of our results to these sources of attrition, we computed inverse-probability-of-attrition weights for each individual. The differences between the size and significance of the coefficients in our baseline regression specification and those of the weighted regressions are found to be negligible.[12]

7. The composition of the urban landscape

There is great diversity among urban environments. Dorosh and Thurlow (2013) show that the urban population in sub-Saharan Africa is bimodally distributed, with roughly 40% living in major cities with a population exceeding 1,000,000 and 40% in small towns with less than 250,000 people. Cities and secondary towns differ in the sectoral composition of their economy (Dorosh and Thurlow, 2013), potentially influencing energy requirements, opportunity costs of time and income levels. Regarding the latter, several studies have, for example, documented the existence of an urban gradient, with average income higher and poverty levels lower in cities compared to secondary towns (e.g. Christiaensen and Kanbur, 2017). Large cities may also have markedly different food environments. Greater international exposure could result in a wider range of foods being available and changing preferences. The higher density of consumers also make cities the place where supermarkets get established (Hawkes, 2008), and options for eating outside of the house or buying processed or prepared food are more abundant. Secondary towns on the other hand are often closer to the rural areas and may have cheaper supplies of locally produced food products.

While these supply and demand factors are thus likely to differ systematically between towns and cities, it is unclear how this will affect food consumption.[13] This section therefore extends our analysis of the

[12] Additional information can be obtained from the corresponding author upon request.
[13] To the best of our knowledge, only one study has explicitly compared food consumption in large cities and secondary towns. Worku et al. (2017) find that quantities and expenditures on food are rather similar in Addis Ababa and secondary towns in Ethiopia.

impact of moving to an urban area on dietary change by exploring the heterogeneity of our results by the type of urban locality the migrant moves to. More specifically, we distinguish cities with a population exceeding the common threshold of 500,000 inhabitants (e.g. OECD, 2012) – Mwanza city and Dar es Salaam – from other urban areas, referred to as secondary towns.[14]

Table 5: Results of the regressions of changes in food consumption by category (in kcal. per capita per day) and diversity score on migration to different rural areas, secondary towns or cities (2008/09-2012/13)

Migration to towns and cities appears to be associated with largely similar dietary changes. The most remarkable differences are that, contrary to migration to cities, relocation to secondary towns is not associated with a significantly more pronounced decline in the (home) consumption of maize (column 2) and other starchy foods (column 4). The increase in the (home) consumption of rice (column 5) then again appears to derive mostly from those who migrated to towns.

The coefficient for relocation to cities is larger in the regressions of categories of food other than rice. The results of the F-tests summarized in the last row of Table 5, however, indicate that the food consumption trends are not significantly different for those who moved to cities compared to individuals who migrated to secondary towns. These findings suggest that the different sectoral composition and food environment will affect food demand in much the same way in secondary towns and in larger cities, even though the drivers of dietary change may be stronger and faster in the latter. In the next section we explore these potential underlying mechanisms in more detail.

An important caveat in this type of research is the lack of consensus on a clear classification of rural and urban areas as well as secondary towns and cities. We therefore also test whether our results hold when we move away from the administrative classification of locations into rural or urban and focus on local population density estimates instead. It can be argued that population density is a crucial gradient in delineating the rural-urban nexus as it can generate economies of scale and agglomeration effects, which are defining features of urban centres (Chomitz et al., 2005; Fujita et al., 1999).[15]

[14] According to this threshold, Mwanza city – which consists of the Ilemela and Nyamanga district (343,001 and 363,452 inhabitants) – and DSM (4,364,541 inhabitants) are the only cities (NBS, 2015). Our results are robust to changing this threshold to 1,000,000 or 250,000.

[15] This seems relevant in the case of Tanzania, since Muzzini and Lindeboom (2008) find that approximately 17 % of the population in mainland Tanzania live in high density settlements (>150 people/km²) that possess significantly different characteristics than rural areas but are nevertheless not officially recognized as 'urban'. It is worth noting, however, that Wenban-Smith (2014b:3) ultimately concludes that "despite the advantage of consistency, a density-based measure has limitations unless used in conjunction with other criteria".

The results of regressions of changes in food consumption by category and dietary diversity on a measure of population density, which are based on the WorldPop Project estimates of the number of inhabitants per 100 m² at the location where the respondent resides, are presented in Appendix B (Table B3) and are very much in line with our previous findings. Living in a higher density area compared to your initial household members is associated with a stronger shift away from traditional staple foods, towards more easily prepared and processed foods and a more pronounced increase in the consumption of food consumed outside the home. Though the results demonstrate a strong positive effect of population density on the change in the consumption of sugary drinks, the effect on intake of sugar, sweets and pastries is not significantly different from zero.

8. Unpacking the effects

In order to develop policies to respond to the dietary changes associated with urbanization, we need to understand the underlying mechanisms. What is it that makes people change their diets upon migrating from rural to urban areas? Does increased income or the urban lifestyle affect food preferences or do people simply adjust their consumption in response to different supply conditions? The answer to these questions could help illuminate whether interventions should be sought on the demand or supply side. While several potential drivers of urban dietary changes have been proposed in the literature (e.g. Kearney, 2010; Ruel et al., 2008), to the best of our knowledge, there is no empirical evidence exploring the extent to which these different proposed factors play a role in shaping the differences between rural and urban consumption.

In this section, we therefore aim to shed light on the drivers, or mediators, of changing food consumption with rural-urban migration. A common approach is to simply control for potential mediator variables in the regression and assess how this affects the coefficient of interest. Acharya et al. (2016), however, demonstrate that this can lead to biased estimates and propose an alternative method to assess whether a mediator variable (such as income change) is a mechanism whereby the treatment (migration) causes the outcome (dietary change). The quantity of interest is the Average Controlled Direct Effect (ACDE), which tells us what the effect of the treatment would be when the mediator is fixed at a particular level. The difference between the total effect and the ACDE is then a measure of the role of the mediator in the causal mechanism.[16]

We proceed by applying sequential g-estimation as suggested by Acharya et al. (2016) to obtain the ACDE estimates. These estimates equate to what the effect of migration would have been had (i) the respondent remained in a farming household, (ii) income not changed, and (iii) food prices remained the same. The corresponding mediator variables are (i) a dummy for whether the respondent was a member of a household headed by a farmer at baseline and lived in a non-farming household in 2012/13 ($Farm_{i,t+1}$); (ii) the change in the logarithm of total real household consumption per capita ($\Delta\ln(cons)_{i,t+1,t}$), (iii) the change in local prices captured by a total food price index ($\Delta PI_{i,t+1,t}$), as well as a price index for each specific food category ($\Delta PI_{ij,t+1,t}$) (see Appendix A, Table A3 for a detailed explanation of the variables). Finally, we estimate the ACDE for rural-urban migration, net of all three mediators simultaneously.

The first stage involves estimating the effect of the mediators on the consumption of different food categories and dietary diversity (see Appendix B, Table B4):

$$(1)\ \Delta C_{ij,t+1,t} = \alpha + \beta_1 M_{i,t+1}^{Rural} + \beta_2 M_{i,t+1}^{Urban} + \gamma X_{i,t} + \phi_1 Farm_{i,t+1} + \phi_2 \Delta\ln(cons)_{i,t+1,t} + \phi_3 \Delta PI_{i,t+1,t} + \phi_4 \Delta PI_{ij,t+1,t} + \delta_{i,h} + \epsilon_{i,t}$$

Next, we use these estimates to purge the outcome variables of the effect of changes in the mediator variable – to 'demediate' them in other words – by taking the estimated coefficient on the mediator variable, multiplying it by each unit's value for the mediator variable, and subtracting that from the observed outcome. The demediated outcomes for $Farm_{i,t+1}$ thus correspond to:

$$(2)\ \Delta \widetilde{C_{ij,t+1,t}} = \Delta C_{ij,t+1,t} - \widehat{\phi_1} Farm_{i,t+1}$$

[16] In line with Acharya et al. (2016), we test the significance of the difference between the total effect and the ACDE by creating a 95 % bootstrapped confidence interval (see Appendix B, Table B5). Note that the role of the mediator (measured as the difference between the total effect and the ACDE) consists of both the indirect effect (measuring how strong a particular causal pathway is) and the interaction effect (telling us how much the mediator influences the direct effect of the treatment).

We then estimate the ACDEs by regressing these demediated outcomes on the dummy variables for migration as well as all (pre-treatment) covariates:

$$(3)\ \Delta\widetilde{C_{ij,t+1,t}} = \alpha + \beta_1 M_{i,t+1}^{Rural} + \beta_2 M_{i,t+1}^{Urban} + \gamma X_{i,t} + \delta_{i,h} + \epsilon_{i,t}$$

Figure 2 provides, for each of the food categories as well as the dietary diversity score, a graphical representation of, respectively, the total effect of rural-urban migration (*Total effect*); the ACDE of moving to an urban area when accounting for (i) the transition from a farming to a non-farming household (*ACDE(Farm)*); (ii) changes in income (*ACDE(Income)*); (iii) changes in food prices (*ACDE(Prices)*); and (iv) all three mechanisms jointly (*ACDE(Farm, income, prices)*). The estimated ACDEs are summarized in more detail in Table B5 (see Appendix B). In addition, the estimated differences between the total effects and the ACDEs, which provide more insight into the strength of the different mechanisms, are summarized in Table B6 (see Appendix B).

Figure 2: ACDEs of rural-urban migration in regressions of changes in food consumption (in kcal. per capita per day) by category and diversity score (2008/09-2012/13)

The results depicted in Figure 2 indicate that income, in particular, is an important mediator through which rural-urban migration affects dietary change. With the exception of cassava (graph 3), the estimated difference between the total effect of rural-urban migration and the ACDE net of income – measuring the strength of the income mechanism – is significantly different from zero for all food categories as well as dietary diversity (see Appendix B, Table B6). Especially for total food consumption (graph 1), rice (graph 5), pulses, nuts and seeds (graph 7), meat, fish and dairy (graph 8), fruits and vegetables (graph 9), sugar, sweets and pastries (graph 11) and meals and snacks consumed away from home (graph 13) the difference is substantial (see Appendix B, Table B6). It is worth noting that the ACDEs net of income in the regressions of the change in the consumption of rice (graph 5), sugar, sweets and pastries (graph 11), and meals and snacks consumed away from home (graph 13) are not statistically significant. That is to say, if it were not for the increases in income associated with rural-urban migration, there would be no significant difference between the change in consumption of those who migrated to urban areas and their relatives who stayed in their baseline rural villages. Another interesting pattern with respect to income can be discerned for total food consumption (graph 1), pulses, nuts and seeds (graph 7), meat, fish and dairy (graph 8) and fruits and vegetables (graph 9). Whereas the estimates for the total effects of rural-urban migration for these categories are not significantly different from zero, the ACDEs net of changes in income have significantly negative coefficients. It implies that if moving to an urban area would not be associated with higher income gains, rural-urban migration would cause migrants to experience a significantly more pronounced decline in their total energy intake as well as in their consumption of pulses, nuts and seeds, meat, fish and dairy and fruits and vegetables compared to those staying behind in rural areas.

Graphs 3 and 4 in turn indicate that the additional decline in the (home) consumption of cassava and other starchy foods upon moving to an urban area, is largely driven by the price mechanism. Since the price differences between rural and urban areas for these goods appear to be particularly large, it is not surprising that the greater fall in consumption upon moving to an urban area is a response to facing higher prices.

For maize (graph 2) and cassava (graph 3), moving out of a farming household appears to play an important role in the greater decline in the consumption for rural-urban migrants. Non-surprisingly these are goods that are typically consumed from own production in rural areas. Maize is, for example, grown by roughly 80 % of farming households in Tanzania (NBS, 2014). For the latter, the ACDE net of the transition from a farming to a non-farming household is not statistically significant, suggesting that if rural-urban migrants would remain part of a farming household, there would be no significant difference between the change in their (home) intake of maize and that of their original household members who remained in their rural baseline villages. At the same time, no longer residing in a farming household also appears to explain part of the greater increase in the consumption of rice (graph 5) upon moving to an urban area. The transition out of farming thus seems to have a positive effect on the intake of rice, possibly to compensate the reduced access to own-produced staples. Alternatively, this could also be related to greater preferences for foods with shorter preparation times when working further away from home.

Finally, we note that changes in income and prices appear to play a relatively small but statistically significant (see Appendix B, Table B6) role in explaining the positive effect of rural-urban migration on the growth in the consumption of bread, pasta and other cereal products (graph 6) and sodas, tea and coffee (graph 12). Nevertheless, the ACDEs of rural-urban migration net of the three potential mechanisms considered (*ACDE (Farm, income, prices)*) are significantly positive. This indicates that there would be a strong effect of moving to an urban area even if all individuals had remained in a farming household and had experienced no income growth and price changes.

9. Conclusion

Although urbanization is increasingly put forward as one of the main determinants of changes in eating patterns and a driver of the nutrition transition in the developing world, our understanding of its effects on diets and the underlying mechanisms through which these take place remains limited. Using data from the Tanzania National Panel Survey for 2008/09 and 2012/13 that traced household members who moved throughout this period, this paper provides empirical evidence on the impact of relocating to an urban area on the total calorie intake as well as the energy obtained from 12 different food categories and dietary diversity. Not only is this focus on rural-urban migrants novel in the literature, it enables us to more accurately capture the effect of living in an urban environment as we are able to observe the same individual in a rural and urban setting. Moreover, the panel nature of the data combined with the tracking exercise in this survey allows us to address concerns about observed or unobserved heterogeneity across migrant and non-migrant families by restricting the comparison to individuals originating from the same baseline household.

The results summarized in this paper clearly demonstrate that, for the same individual, eating patterns depend on whether one resides in an urban or a rural area. We find that compared to household members who remained in their original rural villages, those relocating to urban areas experience a more pronounced shift away from traditional staples and towards more conveniently consumed or prepared foods such as rice, bread and meals away from home. Confirming concerns about the sweetening of urban diets, the results also reveal a significant difference in the change in high-sugar foods consumption. However, several other trends that are commonly associated with urbanization are not reflected in our results. In particular, in spite of large differences in average rural and urban intake, moving to an urban area was not found to have any significant effect on the change in the intake of oils and fats, animal source foods, and the total number of food groups consumed. This suggests that the higher average urban intake of oils and fats, animal source foods and dietary diversity score observed cross-sectionally, may be driven by socio-economic differences between rural and urban residents that are unrelated to the urban environment itself. The fact that we do not have accurate compositional data on meals and snacks consumed away from home, however, poses a caveat for the interpretation of our analysis of dietary diversity and urges increased efforts to collect information on the composition and nutritional value of foods consumed away from home (e.g. Fiedler and Yadav, 2017).

Distinguishing migrants according to the type of their urban destination reveals that while consumption patterns change more drastically when migrating to large cities, the same trends can be observed for those who moved to smaller secondary towns. In addition, most of the differences appear to be independent of the administrative classification into rural or urban and are confirmed when focusing upon population density estimates instead.

Our analysis goes further in exploring the potential drivers of these dietary changes. We find that a substantial part of the observed dietary shifts associated with urban relocation can be explained by the move out of a farming household, by different relative prices for food, and especially by the increases in income that come along with it. More specifically, price changes and the transition to a non-farming household play an important role in producing the overall negative effect of moving to an urban area on the change in consumption of traditional staple foods, which are typically home-produced in rural areas. Our results further suggest that if moving to an urban area would not be associated with higher income gains, rural-urban migrants would have experienced a more pronounced decline in their total food consumption as well as in their intake of pulses, nuts and seeds, meat, fish and dairy and fruits and vegetables compared to those who stayed. At the same time, changes in income appear to be the main channel through which the increase in consumption of rice, high-sugar products and meals and snacks consumed away from home take place upon migrating to urban areas. The more pronounced increase in the consumption of bread, pasta and other cereal products and sodas, tea and coffee after moving to an urban area, however, cannot be solely explained by changes in income, prices and the transition out of farming. Potentially the specific urban supply environment, with more diversity in food retail types, nearby food processing and more international exposure plays a role here.

Considering the health consequences of these changing diets, it is important to emphasize that we find little support for the hypothesis put forward in the literature that urbanization contributes positively to the quality or diversity of food consumption. On the contrary, our results point to a significantly stronger growth of the consumption of high-sugar foods. In addition, the stronger increase of meals consumed outside the home may present a nutritional concern because of problems related to the safety and quality of street foods (e.g. Mensah et al., 2002; Omemu and Aderoju, 2008) as well as their tendency to have higher fat, sugar and salt content (Steyn et al., 2014; Jia et al., 2018). Overall, these findings thus raise the question whether – partly as a consequence of changing diets – urban residence is associated with weight gain and contributes to rising levels of diet-related non-communicable diseases (Popkin et al., 2012). Unfortunately, due to the relatively short-time span of the data and the limited sample of individuals for whom anthropometric indicators are available, the data do not allow us to draw any meaningful conclusions about the impact of moving to an urban area on weight gain. Clearly, this represents an important area of future research. Interestingly, our results do, however, indicate that the increase of more unhealthy food consumption after moving to an urban area is largely linked to rising incomes. As such, health concerns over diets can be expected to spread rapidly to less-urbanized areas as well, as soon as income growth takes off there.

Since our findings are based upon a relatively short period of time and confined to the Tanzanian case, they call for more in-depth research on the extent and consequences of changes in diets and nutrient intake related to living in more urbanized areas. Given the fast projected rates of urban population growth in the coming decades, a better understanding of its impact on dietary patterns will contribute to improved projections on future food demand. This may be crucial to adapt health and food and nutrition security policies as well as agricultural and trade strategies in sub-Saharan Africa and the rest of the developing world. For example, improved rural-urban linkages may reduce price differentials for more perishable traditional staples and enhance urban consumption. Increased demand for easily prepared and processed cereals with rising incomes, could also generate opportunities for investment in domestic processing facilities. Yet at the same time, this calls for initiatives to ensure the quality of processed and prepared foods and increased efforts in nutrition education to promote healthy diets.

References

Abdulai, A., Aubert, D. (2004). A cross-section analysis of household demand for food and nutrients in Tanzania. *Agricultural Economics*, 31 (1), 67-79. http://dx.doi.org/10.1111/j.1574-0862.2004.tb00222.x

Acharya, A., Blackwell, M., Sen, M. (2016). Explaining causal findings without bias: Detecting and assessing direct effects. *American Political Science Review*, 110(3), 512-529. https://doi.org/10.1017/S0003055416000216

Adam, C., Kwimbere, D., Mbowe, W., O'Connell, S. (2012). Food prices and inflation in Tanzania (Working Paper No. 163). Abidjan: African Development Bank.

Ambroz, A., Wenban-Smith, H.B. (2014). Tanzania's urban populations, 1967-2012 (Working Paper C-40211-TZA-1). London: International Growth Centre.

Arimond, M., Ruel, M. T. (2004). Dietary diversity is associated with child nutritional status: evidence from 11 demographic and health surveys. *Journal of Nutrition* 134(10), 2579-2585. https://doi.org/10.1093/jn/134.10.2579

Beegle, K., De Weerdt, J., Dercon, S. (2011). Migration and economic mobility in Tanzania: Evidence from a tracking survey. *Review of Economics and Statistics* 93(3), 1010-1033. hhttp://dx.doi.org/ 10.1162/REST_a_00105

Bergquist, L. F. (2017). Pass-through, competition, and entry in agricultural markets: Experimental evidence from Kenya. Private Enterprise Development in Low-Income Countries (PEDL) Research Paper. Centre for Economic Policy Research (CEPR) and the Department for International Development (DFID): London.

Bloem, S., de Pee, S. (2017). Developing approaches to achieve adequate nutrition among urban populations requires an understanding of urban development. *Global Food Security*, 12, 80-88. https://doi.org/10.1016/j.gfs.2016.09.001

Bosu, W. K. (2015). An overview of the nutrition transition in West Africa: implications for non-communicable diseases. *Proceedings of the Nutrition Society*, 74(4), 466-477. https://doi.org/10.1017/s0029665114001669

Bourne, L. T., Lambert, E. V., Steyn, K. (2002). Where does the black population of South Africa stand on the nutrition transition? *Public Health Nutrition* 5(1a), 157-162. http://dx.doi.org/10.1079/PHN2001288

Bowen, L., Ebrahim, S., De Stavola, B., Ness, A., Kinra, S., Bharathi, A. V., ... Reddy, K. S. (2011). Dietary intake and rural-urban migration in India: a cross-sectional study. *PLoS One* 6(6): e14822. http://dx.doi.org/10.1371/journal.pone.0014822

Chomitz, K.M., Buys, P., Thomas, T.S. (2005). Quantifying the rural-urban gradient in Latin America and the Carribean, *World Bank Policy Research Working Paper* 3634,Washington, D.C.World Bank. https://doi.org/10.2139/ssrn.757164

Christiaensen, L., Kanbur, R. (2017). Secondary towns and poverty reduction: refocusing the urbanization agenda. *Annual Review of Resource Economics*, 9, 405-419. https://doi.org/10.1146/annurev-resource-100516-053453

Crush, J., Frayne, B. 2010. The invisible crisis: urban food security in Southern Africa. Urban Food Security in Southern Africa, *Urban Food Security Series*, No. 1, African Food Security Urban Network (AFSUN)). Cape Town: Unity Press.

Crush, J., Frayne, B., M. McLachlan (2011). Rapid urbanization and the nutrition transition in Southern Africa, *Urban Food Security Series,* No. 7. African Food Security Urban Network (AFSUN). Cape Town: Unity Press.

Dapi, L. N., Omoloko, C., Janlert, U., Dahlgren, L., Håglin, L. (2007). "I eat to be happy, to be strong, and to live." Perceptions of rural and urban adolescents in Cameroon, Africa. *Journal of Nutrition Education and Behavior,* 39(6), 320-326. https://doi.org/10.1016/j.jneb.2007.03.001

de Brauw, A., Mueller, V., Woldehanna, T. (2017). Does internal migration improve overall well-being in Ethiopia? *Journal of African Economies*, 1-19. https://doi.org/10.1093/jae/ejx026

De Nigris, M. (1997). *Urbanization and Food Demand in Africa*. Rome: FAO.

De Weerdt, J., Beegle, K., Friedman, J., Gibson, J. (2016). The challenge of measuring hunger through survey. *Economic Development and Cultural Change*, *64*(4), 727-758. http://dx.doi.org/10.1086/686669

Deaton, A., Drèze, J. (2009). Food and nutrition in India: Facts and interpretations, *Economic and Political Weekly*, 44(7): 42-65. https://doi.org/10.2139/ssrn.1135253

Delgado, C. (1989). Why is rice and wheat consumption increasing in West Africa? Presented to the European Seminar of Agricultural Economists, Montpellier.

Doak, C. M., Adair, L. S., Bentley, M., Monteiro, C., Popkin, B. M. (2005). The dual burden household and the nutrition transition paradox. *International Journal of Obesity*, 29(1), 129-36. https://doi.org/10.1038/sj.ijo.0802824

Dorosh, P., Thurlow, J. (2013). Agriculture and small towns in Africa. *Agricultural Economics,* 44, 449–459.
http://dx.doi.org/10.1111/agec.12027

Ebrahim, S., Kinra, S., Bowen, L., Andersen, E., Ben-Shlomo, Y., Lyngdoh, T., ... Mohan, M. (2010). The effect of rural-to-urban migration on obesity and diabetes in India: a cross-sectional study. *PLoS Med* 7(4), e1000268.
http://dx.doi.org/10.1371/journal.pmed.1000268

Fiedler, J. L., Yadav, S. (2017). How can we better capture food away from Home? Lessons from India's linking person-level meal and household-level food data. *Food policy*, 72, 81-93. https://doi.org/10.1016/j.foodpol.2017.08.015

Friedman, J., Beegle, K., De Weerdt, J., Gibson, J. (2017). Decomposing response error in food consumption measurement: Implications for survey design from a randomized survey experiment in Tanzania. *Food Policy*, 72, 94-111.

Fujita, M., P. Krugman, P., Venables, A.J. (1999). The Spatial Economy: Cities, Regions, and International Trade. Cambridge and London: MIT Press.

Garrett, J. L., Ruel, M. T. (1999). Are determinants of rural and urban food security and nutritional status different? Some insights from Mozambique. *World Development* 27(11), 1955-1975. http://dx.doi.org/10.1016/S0305-750X(99)00091-1

Gollin, D., Goyal, R. (2017). Agricultural transformation in Tanzania: Linking rural to urban through domestic value chains. In Adam, C.S., Collier, P., Ndulu, B. Tanzania: The path to prosperity. Oxford: Oxford Scholarship Online.
https://doi.org/10.1093/acprof:oso/9780198704812.003.0006

Hawkes, C. (2006). Uneven dietary development: linking the policies and processes of globalization with the nutrition transition, obesity and diet-related chronic diseases, *Globalization and Health* 2(1),4.
http://doi.org/10.1186/1744-8603-2-4

Hawkes, C. (2008). Dietary implications of supermarket development: a global perspective. *Development Policy Review* 26(6), 657-692.
http://dx.doi.org/10.1111/j.1467-7679.2008.00428.x

Huang, J., Bouis, H. (2001). Structural changes in the demand for food in Asia: empirical evidence from Taiwan. *Agricultural Economics***,** 26(1), 57-69. http://dx.doi.org/10.1111/j.1574-0862.2001.tb00054.x

Huang, J., David, C. C. (1993). Demand for cereal grains in Asia: the effect of urbanization. *Agricultural Economics* 8(2), 107-124. http://dx.doi.org/10.1016/0169-5150(92)90025-T

Ijumba, C., Snyder, S., Tschirley, D., Reardon, T. (2015). Stages of Transformation in Food Processing and Marketing: results of an Initial Inventory of Processed Food Products in DSM, Arusha, and Mwanza (Policy Brief 3). Dar es Salaam: Feed the Future Tanzania.

Jia, X., Liu, J., Chen, B., Jin, D., Fu, Z., Liu, H., ... Mendez, M. A. (2018). Differences in nutrient and energy contents of commonly consumed dishes prepared in restaurants v. at home in Hunan Province, China. *Public Health Nutrition*, 1-12. https://doi.org/10.1017/s1368980017003779

Kearney, J. (2010). Food consumption trends and drivers. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 365(1554), 2793-2807. https://doi.org/10.1098/rstb.2010.0149

Kennedy, E., Reardon, T. (1994). Shift to non-traditional grains in the diets of East and West Africa: role of women's opportunity cost of time. *Food Policy* 19(1), 45-56. http://dx.doi.org/10.1016/0306-9192(94)90007-8

Kennedy, G., Ballard, T., Dop, M.C. (2013). Guidelines for measuring household and individual dietary diversity. Rome: Food and Agriculture Organization of the United Nations.

Kudo, Y. (2015). Female migration for marriage: Implications from the land reform in rural Tanzania. *World Development* 65,41-61. http://dx.doi.org/10.1016/j.worlddev.2014.05.029

MacIntyre, U. E., Kruger, H. S., Venter, C. S.,Vorster, H. H. (2002). Dietary intakes of an African population in different stages of transition in the North West Province, South Africa: the THUSA study. *Nutrition Research* 22(3), 239-256. http://dx.doi.org/10.1016/S0271-5317(01)00392-X

Maruapula, S. D., Jackson, J. C., Holsten,... Compher, C. (2011). Socio-economic status and urbanization are linked to snacks and obesity in adolescents in Botswana. *Public Health Nutrition* 14(12), 2260-2267. http://dx.doi.org/10.1017/S1368980011001339

Maxwell, D., Levin, C., Armar-Klemesu, M., Ruel, M., Morris, S., Ahiadeke, C. (2000). Urban livelihoods and food and nutrition security in Greater Accra (Research Report 112). Washington, D.C.: International Food Policy Research Institute (IFPRI). https://doi.org/10.2499/0896291154rr112

Mazengo, M. C., O. Simell, Z. Lukmanji, R. Shirima, Karvetti, R-L. (1997). Food consumption in rural and urban Tanzania. *Acta Tropica* 68(3), 313-326. https://doi.org/10.1016/s0001-706x(97)00113-7

McGranahan, G., Satterthwaite, D. (2014) *Urbanisation concepts and trends.* IEED Working Paper. IIED, London.

Mendez, M., Popkin, B. (2004). Globalization, urbanization and nutritional change in the developing world. In: Globalization of food systems in developing countries: impact on food security and nutrition. *FAO Food and Nutrition Paper* 83: 57-80, FAO: Rome.

Mensah, P., Yeboah-Manu, D., Owusu-Darko, K., Ablordey, A. (2002). Street foods in Accra, Ghana: how safe are they? *Bulletin of the World Health Organization* 80(7), 546-554. http://dx.doi.org/10.1590/S0042-96862002000700006

Mohiddin, L., Phelps, L., Walters, T. (2012) Urban malnutrition: a review of food security and nutrition among the urban poor, *Nutrition Works* 8, International Public Nutrition Research Group.

Montgomery, M.R., R. Stren, B. Cohen, Reed, H.E., eds. (2003). *Cities Transformed: Demographic Change and its Implication for the Developing World*. Washington, D.C.: National Academy Press.

Moser, C., Barrett, C., Minten, B. (2009). Spatial integration at multiple scales: rice markets in Madagascar, *Agricultural Economics* 40: 281-294. https://doi.org/10.1111/j.1574-0862.2009.00380.x

Muzzini, E., Lindeboom, W. (2008). The urban transition in Tanzania: Building the empirical base for policy dialogue (Working Paper 44972). Washington, D.C.: World Bank.

NBS (2006). Analytical Report of the 2002 Tanzania Census. Dar es Salaam: National Bureau of Statistics, Ministry of Planning, Economy and Empowerment.

NBS (2014). Tanzania Mainland Household Budget Survey 2011. Dar es Salaam: National Bureau of Statistics.

NBS (2015). The United Republic of Tanzania : Migration and Urbanization Report 2015. Dar es Salaam: National Bureau of Statistics.

Nickanor N., Kazembe, L., Crush, J., Wagner, N. (2017). The Supermarket revolution and food security in Namibia, *Urban Food Security Series* No. 26, African Food Security Urban Network (AFSUN). Cape Town: Unity Press.

Ntandou, G., Delisle, H., Agueh, V., Fayomi, B. (2008). Physical activity and socioeconomic status explain rural-urban differences in obesity: a cross-sectional study in Benin (West Africa). *Ecology of*

Food and Nutrition, 47(4), 313-337.
https://doi.org/10.1080/03670240802003835

OECD (2012). *Redefining "Urban". A new way to measure metropolitan areas*. Paris: OECD Publishing.
https://doi.org/10.1787/9789264174108

Okpechi, I. G., Chukwuonye, I. I., Tiffin, N., Madukwe, O. O., Onyeonoro, U. U., Umeizudike, T. I., Ogah, O. S. (2013). Blood pressure gradients and cardiovascular risk factors in urban and rural populations in Abia State South Eastern Nigeria using the WHO STEPwise approach. *PLoS One*, 8(9), e73403.
https://doi.org/10.1371/journal.pone.0073403

Omemu, A. M., Aderoju, S. T. (2008). Food safety knowledge and practices of street food vendors in the city of Abeokuta, Nigeria. *Food Contro*l 19(4), 396-402.
http://dx.doi.org/10.1016/j.foodcont.2007.04.021

Osborne, T. (2005). Imperfect competition in agricultural markets: evidence from Ethiopia. *Journal of Development Economics*, 76 (2), 405-428.
https://doi.org/10.1016/j.jdeveco.2004.02.002

Peer, N., Bradshaw, D., Laubscher, R., Steyn, N., & Steyn, K. (2013). Urban–rural and gender differences in tobacco and alcohol use, diet and physical activity among young black South Africans between 1998 and 2003. *Global health action*, 6(1), 19216.
https://doi.org/10.3402/gha.v6i0.19216

Popkin, B. M. (1999). Urbanization, lifestyle changes and the nutrition transition. *World Development* 27(11), 1905-1916.
http://dx.doi.org/10.1016/S0305-750X(99)00094-7

Popkin, B. M. (2001). The nutrition transition and obesity in the developing world. *The Journal of nutrition*, 131(3), 871S-873S. https://doi.org/10.1093/jn/131.3.871S

Popkin, B. M., Du, S. (2003). Dynamics of the nutrition transition toward the animal foods sector in China and its implications: a worried perspective. *Journal of Nutrition* 133(11), 3898S-3906S.

Popkin, B. M., Adair, L. S., & Ng, S. W. (2012). Global nutrition transition and the pandemic of obesity in developing countries. *Nutrition Reviews* 70(1), 3-21.
http://dx.doi.org/10.1111/j.1753-4887.2011.00456.x

Rae, A. N. (1998). The effects of expenditure growth and urbanisation on food consumption in East Asia: a note on animal products. *Agricultural Economics* 18(3), 291-299.
http://dx.doi.org/10.1016/S0169-5150(97)00051-0

Reardon, T. (1993). Cereals demand in the Sahel and potential impacts of regional cereals protection. *World Development*, 21(1), 17-35.
http://dx.doi.org/10.1016/0305-750X(93)90134-U

Regmi, A., Dyck, J. (2001). Effects of urbanization on global food demand. In: Regmi, A. (Eds.), *Changing structure of global food consumption and trade*, 23-30). Washington D.C.: USDA-ERS.

Ruel, M. T., Garrett, J.L. (2004). Features of Urban Food and Nutrition Security and Considerations for Successful Urban Programming. In: Globalization of food systems in developing countries: Impact on food security and nutrition, *FAO Food and Nutrition Paper* 83: 27-53, FAO: Rome.

Ruel, M. T., Garrett, J. L., Haddad, L. (2008). Rapid urbanization and the challenges of obtaining food and nutrition security. In: *Nutrition and health in developing* countries, 639-656. Humana Press.

Ruel, M. T., Garrett, J. L.,Sivan, Y. (2017). Food security and nutrition: Growing cities, new challenges. In: *Global Food Policy Report*, 24-33. Washington, DC: International Food Policy Research Institute (IFPRI).
https://doi.org/10.2499/9780896292529_03

Ruel, M.T., Minot, N., Smith, L. (2005). Patterns and determinants of fruit and vegetable consumption in sub-Saharan Africa: a multi-country comparison. Backgroundpaper for the Joint FAO/WHO Workshop on Fruit and Vegetables for Health, 1-3 September 2004, Kobe, Japan. Geneva: World Health Organisation.

Satterthwaite, D. (2006). Outside the Large Cities: the demographic importance of small urban centres and large villages in Africa, Asia and Latin America (Human Settlements Discussion Paper; Urban Change –3). London: International Institute for Environment and Development (IIED).

Seto, K. C., Ramankutty, N. (2016). Hidden linkages between urbanization and food systems. *Science*, 352(6288), 943-945.

Shetty, P. S. (2002). Nutrition transition in India. *Public health nutrition*, 5(1a), 175-182.
http://dx.doi.org/10.1079/PHN2001291

Smith, L. C., Subandoro, A. (2007). Measuring food security using household expenditure surveys. Washington, D.C.: International Food Policy Research Institute (IFPRI).

Smith, L. C., Alderman, H., Aduayom, D. (2006). Food insecurity in sub-Saharan Africa: new estimates from household expenditure surveys (Research Report 146). Washington, D.C.: International Food Policy Research Institute (IFPRI).

Sobngwi, E., Mbanya, J. N., Unwin, N. C., Kengne, A. P., Fezeu, L., Minkoulou, E. M., ... Alberti, K. G. M. M. (2002). Physical activity and its relationship with obesity, hypertension and diabetes in urban and rural Cameroon. *International Journal of Obesity*, 26(7), 1009. https://doi.org/10.1038/sj.ijo.0802008

Spence, M., Annez, P.C., Buckley, R.M. (2009). Urbanization and Growth. Washington, D.C.: World Bank.

Stage, J., Stage, J., McGranahan, G. (2010). Is urbanization contributing to higher food prices?. *Environment and Urbanization*, 22(1), 199-215. http://doi.org/10.1177/0956247809359644

Stern, R., Puoane, T., Tsolekile, L. (2010). An Exploration into the Determinants of Noncommunicable Diseases Among Rural-to-Urban Migrants in Periurban South Africa. *Preventing Chronic Disease*, 7(6).

Steyn, N. P., Labadarios, D., Nel, J. H. (2011). Factors which influence the consumption of street foods and fast foods in South Africa-a national survey. *Nutrition Journal* 10(1), 104. http://doi.org/10.1186/1475-2891-10-104©

Steyn, N. P., Nel, J. H., Parker, W., Ayah, R., Mbithe, D. (2012). Urbanisation and the nutrition transition: a comparison of diet and weight status of South African and Kenyan women. *Scandinavian Journal of Public Health*, 40(3), 229-238.

Steyn, N. P., Senekal, M., Brtis, S., Nel, J. (2000). Urban and rural differences in dietary intake, weight status and nutrition knowledge of black female students. *Asia Pacific Journal of Clinical Nutrition*, 9(1), 53-59.

Steyn, N. P., Mchiza, Z., Hill, J., Davids, Y. D., Venter, I., Hinrichsen, E., ... Jacobs, P. (2014). Nutritional contribution of street foods to the diet of people in developing countries: a systematic review. *Public Health Nutrition*, *17*(6), 1363-1374.

THDS-MIS (2016). Tanzania Demographic and Health Survey and Malaria Indicator Survey (TDHS-MIS) 2015-16. Ministry of Health, Community Development, Gender, Elderly and Children (MoHCDGEC), Ministry of Health (MoH), National Bureau of Statistics (NBS), Office of the Chief Government Statistician (OCGS), and ICF.

Thiele, S., Weiss, C. (2003). Consumer demand for food diversity: evidence for Germany. *Food Policy* 28(2), 99-115. https://doi.org/10.1016/s0306-9192(02)00068-4

Torheim, L. E., Ouattara, F., Diarra, M. M., Thiam, F. D., Barikmo, I., Hatløy, A., Oshaug, A. (2004). Nutrient adequacy and dietary diversity in rural Mali: association and determinants. *European Journal of Clinical Nutrition* 58(4), 594-604. http://dx.doi.org/10.1038/sj.ejcn.1601853

Tschirley, D., Cunguara, B., Haggblade, S., Reardon, T., Kondo, M. (2017). Africa's Unfolding Diet Transformation and Farm Employment: Evidence from Tanzania (Research Paper 43). Michigan State University and International Food Policy Research Institute (IFPRI).

Tschirley, D., Reardon, T., Dolislager, M., Snyder, J. (2015). The rise of a middle class in East and Southern Africa: Implications for food system transformation. *Journal of International .Development* 27(5), 628-646.
http://dx.doi.org/10.1002/jid.3107

UN (2015). World Population Prospects: The 2015 Revision, Key Findings and Advance Tables. Working Paper No. ESA/P/WP.241. New York: United Nations, Department of Economic and Social Affairs, Population Division.

UN (2016). The World's Cities in 2016 – Data Booklet. New York: United Nations, Department of Economic and Social Affairs, Population Division.

UNICEF-WHO-World Bank (2016). Joint malnutrition estimates. Available at http://www.who.int/nutgrowthdb/estimates/en/.

Unwin, N., James, P., McLarty, D., Machybia, H., Nkulila, P., Tamin, B .et al. (2010). Rural to urban migration and changes in cardiovascular risk factors in Tanzania: a prospective cohort study. *BMC Public Health*; 10: 272.
http://dx.doi.org/10.1186/1471-2458-10-272

Vorster, H. H., Kruger, A., Margetts, B. M. (2011). The nutrition transition in Africa: can it be steered into a more positive direction?. *Nutrients*, 3(4), 429-441.

Vorster, H. H., Venter, C. S., Wissing, M. P., Margetts, B. M. (2005). The nutrition and health transition in the North West Province of South Africa: a review of the THUSA (Transition and Health during Urbanisation of South Africans) study. *Public Health Nutrition*, 8(05), 480-490.

Wenban-Smith, H. B. (2014a). Population growth, internal migration and urbanisation in Tanzania, 1967-2012: A Census based regional analysis (Working Paper). London: International Growth Centre (IGC).

Wenban-Smith, H.B. (2014b). A density-based measure of "urban' for Tanzania ? A feasibility study using Dodoma region (Working Paper). London: International Growth Centre (IGC).

WFP - World Food Programme (2013). Comprehensive Food Security & Vulnerability Analysis (CFSVA), Tanzania, 2012. Rome: World Food Programme.

WHO (2016a). United Republic of Tanzania – Urban health profile. Available at http://www.who.int/kobe_centre/measuring/urban_health_observatory/tanzania.pdf.

WHO (2016b). Global Health Observatory (GHO) data on overweight and obesity. Available at http://www.who.int/gho/ncd/risk_factors/overweight/en/.

Willaarts, B., Pardo, I., Mora, G. D. L. (2013). Urbanization, socio-economic changes and population growth in Brazil: dietary shifts and environmental implications. Presented at the International Population Conference, Busan.

Witcher, B., Kolasa, K. M., Bond, J. T. (1988). Influence of rural-urban migration on adult women's food patterns and adequacy of their children's diet in Ecuador. *Ecology of Food and Nutrition* 21(3), 189-198.

Worku, I. H., Dereje, M., Minten, B., Hirvonen, K. (2017). Diet transformation in Africa: The case of Ethiopia. *Agricultural Economics*, 48(S1), 73-86.

World Bank. (2008). Africa's urbanization for development: Understanding Africa's urban challenges and opportunities. Washington D.C.: World Bank.

World Bank. (2016). World Development Indicators. Available at http://data.worldbank.org/data-catalog/world-development-indicators.

Zhai, F., Wang, H., Du, S., He, Y., Wang, Z., Ge, K., Popkin, B. M. (2009). Prospective study on nutrition transition in China. *Nutrition reviews* 67, S56-S61. http://dx.doi.org/ 10.1111/j.1753-4887.2009.00160.x

Zheng, Z., Henneberry, S. R. (2009). An analysis of food demand in China: a case study of urban households in Jiangsu province. *Applied Economic Perspectives and Policy* 31(4), 873-893. http://dx.doi.org/10.1111/j.1467-9353.2009.01471.x

Appendix A: Variables

Table A1: Food categories

Food category	Food items
Maize	Maize (green, cob) Maize (grain) Maize (flour)
Cassava	Cassava fresh Cassava dry/flour
Other starchy foods	Millet and sorghum (grain) Millet and sorghum (flour) Wheat, barley grain and other cereals Sweet potatoes Cooking bananas, plantains Yams/cocoyams Irish potatoes Other roots and tubers
Rice	Rice (paddy) Rice (husked)
Bread, pasta, cereal products	Bread Macaroni, spaghetti Other cereal products
Pulses, nuts and seeds	Peas, beans, lentils and other pulses Groundnuts in shell/shelled Coconuts (mature/immature) Cashew, almonds and other nuts Seeds and products from nuts/seeds (excl. cooking oil)
Meat, fish and dairy	Goat meat Beef including minced sausage Pork including sausages and bacon Chicken and other poultry Wild birds and insects Other domestic/wild meat products Eggs Fresh fish and seafood (including dagaa) Dried/salted/canned fish and seafood (incl. dagaa) Fresh milk Milk products (like cream, cheese, yoghurt etc.) Canned milk/milk powder
Fruits and vegetables	Ripe bananas Citrus fruits (oranges, lemon, tangerines, etc.) Mangoes, avocadoes and other fruits Onions, tomatoes, carrots and green pepper Spinach, cabbage and other green vegetables Canned, dried and wild vegetables
Oils and fats	Cooking oil Butter, margarine, ghee and other fat products
Sugar and sweets	Sugar Sugarcane Sweets Honey, syrups, jams, marmalade, jellies, canned fruits Maandazi (donuts), cakes, biscuits Sweets, ice-cream (consumed away from home)
Sodas, tea and coffee	Tea dry Coffee and cocoa Bottled/canned soft drinks (soda, juice, water) Prepared tea, coffee Sodas and other non-alcoholic drinks (consumed away from home)
Meals and snacks consumed away from home	Full meals (breakfast, lunch or dinner) (consumed away from home) Barbecued meat, chips, roast bananas and other snacks prepared on charcoal (consumed away from home) Tea, coffee, samosa, cake and other snacks (consumed away from home)

Table A2: Food groups (used to determine dietary diversity)

Food group	Food items
Cereals	Rice (paddy) Rice (husked) Maize (green, cob) Maize (grain) Maize (flour) Bread Macaroni, spaghetti Other cereal products Millet and sorghum (grain) Millet and sorghum (flour) Wheat, barley grain and other cereals
White roots and tubers	Cassava fresh Cassava dry/flour Cooking bananas, plantains Yams/cocoyams Irish potatoes Other roots and tubers
Sugar and sweets	Sugar Sweets Honey, syrups, jams, marmalade, jellies, canned fruits Maandazi (donuts), cakes, biscuits Sweets, ice-cream (consumed away from home)
Legumes, nuts and seeds	Peas, beans, lentils and other pulses Groundnuts (in shell/shelled) Coconuts (mature/immature) Cashew, almonds and other nuts Seeds and products from nuts/seeds (excl. cooking oil)
Fruit	Ripe bananas Citrus fruits (oranges, lemon, tangerines, etc.) Mangoes, avocadoes and other fruits
Vegetables	Onions, tomatoes, carrots and green pepper Spinach, cabbage and other green vegetables Canned, dried and wild vegetables Sweet potatoes
Meat	Goat meat Beef including minced sausage Pork including sausages and bacon Chicken and other poultry Wild birds and insects Other domestic/wild meat products
Eggs	Eggs
Fish and other seafood	Fresh fish and seafood Dried/salted/canned fish and seafood
Milk and milk products	Fresh milk Milk products (like cream, cheese, yoghurt etc.) Canned milk/milk powder
Oils and fats	Cooking oil Butter, margarine, ghee and other fat products
Miscellaneous	Tea dry Coffee and cocoa Bottled/canned soft drinks (soda, juice, water) Prepared tea, coffee Sodas and other non-alcoholic drinks (consumed away from home) Full meals (breakfast, lunch or dinner) (consumed away from home) Barbecued meat, chips, roast bananas and other snacks prepared on charcoal (consumed away from home) Tea, coffee, samosa, cake and other snacks (consumed away from home)

Note: The delineation of different food groups was based on FAO guidelines for measuring dietary diversity (Kennedy et al., 2013).

Table A3: Independent variables

M^{Rural}	Migration to different rural area Dummy variable equal to one when in 2012/13 individual was found to reside in a household in a different and distant (>1hour drive) rural (as defined by the 2002 Census classification) area than during the 2008/09 round.
M^{Urban}	Migration to urban area Dummy variable equal to one when in 2012/13 individual was found to reside in a distant (> 1hour drive) urban (as defined by the 2002 Census classification) household.
$M^{Sec.\ Towns}$	Migration to secondary town Dummy variable equal to one when in 2012/13 individual was found to reside in a distant (> 1hour drive) urban (as defined by the 2002 Census classification) household outside of Dar es Salaam or the Ilemela or Nyamanga districts in Mwanza.
M^{Cities}	Migration to city Dummy variable equal to one when in 2012/13 individual was found to reside in a distant (> 1hour drive) urban (as defined by the 2002 Census classification) household in Dar es Salaam or the Ilemela or Nyamanga districts in Mwanza.
$M^{Rural\ (before\ 2010/11)}$	Migration to different rural area before 2010/11 Interaction term of dummy variable M^{Rural} with a dummy variable equal to one if the individual migrated in the period 2008/09 to 2010/11, and equal to zero if migration took place between 2010/11 and 2012/13.
$M^{Urban\ (before\ 2010/11)}$	Migration to urban area before 2010/11 Interaction term of dummy variable M^{Urban} with a dummy variable equal to one if the individual migrated in the period 2008/09 to 2010/11, and equal to zero if migration took place between 2010/11 and 2012/13.
Controls	- Age Self-reported age expressed in years - Sex 1 = male, 2 = female - Education Years of schooling derived from information on "highest grade obtained" ranging from the first grade of primary school (=1) to the 5th grade at university level (=18). We attribute missing values to zero years of schooling and include a dummy variable that equals one when the observation was originally reported as missing - Relation to the household head Dummy variables for household head/spouse and child of household head. - Marital status 0= never married, 1 = married or having been married. Marital status was not reported for respondents below the age of 12 and therefore assumed to be zero. We assume that individuals are unmarried when information on their marital status is missing and again include a dummy variable for the original missing values.
Farm	Transition out of farming Dummy variable that equals one when an individual who was part of a household headed by an individual who reported that his main occupation as farming in 2008/09, resided in a non-farming household by 2012/13, be it because of the individual's relocation or because the household head switched to off-farm employment over time.
Ln(Cons)	Income growth The difference in the logarithm of real – adjusted for – total household consumption per capita over time.
PI_{Total} PI_j	Price index For each food category *j* composed of a group of food items f (PI_j), as well as for the all food categories jointly (PI_{Total}), an individual-specific a Laspeyres-type price index PI_j is constructed: $PI_j = \frac{\sum_f (p_{f,2012/13} \cdot q_{f,2008/09})}{\sum_f (p_{f,2008/09} \cdot q_{f,2008/09})}$ where $q_{f,2008/09}$ is the amount of kcal consumed from food item *f* by the individual's household in 2008/09, $p_{f,2008/09}$ and $p_{f,2012/13}$ are the median prices of food item *f* in the location where the individual was residing during the baseline and endline interviews respectively. This price index weighs the price of (one kcal of) each food item in food category *j* by its contribution in 2008 to the total expenses of food category *j* in 2008/09. For migrants, this price index thus measures whether the migrant needs to pay more or less to keep the same consumption basket he or she had before migration, compared to the case in which he or she would not have migrated. For each food item, price information is derived from the reported value and amount purchased by each household. The median price is derived across all enumeration areas that are classified as rural/secondary town/city within the same region. In the case of less than 10 price observations for a food item, the median is taken at a higher level (regional, urban classification, or across the whole sample). For meals consumed outside, no price information is available. As such, no price index could be constructed, nor is this category included in the price index for total food.
Population density	Population Density expressed as 100 inhabitants/km² Each household is attributed to one of 19 ranges of people/km² based upon their GPS coordinates that were matched to the WorldPop population density map of Tanzania. This information is included in the regression by taking the arithmetic mean of the range expressed as 100 inhabitants/km². (0.25=0-50 people/km²; 0.75= 50-100 people/km²; 1.5 = 100-200 people/km²; 2.5= 200-300 people/km²; 3.5=300-400 people/km²; 4.5=400-500 people/km²; 7.5=500-1000 people/km²; 15= 1000-2000 people/km²; 25= 2000-3000 people/km²; 35= 3000-4000 people/km²;45=4000-5000 people/km²;75= 5000-10000 people/km²; 150= 10000-20000 people/km²; 250 = 20000-30000 people/km²; 300 = > 30000 people/km²)

Appendix B: Additional regression results

Table B1: Results of the regressions of changes in food consumption (in kcal. per capita per day) by category and diversity score for women(2008/09-2012/13)

	Δ Total	Δ Maize	Δ Cassava	Δ Other starchy foods	Δ Rice	Δ Bread, pasta, cereal products	Δ Pulses, nuts, seeds	Δ Meat, fish, dairy	Δ Fruits, veg.	Δ Oils, fats	Δ Sugar, sweets, pastries	Δ Sodas, tea, coffee	Δ Meals, snacks cons. outs.	Δ Diversity Score[a]
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
M^{Rural}	-36.74	-60.64	-10.52	12.30	65.81	13.80	-55.52*	-12.43	9.82	-15.13	-0.58	1.76	14.60	-0.14
	(130.54)	(75.71)	(51.86)	(16.97)	(47.48)	(9.61)	(29.60)	(15.93)	(12.12)	(10.50)	(15.95)	(1.96)	(59.18)	(0.23)
M^{Urban}	-52.55	-87.36	-149.39***	-118.29*	145.06*	75.38***	-23.27	30.53	-6.46	9.74	70.88***	1.82	-1.18	0.88**
	(211.62)	(109.98)	(54.27)	(69.52)	(74.52)	(21.34)	(48.08)	(25.39)	(16.78)	(21.82)	(26.78)	(6.17)	(70.23)	(0.37)
Const.	-424.42***	-233.29***	-92.75***	-15.65*	-3.58	3.56	-33.09***	-17.64***	-12.06***	-55.14***	-17.29***	-1.45*	53.96**	0.12*
	(39.41)	(21.17)	(11.92)	(9.26)	(14.74)	(3.03)	(8.45)	(4.24)	(2.84)	(3.05)	(4.87)	(0.84)	(21.40)	(0.07)
Controls[b]	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
IHHFE[c]	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
N	4898	4898	4898	4898	4898	4898	4898	4898	4898	4898	4898	4898	4898	4898
F-stat. Ha: $M^{Urban} \neq M^{Rural}$	0.00	0.05	3.73**	3.64*	0.73	7.47***	0.32	2.01	0.69	1.18	5.94***	0.00	0.03	5.77**

Notes: Standard errors in parentheses.

[a] Diversity score equals the number of food groups (see Appendix A2) consumed.

[b] The following individual baseline characteristics are included: age, sex, relation to the household head, education and marital status.

[c] IHHFE stands for initial household fixed effects..

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table B2: Results of the regressions of changes in food consumption (in kcal. per capita per day) by category and diversity score for men (2008/09-2012/13)

	Δ Total (1)	Δ Maize (2)	Δ Cassava (3)	Δ Other starchy foods (4)	Δ Rice (5)	Δ Bread, pasta, cereal products (6)	Δ Pulses, nuts, seeds (7)	Δ Meat, fish, dairy (8)	Δ Fruits, veg. (9)	Δ Oils, fats (10)	Δ Sugar, sweets, pastries (11)	Δ Sodas, tea, coffee (12)	Δ Meals, snacks cons. outs. (13)	Δ Diversity Score[a] (14)
M^{Rural}	234.23	174.65	-17.58	19.73	-7.73	7.11	-3.77	-20.92	-30.48**	-1.71	-19.20	9.58*	124.55	-0.25
	(213.32)	(124.55)	(45.42)	(32.45)	(54.40)	(11.05)	(36.97)	(26.97)	(14.31)	(14.08)	(27.79)	(5.67)	(133.87)	(0.33)
M^{Urban}	535.30**	-273.62**	-90.90***	-63.40***	95.82	72.30**	-57.10	38.84	-11.08	-25.23	36.96	52.28***	760.43***	-1.30**
	(243.77)	(131.72)	(31.44)	(23.50)	(106.72)	(31.89)	(59.69)	(36.88)	(16.00)	(29.56)	(38.49)	(12.98)	(219.83)	(0.62)
Const.	-424.49***	-229.40***	-84.46***	-30.04***	3.58	5.70	-44.10***	-18.77***	-8.23**	-48.95***	-11.90**	-3.35*	45.42	0.16**
	(45.10)	(23.06)	(9.43)	(6.76)	(12.38)	(3.78)	(7.06)	(6.22)	(3.35)	(3.61)	(5.68)	(1.95)	(32.87)	(0.08)
Controls[b]	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
IHHFE[c]	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
N	4519	4519	4519	4519	4519	4519	4519	4519	4519	4519	4519	4519	4519	4519
F-stat. Ha: $M^{Urban} \neq M^{Rural}$	0.88	6.22***	1.90	4.45**	0.77	3.75**	0.60	1.78	0.84	0.49	1.39	9.32***	6.31***	2.31

Notes: Standard errors in parentheses.

[a] Diversity score equals the number of food groups (see Appendix A2) consumed.

[b] The following individual baseline characteristics are included: age, sex, relation to the household head, education and marital status.

[c] IHHFE stands for initial household fixed effects..

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table B3: Results of the regressions of changes in food consumption (in kcal. per capita per day) by category and diversity score on population density (2008/09-2012/13)

	Δ Total	Δ Maize	Δ Cassava	Δ Other starchy foods	Δ Rice	Δ Bread, pasta, cereal products	Δ Pulses, nuts, seeds	Δ Meat, fish, dairy	Δ Fruits, veg.	Δ Oils, fats	Δ Sugar, sweets, pastries	Δ Sodas, tea, coffee	Δ Meals, snacks cons. outs.	Δ Diversity Score[a]
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Pop. dens.	0.90	-1.10***	-1.10***	-0.98**	1.24***	0.29***	-0.62***	0.13	-0.12*	0.13	0.22	0.12***	2.70***	-0.00
	(0.95)	(0.40)	(0.26)	(0.39)	(0.43)	(0.11)	(0.21)	(0.12)	(0.06)	(0.12)	(0.15)	(0.04)	(0.89)	(0.00)
Const.	-390.38***	-202.20***	-88.07***	-21.23***	-10.17	3.46	-46.02***	-21.35***	-12.24***	-52.69***	-20.67***	-0.64	81.45***	0.03
	(30.87)	(16.49)	(7.95)	(7.77)	(10.29)	(2.27)	(6.08)	(4.11)	(2.46)	(2.41)	(3.83)	(1.13)	(21.57)	(0.05)
Controls[b]	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
IHHFE[c]	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
N	9405	9405	9405	9405	9405	9405	9405	9405	9405	9405	9405	9405	9405	9405

Notes: Standard errors in parentheses.

[a] Diversity score equals the number of food groups (see Appendix, Table A2) consumed.

[b] The following individual baseline characteristics are included: age, sex, relation to the household head, education and marital status.

[c] IHHFE stands for initial household fixed effects.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table B4: Results of the regressions of changes in food consumption (in kcal. per capita per day) by category and diversity score incl. mediator variables (2008/09-2012/13)

	Δ Total [a]	Δ Maize	Δ Cassava	Δ Other starchy foods	Δ Rice	Δ Bread, pasta, cereal products	Δ Pulses, nuts, seeds	Δ Meat, fish, dairy	Δ Fruits, veg.	Δ Oils, fats	Δ Sugar, sweets, pastries [a]	Δ Sodas, tea, coffee [a]	Δ Meals, snacks cons. outs. [b]	Δ Diversity Score [c]
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
M^{Rural}	-31.10	-30.81	-19.18	7.11	45.64	24.59***	-39.97	-37.17**	-14.76	-3.88	-28.47*	0.15	33.70	-0.23
	(-0.43)	(-0.36)	(-0.53)	(0.37)	(1.28)	(2.76)	(-1.60)	(-2.51)	(-1.18)	(-0.38)	(-1.67)	(0.06)	(0.55)	(-1.04)
M^{Urban}	-383.02***	-231.25**	-61.09	-122.79***	2.10	35.20**	-50.36	-40.90**	-49.58***	-43.28*	-7.64	17.69***	152.83	-0.71**
	(-2.97)	(-2.19)	(-0.96)	(-2.71)	(0.04)	(2.00)	(-1.03)	(-2.15)	(-3.64)	(-1.89)	(-0.29)	(2.87)	(1.24)	(-1.97)
Farm	-234.50***	-207.27***	-63.56***	-8.52	95.89***	9.03	-109.37***	-12.62	-29.48***	-16.42*	9.58	3.96*	113.10**	0.00
	(-2.92)	(-3.74)	(-2.65)	(-0.43)	(3.10)	(0.90)	(-4.86)	(-0.84)	(-3.27)	(-1.71)	(0.72)	(1.79)	(1.97)	(0.02)
$\Delta Ln(cons.)$	1265.08***	246.70***	11.41	45.03***	190.77***	28.57***	128.78***	123.79***	42.50***	21.95***	84.43***	8.44***	349.96***	0.60***
	(23.90)	(6.91)	(0.60)	(3.64)	(8.63)	(5.14)	(9.28)	(12.25)	(7.64)	(4.37)	(10.33)	(5.58)	(8.78)	(4.60)
ΔPI_{Total}	-565.84***	-89.00	-267.40***	11.52	-7.60	5.15	-40.69	15.08	-6.48	10.86	-15.94	-2.83		
	(-4.67)	(-0.81)	(-2.86)	(0.38)	(-0.14)	(0.40)	(-1.21)	(0.66)	(-0.54)	(0.51)	(-0.81)	(-0.57)		
ΔPI_j		-169.18	-750.63***	-570.04***	-586.17***	-135.14	-76.61	17.08	-7.44	13.81	13.81	0.88		
		(-0.59)	(-3.73)	(-3.01)	(-3.81)	(-0.54)	(-1.38)	(0.48)	(-1.38)	(0.45)	(0.45)	(0.46)		
Const.	1775.75***	1220.98***	1290.17***	154.21	412.94**	14.26	436.31***	106.69	99.74**	139.07***	163.02**	14.03	97.15***	0.10*
	(4.05)	(3.23)	(3.82)	(1.61)	(2.10)	(0.27)	(3.56)	(1.37)	(2.23)	(2.58)	(2.45)	(0.70)	(4.50)	(1.81)
Controls[b]	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
IHHFE[c]	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
N	9344	9344	9344	9344	9344	9344	9344	9344	9344	9344	9344	9344	9344	9344
F-stat. Ha: $M^{Urban} \neq M^{Rural}$	6.13***	2.09	0.30	7.26***	0.42	0.29	0.04	0.02	3.90**	2.31	0.47	6.71***	0.79	1.30

Notes: Standard errors in parentheses.

[a] Whereas the dependent variable includes both home and outside consumption, the price index is based upon the former. Restricting our analysis to at home consumption does not alter out findings.

[b] Since the data do not contain price information for meals and snacks consumed outside the home, no price index could be included for this food category

[c] Diversity score equals the number of food groups (see Appendix A2) consumed.

[d] The following individual baseline characteristics are included: age, sex, relation to the household head, education and marital status.

[e] IHHFE stands for initial household fixed effects.

* p < 0.10, ** p < 0.05, *** p < 0.01

Table B5: ACDEs of rural-urban migration in regressions of changes in food consumption (in kcal. per capita per day) by category and diversity score (2008/09-2012/13)

	Δ Total[a]	Δ Maize	Δ Cassava	Δ Other starchy foods	Δ Rice	Δ Bread, pasta, cereal products	Δ Pulses, nuts, seeds	Δ Meat, fish, dairy	Δ Fruits, veg.	Δ Oils, fats	Δ Sugar, sweets, pastries[a]	Δ Sodas, tea, coffee[a]	Δ Meals, snacks cons. outs.[b]	Δ Diversity Score[c]
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
M^{Urban} (Total effect)	149.56	-177.58**	-153.60***	-113.64***	131.19***	70.37***	-27.47	25.37	-7.50	-8.21	56.51***	25.68***	328.43***	0.21
	(155.65)	(82.37)	(38.66)	(43.54)	(49.64)	(18.13)	(36.45)	(21.56)	(11.75)	(15.41)	(20.56)	(6.21)	(91.91)	(0.31)
M^{Urban} ACDE (Farm)	247.26	-91.94	-128.12**	-110.99*	90.89*	66.19***	18.02	30.60	4.28	-1.83	52.24**	24.27***	282.41***	0.19
	(183.04)	(98.98)	(49.89)	(63.37)	(55.05)	(18.44)	(44.85)	(25.24)	(13.94)	(17.91)	(24.64)	(6.94)	(92.99)	(0.34)
M^{Urban} ACDE (Income)	-527.26***	-308.99***	-159.20***	-137.12**	29.28	55.37***	-96.14**	-40.72*	-29.87*	-19.61	11.68	21.50***	140.45	-0.11
	(154.63)	(98.04)	(47.52)	(68.36)	(52.65)	(17.70)	(43.17)	(21.42)	(15.41)	(18.66)	(24.56)	(6.25)	(91.70)	(0.34)
M^{Urban} ACDE (Prices)	196.11	-142.11	-35.71	-55.44	147.11***	69.79***	-11.82	38.36	-8.68	-15.04	59.80**	25.81***		
	(188.67)	(102.07)	(49.09)	(43.10)	(56.56)	(17.95)	(46.47)	(25.33)	(15.32)	(19.52)	(24.56)	(6.69)		
M^{Urban} ACDE (Farm, income, prices)	-383.02**	-187.88*	-15.83	-76.27*	4.90	50.60***	-35.02	-22.51	-19.26	-20.05	10.70	20.22***	94.43	-0.12
	(152.11)	(106.89)	(53.53)	(41.78)	(53.68)	(17.64)	(45.29)	(23.74)	(14.97)	(19.23)	(25.62)	(6.63)	(92.78)	(0.34)
Controls[d]	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
IHHFE[e]	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
N	9344	9344	9344	9344	9344	9344	9344	9344	9344	9344	9344	9344	9344	9344

Notes: ACDE(*mediator*) refers to the Average Controlled Direct Effect net of the causal effect taking place through the mediator variable, derived using the method proposed by Acharya et al. (2016).

Standard errors in parentheses. For the ACDEs these are the standard errors from 1000 bootstrapped replications.

[a] Whereas the dependent variable includes both home and outside consumption, the price index is based upon the former. Restricting our analysis to at home consumption does not alter out findings.

[b] Since the data do not contain price information for meals and snacks consumed outside the home, no price index could be included for this food category

[c] Diversity score equals the number of food groups (see Appendix A2) consumed.

[d] The following individual baseline characteristics are included: age, sex, relation to the household head, education and marital status.

[e] IHHFE stands for initial household fixed effects.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table B6:Estimated difference between the total effects and the ACDEs of rural-urban migration in regressions of changes in food consumption (in kcal. per capita per day) by category and diversity score (2008/09-2012/13)

	Δ Total[a]	Δ Maize	Δ Cassava	Δ Other starchy foods	Δ Rice	Δ Bread, pasta, cer. products	Δ Pulses, nuts, seeds	Δ Meat, fish, dairy	Δ Fruits, veg.	Δ Oils, fats	Δ Sugar, sweets, pastries[a]	Δ Sodas, tea, coffee[a]	Δ Meals, snacks cons. outs.[b]	Δ Div. Score[c]
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
M^{Urban} (Total effect) - M^{Urban} ACDE (Farm)	-97.70**	-85.64***	-25.48**	-2.65	40.29**	4.18	-45.48***	-5.22	-11.78**	-6.38	4.27	1.41	46.01*	0.01
	(44.68)	(32.43)	(12.07)	(12.57)	(16.24)	(5.18)	(12.81)	(8.22)	(5.12)	(4.98)	(6.50)	(1.02)	(24.98)	(0.09)
M^{Urban} (Total effect) - M^{Urban} ACDE (Income)	676.82***	131.41***	5.60	23.48***	101.91***	15.01***	68.68***	66.09***	22.37***	11.40***	44.83***	4.19***	187.98***	0.31***
	(114.14)	(34.54)	(12.47)	(8.86)	(19.94)	(4.05)	(12.97)	(12.75)	(5.37)	(3.73)	(8.96)	(1.20)	(39.86)	(0.09)
M^{Urban} (Total effect) - M^{Urban} ACDE (Prices)	-46.55	-35.47	-117.89***	-58.20*	-15.92	0.59	-15.65	-12.99	1.18	6.82	-3.29	-0.13		
	(25.60)	(52.59)	(36.13)	(32.69)	(15.28)	(3.34)	(12.94)	(11.46)	(5.16)	(7.70)	(8.23)	(0.81)		
M^{Urban} (Total effect) - M^{Urban} ACDE (Farm, income, prices)	532.58	10.30	-137.77***	-37.37	126.29***	19.78***	7.55	47.88***	11.76	11.84	45.81***	5.46***	234.00***	0.33***
	(122.73)	(64.30)	(38.13)	(37.85)	(30.16)	(6.61)	(20.68)	(17.06)	(7.27)	(8.23)	(8.96)	(1.62)	(49.20)	(0.12)
Controls[d]	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
IHHFE[e]	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
N	9344	9344	9344	9344	9344	9344	9344	9344	9344	9344	9344	9344	9344	9344

Notes: ACDE(*mediator*) refers to the Average Controlled Direct Effect net of the causal effect taking place through the mediator variable, derived using the method proposed by Acharya et al. (2016).
Standard errors from 1000 bootstrapped replications in parentheses.
[a] Whereas the dependent variable includes both home and outside consumption, the price index is based upon the former. Restricting our analysis to at home consumption does not alter out findings.
[b] Since the data do not contain price information for meals and snacks consumed outside the home, no price index could be included for this food category
[c] Diversity score equals the number of food groups (see Appendix A2) consumed.
[d] The following individual baseline characteristics are included: age, sex, relation to the household head, education and marital status.
[e] IHHFE stands for initial household fixed effects.
* p < 0.10, ** p < 0.05, *** p < 0.01

Tables

Table 1: Baseline (2008/09) summary statistics according to 2012/13 migration status

	Rural stayed (8469)	Rural-rural migrants (710)	T-stat. Ha: diff ≠ 0	Rural-urban migrants (238)	T-stat. Ha: diff ≠ 0
Age (years)	22.73	21.91	1.07	20.88	1.43
Female (%)	51.53	56.34	-2.46**	56.72	-1.58
Education (years completed)	3.18	3.20	-0.16	4.58	-6.32***
Ever married (%)	38.69	41.13	-1.28	32.77	1.85*
Household head or spouse (%)	34.29	35.92	-0.88	29.83	1.43
Child of household head (%)	49.23	48.17	0.51	50	-0.24
Household size	6.81	5.91	5.83***	5.95	3.27***
Farming household (%)	83.63	82.54	0.76	58.40	10.27***
Total consumption per capita (TZS) [a]	638641	666537	-1.62	793935	-5.35***

Notes: The reported t-statistics are the result of the t-test comparing rural-rural migrants or rural-urban migrants with those who stayed in their rural baseline village.

[a] Total consumption per capita is expressed in 2012/13 Tanzanian Shillings (TZS)

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 2: Summary statistics of food consumption (in kcal. per capita per day) by category and diversity score

	Baseline			Change between 2008/09-2012/13					
	Urban (4527)	Rural (9417)	T-stat. Ha: diff ≠ 0	All rural at baseline (9417)	Rural stayed (8469)	Rural-rural migrants (710)	T-stat.[a] Ha: diff ≠ 0	Rural-urban migrants (238)	T-stat.[a] Ha: diff ≠ 0
Total	2651.55	2506.71	-6.43***	-324.11	-327.61	-400.31	1.27	27.69	-3.72***
Maize	597.28	991.76	25.72***	-204.71	-207.57	-136.64	-1.95	-306.10	1.64
Cassava	66.22	292.99	-25.05***	-91.02	-86.49	-129.19	2.19**	-138.54	1.64
Other starchy foods	92.02	146.87	9.90***	-25.05	-21.26	-61.75	2.77***	-50.42	1.21
Rice	511.48	257.99	-31.22***	17.99	16.75	-6.78	1.17	136.04	-3.52***
Bread, pasta, cereal products	119.25	17.60	-48.84***	8.00	6.83	-2.29	2.36**	80.24	-11.60***
Pulses, nuts, seeds	329.79	287.96	-7.63***	-30.90	-28.22	-65.61	2.74***	-22.87	-0.24
Meat, fish, dairy	171.47	139.49	-10.33***	-11.26	-11.45	-14.76	0.44	6.14	-1.40
Fruits, veg.	69.13	88.26	9.47***	-8.32	-8.78	-3.60	-0.95	-6.29	-0.28
Oils, fats	181.07	89.48	-40.86***	-50.84	-50.30	-61.31	2.33	-38.83	-1.43
Sugar, sweets, pastries	231.61	126.58	-35.24***	-7.01	-8.19	-6.80	-0.19	34.16	-2.46***
Sodas, tea, coffee	33.99	4.97	-33.74***	-0.49	-1.14	1.33	-2.44**	17.07	-10.13***
Meals, snacks cons. outs.	248.25	62.77	-25.03***	79.52	72.21	87.08	-0.73	2.29	-6.82***
Diversity Score[b]	9.09	7.33	-45.28***	0.20	0.18	0.23	-0.55	0.76	-3.77***

Notes:

[a] The reported t-statistics are the result of the t-test comparing rural-rural migrants or rural-urban migrants with those who stayed in their rural baseline or a nearby village.

[b] Diversity score equals the number of food groups (see Appendix, Table A2) consumed.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 3: Results of the regressions of changes in food consumption (in kcal. per capita per day) by category and diversity score (2008/09-2012/13)

	Δ Total	Δ Maize	Δ Cassava	Δ Other starchy foods	Δ Rice	Δ Bread, pasta, cereal products	Δ Pulses, nuts, seeds	Δ Meat, fish, dairy	Δ Fruits, veg.	Δ Oils, fats	Δ Sugar, sweets, pastries	Δ Sodas, tea, coffee	Δ Meals, snacks cons. outs.	Δ Diversity Score[a]
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
M^{Rural}	47.95	-13.71	-4.74	16.11	44.68	12.87**	-32.36	-0.76	-7.20	-9.59	-10.66	2.98	50.34	-0.19
	(98.11)	(59.73)	(32.33)	(14.32)	(31.77)	(6.27)	(20.26)	(13.71)	(8.63)	(7.17)	(12.74)	(2.02)	(52.81)	(0.17)
M^{Urban}	169.73	-179.61**	-155.17***	-111.88***	130.10**	71.28***	-35.02	27.75	-8.50	0.52	60.03***	24.70***	345.53***	0.12
	(148.58)	(76.86)	(37.05)	(40.00)	(52.96)	(17.15)	(35.40)	(20.52)	(10.91)	(15.14)	(19.73)	(6.11)	(94.76)	(0.32)
Const.	-392.61***	-206.06***	-90.78***	-25.63***	-10.55	3.17	-46.31***	-21.03***	-12.36***	-51.65***	-18.38***	-0.62	87.60***	0.04
	(31.19)	(16.51)	(8.35)	(7.51)	(10.46)	(2.25)	(6.14)	(4.07)	(2.49)	(2.43)	(4.02)	(1.13)	(21.54)	(0.05)
Controls[b]	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
IHHFE[c]	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
N	9417	9417	9417	9417	9417	9417	9417	9417	9417	9417	9417	9417	9417	9417
F-stat. Ha: $M^{Urban} \neq M^{Rural}$	0.49	3.17*	8.73***	9.85***	1.90	10.58***	0.00	1.25	0.01	0.38	10.10***	11.47***	8.05***	0.81

Notes: Standard errors in parentheses.
[a] Diversity score equals the number of food groups (see Appendix, Table A2) consumed.
[b] The following individual baseline characteristics are included: age, sex, relation to the household head, education and marital status.
[c] IHHFE stands for initial household fixed effects.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 4: Results of the regressions of changes in the share of each food category (in kcal. per capita per day) in total energy intake (2008/09-2012/13)

	Δ Total	Δ Maize	Δ Cassava	Δ Other starchy foods	Δ Rice	Δ Bread, pasta, cereal products	Δ Pulses, nuts, seeds	Δ Meat, fish, dairy	Δ Fruits, veg.	Δ Oils, fats	Δ Sugar, sweets, pastries	Δ Sodas, tea, coffee	Δ Meals, snacks cons. outs.
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
M^{Rural}		-0.69	-1.82	0.60	1.12	0.51^{**}	-0.70	-0.55	0.59	-0.25	-0.63	0.12^{*}	1.70
		(1.74)	(1.21)	(0.65)	(1.03)	(0.25)	(0.70)	(0.51)	(0.48)	(0.25)	(0.43)	(0.06)	(1.58)
M^{Urban}		-6.51^{**}	-6.91^{***}	-3.02^{***}	3.53^{**}	2.43^{***}	-1.33	-0.22	-0.54	-0.02	2.19^{***}	0.70^{***}	9.69^{***}
	n.a.	(2.89)	(1.41)	(1.08)	(1.77)	(0.54)	(0.93)	(0.65)	(0.44)	(0.48)	(0.72)	(0.17)	(2.93)
Const.		-0.19	-1.56^{***}	-0.42	1.40^{***}	0.09	-0.09	-0.31^{*}	-0.09	-1.95^{***}	-0.22	-0.03	3.38^{***}
		(0.61)	(0.35)	(0.32)	(0.35)	(0.07)	(0.23)	(0.16)	(0.14)	(0.09)	(0.15)	(0.04)	(0.68)
Controls		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
IHHFE		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
N		9417	9417	9417	9417	9417	9417	9417	9417	9417	9417	9417	9417
F-stat. Ha: $M^{Urban} \neq M^{Rural}$		3.00^{*}	7.80^{**}	9.13^{***}	1.43	10.82^{***}	0.32	0.17	3.33^{*}	0.19	12.67^{***}	9.54^{***}	6.23^{**}

Notes: Standard errors in parentheses.
[a] Diversity score equals the number of food groups (see Appendix, Table A2) consumed.
[b] The following individual baseline characteristics are included: age, sex, relation to the household head, education and marital status.
[c] IHHFE stands for initial household fixed effects.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 5: Results of the regressions of changes in food consumption by category (in kcal. per capita per day) and diversity score on migration to different rural areas, secondary towns or cities (2008/09-2012/13)

	Δ Total	Δ Maize	Δ Cassava	Δ Other starchy foods	Δ Rice	Δ Bread, pasta, cereal products	Δ Pulses, nuts, seeds	Δ Meat, fish, dairy	Δ Fruits, veg.	Δ Oils, fats	Δ Sugar, sweets, pastries	Δ Sodas, tea, coffee	Δ Meals, snacks cons. outs.	Δ Diversity Score[a]
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
M^{Rural}	46.97	-15.67	-4.61	14.88	44.35	13.06**	-32.19	-0.67	-7.16	-9.18	-10.29	2.91	51.54	-0.19
	(98.13)	(59.81)	(32.24)	(14.40)	(31.74)	(6.26)	(20.25)	(13.77)	(8.62)	(7.16)	(12.76)	(2.04)	(52.94)	(0.17)
$M^{Sec. Towns}$	216.08	-86.75	-161.39***	-53.97	145.82**	62.32**	-43.11	23.34	-10.47	-19.10	42.30*	28.01***	289.07**	0.01
	(198.55)	(108.57)	(48.17)	(36.42)	(65.43)	(24.33)	(45.38)	(28.25)	(14.38)	(22.09)	(23.98)	(9.26)	(113.27)	(0.41)
M^{Cities}	105.78	-307.74***	-146.60**	-191.77**	108.41	83.65***	-23.85	33.83	-5.79	27.59	84.50***	20.14***	423.41***	0.26
	(220.22)	(99.84)	(58.07)	(79.52)	(86.86)	(22.78)	(55.94)	(29.29)	(16.55)	(18.08)	(32.12)	(6.67)	(159.03)	(0.49)
Const.	-392.71***	-206.27***	-90.77***	-25.76***	-10.58	3.19	-46.29***	-21.02***	-12.35***	-51.61***	-18.34***	-0.63	87.73***	0.04
	(31.18)	(16.49)	(8.36)	(7.47)	(10.47)	(2.24)	(6.14)	(4.07)	(2.49)	(2.43)	(4.02)	(1.13)	(21.55)	(0.05)
Controls[b]	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
IHHFE[c]	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
N	9417	9417	9417	9417	9417	9417	9417	9417	9417	9417	9417	9417	9417	9417
F-stat. Ha: $M^{Sec. Towns} \neq M^{Rural}$	0.60	0.33	7.50***	3.24*	1.96	3.86**	0.05	0.52	0.04	0.19	3.86**	6.73***	3.64*	0.21
F-stat. Ha: $M^{Cities} \neq M^{Rural}$	0.06	7.02***	4.07**	6.87***	0.48	9.26	0.02	1.22	0.01	3.67	8.28***	6.69***	5.34**	0.81
F-stat. Ha: $M^{Sec. Towns} \neq M^{Cities}$	0.14	2.27	0.04	2.50	0.12	0.41	0.07	0.07	0.05	2.71*	1.13	0.48	0.48	0.16

Notes: Standard errors in parentheses.
[a] Diversity score equals the number of food groups (see Appendix, Table A2) consumed.
[b] The following individual baseline characteristics are included: age, sex, relation to the household head, education and marital status.
[c] IHHFE stands for initial household fixed effects.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Figures

Figure 1: Evolution of the sample between survey rounds

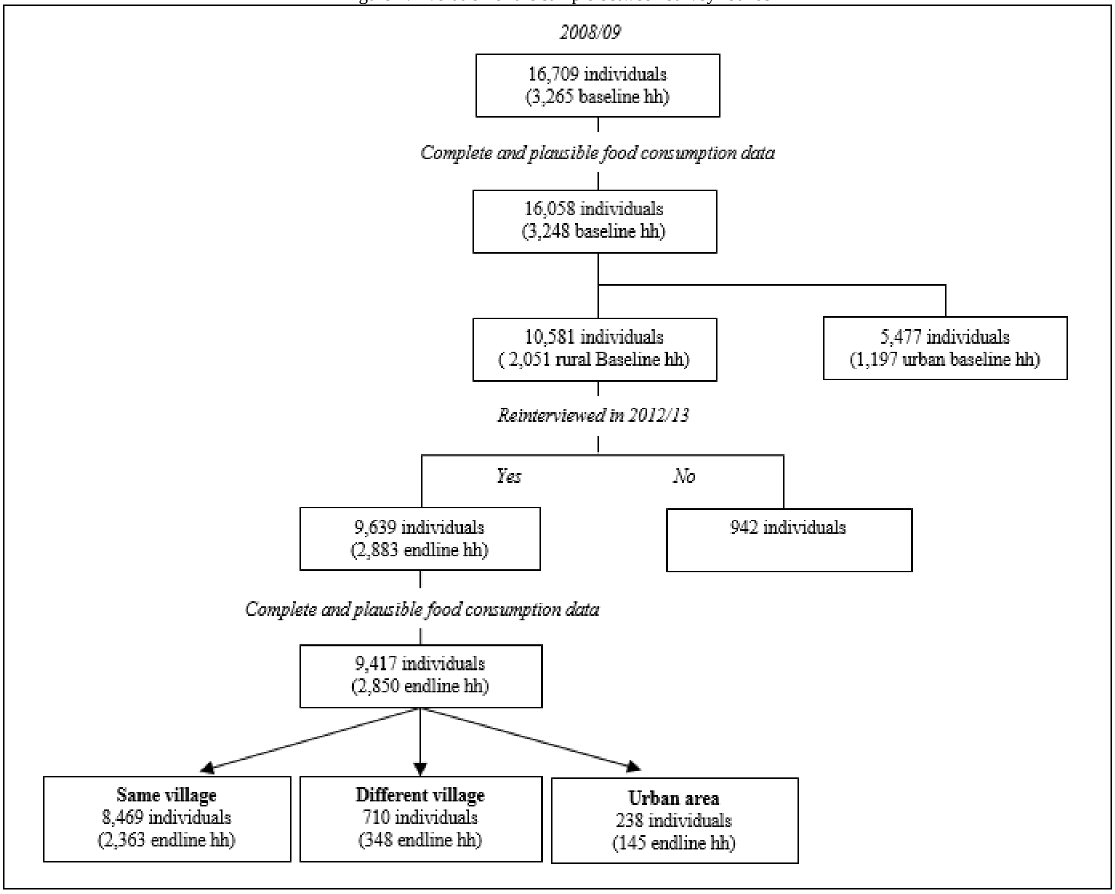
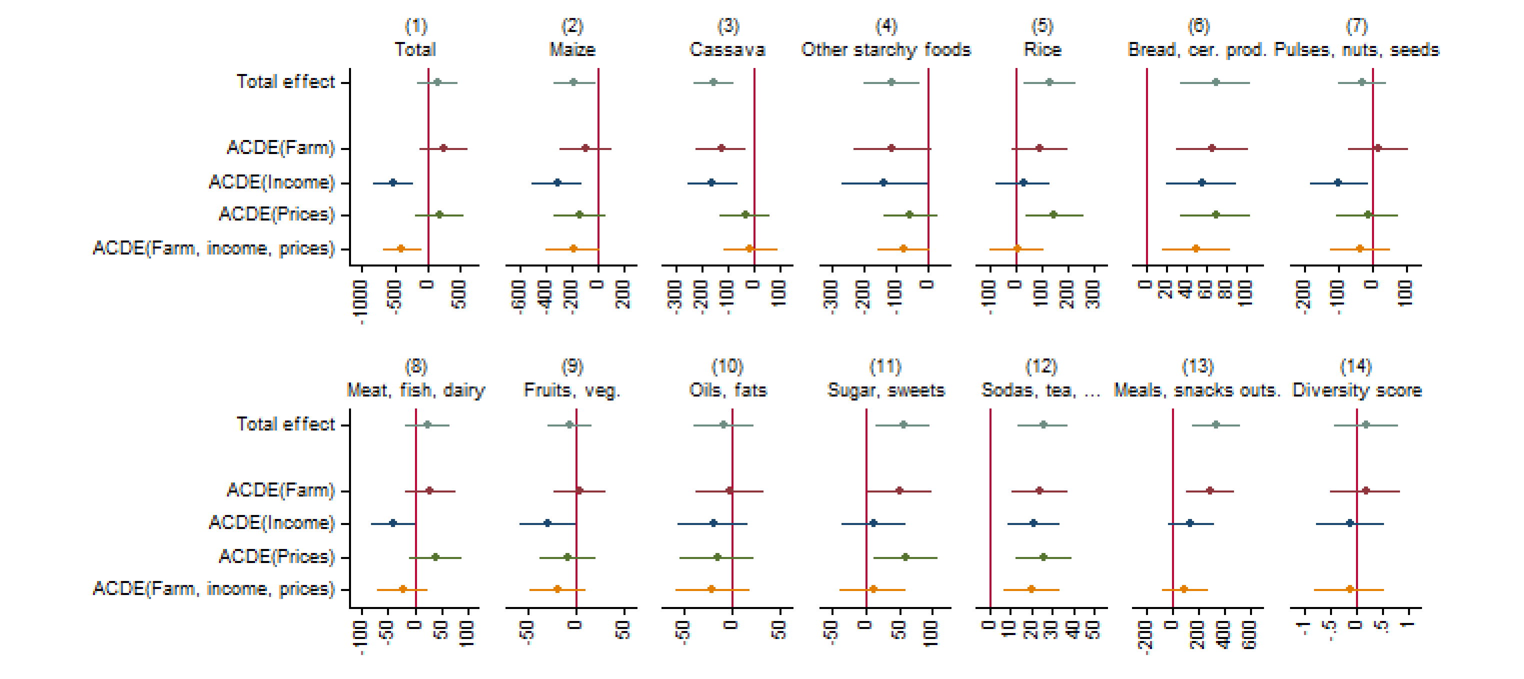


Figure 2: ACDEs of rural-urban migration in regressions of changes in food consumption (in kcal. per capita per day) by category and diversity score[a] (2008/09-2012/13)



Notes: ACDE(*mediator*) refers to the Average Controlled Direct Effect net of the causal effect taking place through the mediator variable, derived using the method proposed by Acharya et al. (2016). Horizontal spikes represent the 95% confidence intervals from 1000 bootstrapped replications.
For a detailed summary of the differences between the total effect and the ACDEs see Appendix B, Table B6.
[a] Diversity score equals the number of food groups (see Appendix, Table A2) consumed.