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Consumption of processed food & food away from home in big cities, small towns, and rural areas of Tanzania

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Abstract

We study household consumption of various categories of processed food, including ultra-processed food and meals away from home in Tanzania. We compare peri-urban versus hinterland rural areas, and large cities versus small towns. Three sets of findings stand out. (1) Contrary to the common view in Africa that processed food is mainly an urban middle-class phenomenon, we found it has penetrated the diets of the rural areas and the rural and urban poor. In rural areas, surprisingly 60% of food consumption comes from purchases in value terms, and processed food accounts for 76% of purchases and 47% of all food consumed. For the rural poor, purchased processed food is 38% of food consumption. In urban areas processed food's share of purchases (hence consumption) is 78%, similar for the rich and poor. (2) We found that ultra-processed food (such as sugar-sweetened beverages and cookies) and meals-away-from-home (MAFH) have emerged as important in urban as well as rural areas. As these foods tend to be high in oil, salt, and sugar, this is a health concern. The share of ultra-processed foods and MAFH is 21% in rural areas and 36% in cities albeit twice as high in large cities compared with small towns and among richer compared to poorer consumers. (3) Our regressions show the spread of processed food consumption in rural and urban areas, among the rich and poor, is driven mainly by opportunity costs of the time of women and men, and thus the pursuit of saving home-processing and cooking time, as well as food environment factors. As these drivers are long term trends this suggests processed food consumption will continue to grow.

KEYWORDS
Africa, consumption, food away from home, peri-urban, processed food, secondary cities, small towns

JEL CLASSIFICATION
D12, J20, O12, O18, Q12, Q18

1 | INTRODUCTION

Over the past century there has been rapid growth of demand by consumers for purchased-processed food (as opposed to home-processed food) and for prepared "meals away from home" (MAFH). The growth started in developed regions in the late 1800s and increased over the 20th century. The demand for "convenience foods" was driven on the demand side in large part by the rise of the opportunity cost of women's time as women took up employment outside the home (Kinsey, 1983). This was consistent with the theory of Mincer (1963) and Becker (1965) of consumption decisions being affected by own value of time.

In the past half century in Africa, Asia, and Latin America, there has been a parallel increase in consumption of processed food. In general, this has been driven by factors similar to those in developed countries: the rise of opportunity costs of time to home-process and home-prepare food for women and to return home to eat by men and women. These costs are correlated with incomes and lifestyle and employment changes brought by urbanization (Senauer et al., 1986 for Sri Lanka), as well as, we posit, the rise of rural nonfarm employment among women and men.

Women first sought low-processed products such as purchased-flour or milled rice (such as in Burkina Faso, Reardon et al., 1989) to avoid hand-pounding of grain, which was taking around 4 hours a day per woman in Africa in the 1980s (Barrett & Browne, 1994). Households next sought high-processed products, at first unpackaged then eventually packaged, ready-to-eat products such as bread in Sri Lanka (Senauer et al., 1986) or Kenya (Kennedy & Reardon, 1994) or heat and eat, such as *enjera* in Ethiopia (Minten et al., 2016). The purchase of processed foods and meals away from home had grown substantial by the 2000s in Asia (Pingali, 2006) and 2010s in Africa (Tschirley et al., 2015a).

A subset of the high-processed products increasingly came to include ultra-processed foods such as sugar-sweetened beverages (SSBs) and snacks high in sugars and salt and fats. The latter in particular alarmed nutritionists. Popkin (1994) highlighted the health risks (including obesity and increased risk of non-communicable diseases (NCDs) such as heart disease) of a "nutrition transition" in developing regions into consumption of ultra-processed foods. Alarm over this transition spread in Africa in the past decades as research showed that overweight and obesity are rapidly increasing (Popkin et al., 2019). Some survey-based studies in Africa showed that ultra-processed food intake increases obesity, and that some poor consumers seek their macronutrients such as calories and proteins by consuming ultra-processed foods (Khonje et al., 2020).

In Africa, the literature on processed food consumption has focused mainly on urban areas. In general, the latter have been treated as homogeneous, with the exception of recent research on processed food in secondary/tertiary cities per se (Demmler et al., 2018; Kimenju et al., 2015; Rischke et al., 2015) or on primary cities per se (Khonje & Qaim, 2019). To our knowledge there has been no systematic analysis over city types in one country for all categories of processed food and MAFH.

However, we would expect the consumption of processed food and MAFH to differ over city size, controlling for household income and other characteristics. The meso-level density of micro characteristics such as the agglomeration of purchasing power may affect household choices. Cities of different sizes may differ in the density and supply of prepared food vendors. Larger cities entail longer commutes and more inducement to save time returning to home to eat; such congestion is a manifestation of lifestyle factors (noted by Rischke et al., 2015, for Kenya). Different city sizes may also correlate with different food environments and advertising contexts that influence consumption of convenience and "junk" foods.

Moreover, when processed food consumption research in Africa has included rural areas, it has largely treated them as one homogeneous group (e.g. Tschirley et al. 2015a), and has not separately treated MAFH. Nor has there been research on the effect of distance from urban areas on rural uptake of processed foods, including ultra-processed and MAFH; yet urban distance has been studied with respect to other rural behavior such as farm input use and intensification (e.g. Vandercasteelen et al., 2018 for Ethiopia). However, we expect distance from cities to affect processed and prepared food purchase for reasons parallel to those for differences in city size, with respect to access to these foods, lifestyle differences, and food environment variation.

Finally, research on the determinants of consumption of the different categories of processed food and MAFH has dwelt largely on incomes and demographic factors, including recent migration experience (Cockx et al., 2018). To our knowledge there has been no survey-based study of income sources of men and women, in particular employment outside the home and outside farming. However, we expect differing employment profiles to affect the quest for convenience foods as discussed above.

To address these three gaps in literature on processed food consumption in Africa with respect to city sizes, rural distance to cities, and employment categories of consumers, we undertake an analysis of a uniquely detailed household consumption data set for urban and rural Tanzania. The data come from a survey of 9788 households by

the Tanzania Household Budget Survey (HBS) in 2011/2012 (the most recent HBS). We use HBS instead of LSMS to get the needed food item detail, as HBS distinguished 199 food items while LSMS followed 59.

The article proceeds as follows. Section 2 lays out our general conceptual framework. Section 3 specifies definitions and discusses the data. Section 4 presents descriptive results on processed and prepared food consumption. Section 5 provides regression results. Section 6 concludes.

2 | GENERAL MODEL AND HYPOTHESES

Our analysis uses an Engel curve model, following Lewbel (2006).[1] The shares of household consumption of five categories of food, with varying levels of processing, are functions of the total expenditure of the household (modeled as total consumption, summing purchases and home-consumption of own production) and other household characteristics:

$$w_i = h_i\left[log\left(y\right), \mathbf{z}\right] \quad (1)$$

where w_i is the share of the budget spent on processing category i (unprocessed; low processed; unpackaged high processed; packaged high processed; and meals away from home (MAFH)); y is total expenditure; and **z** is a vector of household demographic variables. We hypothesize that as income (proxied by total expenditure) increases, the opportunity cost of time for home processing and home food preparation increases, and the demand for processed food and MAFH increases.

We augment the basic Engel curve analysis with a vector **z** of household demographic and human capital variables, as is common (Banks et al., 1997; Lewbel, 2006). These include the age, gender, marital status, and education of the household head, the household's dependency ratio, and its size in adult equivalents. We also include variables that would influence the food environment affecting diet preferences, and assets that save time in home processing and preparation and transport: televisions, mobile phones, various cooking appliances, and motorized vehicles.

Second, to model the household's opportunity cost of time, we include employment variables for women (that would affect their incentive and capacity to spend time in home-processing and preparation) and men (that affect their incentive and capacity to wait for breakfast at home in the early morning and to return home for lunch or dinner depending on their work schedule). Women's employment effects are commonly discussed in the consumption literature but the effects of men's employment patterns are rarely analyzed, especially their effects on consumption of MAFH.

For rural areas, we augment the Engel curve model with a measure (full time equivalents, FTEs) of the time spent in non-farm self-employment and non-farm wage work, separately for men and women. We hypothesize that an increase in women's time spent in the non-farm labor force (be it self-employment or wage) will increase consumption of highly processed food and MAFH. For urban areas we also model employment outside the home in self-employment and wage employment. We expect the magnitude of the effect to be higher for wage work, as that is usually done outside of the home. But self-employment may be done from home, which would permit more flexibility to cook at home. We expect men's time working away from the farm and its nearby household, and in urban work away from the home premises, to be correlated with MAFH.

Finally, we augment the basic Engel curve model with geo-spatial variables, with the hypotheses justified in the introduction. For rural households, we use the distance from the village to the nearest urban area. We expect that as such distance increases, the consumption shares of unprocessed and low-processed food will increase, and the shares of high processed food and MAFH will decrease. For urban households, we use the size of the city (in order of increasing population size, these are towns, secondary cities, and primary cities, defined below). We hypothesize that the size of the city is positively correlated with shares of the more highly processed types of foods (packaged high processed and meals away from home).

3 | SURVEY DATA AND DEFINITIONS OF PRODUCT AND SPATIAL CATEGORIES

3.1 | Survey data

We use the consumption data from the Tanzania Household Budget Survey (HBS), a detailed cross-sectional, nationally representative survey conducted from October 2011 to October 2012; this is the most recent HBS available. The HBS sample includes 9788 households of which 5628 (57%) are rural, and 4149 (43%) are urban. The distinction between rural and urban is based on HBS's using the government's criteria of population and infrastructure density (National Bureau of Statistics 2014).

We use the HBS data set instead of LSMS (Living Standards Measurement Survey) data for Tanzania because to compose our processed food categories we need the

[1] Estimation of a full demand system such as QUAIDS or EASI is not possible due to a lack of price data.

TABLE 1 Example products in each processing category

Category	Example products
Unprocessed	Raw fruits and vegetables, roots and tubers, grains, beans and lentils, fresh cow milk
Low Processed	Maize flour, rice, cooking oils, butchered meat, sugar, drinking water
High Processed, Unpackaged	Fried wheat buns (*mandazi*), chickpea patties (*bagia*)
Ultra-Processed	Bread, sugar-sweetened beverages, alcohol, pasta, biscuits, cake, coffee and tea

greatest disaggregation possible in the food category. HBS has 199 food items in its consumption diary while LSMS only has 59 food items in its consumption recall.

Moreover, HBS, unlike LSMS, provides a breakdown of food away from home into meals away from home (MAFH) versus products that are bought away from home that are not meals, like a sweet cake at a street vendor. Using the category MAFH draws a sharper line between food service (restaurants, food stalls) and retail; it highlights MAFH as a substitute for home cooking. By contrast, other food away from home could be considered just food bought from a retailer or a food service stall and taken back home or on the road or eaten in situ. Of course, MAFH can also be take-away.

The HBS collected information on, inter alia, household members' employment, assets, and consumption of non-food and food products. The latter are recorded as to their source: (1) from own production on the household farm; (2) from purchases of food to consume at home; (3) from purchases of meals consumed away from home; (4) from purchases of other food products consumed away from home.

The household-level food consumption data are from a 28-day diary. Respondents were instructed to record all food consumed (in unit and value terms) and the four sources noted above by all members of the household during the day, for 28 consecutive days. For illiterate households, enumerators visited daily to record consumption; for other households, enumerators checked in every few days. For food that was home-produced, the household was asked to estimate the monetary value of the food in Tanzanian shillings. The survey implementation was undertaken so that diaries were being done all year over the sample; thus there is little bias where the consumption in a certain part of the country is correlated with only one season.

3.2 | Definitions of variables

3.2.1 | Processed food categories

We consider five levels of food processing characterizing the product in order of increasing convenience and value added. The online appendix presents a detailed comparison of our processing categorization with that of Monteiro et al. (2010), a leading reference in the highly processed food consumption literature. We show that our categorization is close to theirs but adjusted for the African situation and the HBS data. Our five categories are the following (with examples given in Table 1):

1. unprocessed: raw fruits and vegetables, grains, beans, and live animals, that have undergone no physical or chemical processing;
2. low-processed: a food with a single unprocessed product that has undergone one physical process such as milling or grating (what may also be termed first-stage processing or minimally processed). In the Tanzanian context, the most common are maize flour and milled rice. Unprocessed and low-processed foods require some preparation (peeling, chopping, cooking, etc.) before consumption;
3. highly processed unpackaged: a food comprising multiple low-processed products, with the set undergoing further processing such as frying or baking. A main example of this category in Tanzania is the mandazi, a fried wheat bun like a donut that is a common snack;
4. highly processed packaged: we refer to this as an ultra-processed food, and includes items such as biscuits/cookies, bread, soda, and alcoholic beverages;
5. meals consumed away from home (MAFH): typical examples include rice with beans, chips (French fries) and eggs, and purchases from cafés. Because these products are home meal replacements, they are the category of greatest convenience.

We categorized the item at its state at acquisition, before any further home processing or preparation. Thus, all home-produced products are acquired unprocessed (like grain from the farm). Beans and fruit are usually acquired unprocessed. All acquired-processed products are purchased. Note that FAFH (food away from home) is the aggregate of MAFH and any of 1–4 that is purchased and consumed away from home.

After classifying each food product, we calculated food consumption shares using the consumption diary data. The shares are calculated by dividing the total consumption (whether purchased or home-produced) of each processing category by total food consumption. The latter is

the total in value (shilling) terms of own production and food purchases for at-home consumption and FAFH. We exclude transfers and hunted and gathered food (a tiny part of consumption).[2]

3.2.2 | Spatial categories

To analyze how processed food consumption varies spatially, we created geographic variables using GPS coordinates obtained from the Tanzanian National Bureau of Statistics for the surveyed enumeration areas (EA). We took the following steps.

First, we used the 2012 census data to obtain the population and administrative classification of all 33 urban areas in Tanzania. The government of Tanzania classes urban areas into: (1) primary cities, with population above 500,000; (2) municipalities which we call "secondary cities," with population between 100,000 and 500,000; and (3) towns, with population between 20,000 and 100,000.

Second, using the HERE API (Application Programming Interface) (www.developer.here.com) we calculated the distance in kilometers (km) and travel time in hours of each of the 395 EAs in the full sample from the centers of all the 33 urban areas, as follows: (a) we calculated the average radius of primary and secondary cities and towns using Google Maps; (b) we classed urban EAs into one of the three urban categories above based on which the EA was in; (c) we classed EAs that straddled the border of urban areas as follows: if it was within 10 km of the border of the urban area it was classed as being in that type of city; this accounts for 23% of mixed EAs; the other 77% of mixed EAs was classed as rural.

Third, in the spatial analysis of rural EAs, we further classed them into three sets: (a) peri-urban, within 1 hour of a city or town; (b) intermediate, between 1 and 3 hours, and hinterland, 3 or more hours from an urban area.

3.2.3 | Employment variables

A key hypothesized determinant of consumption of processed food is employment. For example, urban women who work outside the home, and rural women engaged in RNFE (rural nonfarm employment), would have higher opportunity costs of time to stay home and home-process and home-prepare food. Thus we calculated from the HBS labor module the FTEs (full time equivalents) of employment by working-age (ages 15–64) men and women in the household working in nonfarm self-employment and wage employment. Aggregating over the course of a year and dividing by 2,016 gives the FTE spent in each type of work.[3] Therefore, an FTE value of 1 corresponds to an average of 40 hours worked per week over the year; an FTE value of .5 corresponds to an average of 20 hours per week, and so on.

4 | DESCRIPTIVE RESULTS ON PROCESSED FOOD CONSUMPTION

Below we present descriptive results for rural compared with urban processed food consumption. It is striking that whereas the conventional image has the urban areas and especially the urban middle class as the focal point of processed food penetration, we find that rural and urban areas are not very far apart in their processed food consumption, with a gradation and continuum over space from intermediate to peri-urban to small towns and secondary cities and then a jump up to primary cities, but a continuum and not an abrupt leap from nearly nothing to a high share in urban areas. Moreover, we find that hinterland areas (where 11% of rural Tanzanians live) far from the cities show a spike in ultra-processed food, showing SSBs and snacks and MAFH penetrating these areas. Finally, we find that in each area, the processed food profile of the poor is somewhat below that of the upper tercile, but again not with an abrupt jump. These results imply that the rise in the opportunity cost of time in rural and urban areas, and among rich and poor alike, has driven a much broader diffusion of processed food than we expected. The details are presented below.

4.1 | Rural results

Table 2 shows processed food consumption by rural tercile of total expenditure per adult equivalent (a proxy for income). Terciles are calculated within the overall rural sample. Several points stand out.

First, annual food consumption per AE is 55% of total expenditure in rural areas. That share is 1.5 times higher for tercile 1 (68%) compared with tercile 3 (44%). This pattern is expected from Engels' Law. Total food consumption per AE (adult equivalent) is 276 USD per year, about 70% of the urban level shown below.

Second, on average about 60% of rural food consumption is purchased (in value terms).[4] This is noteworthy when

[2] Together, transfers and hunted and gathered food account for 1.5% of the observations in the diary of food consumed at home; this rises to 2.5% for rural diary entries, and is just 0.37% of urban diary entries.

[3] We define "full time" to be 2,016 hours per year (= 40 hours/week * 4.2 weeks/month * 12 months/year).

[4] The value of home production was estimated by the household. The survey questionnaire did not specify to the respondent whether to use the

TABLE 2 Average shares (percentages) of processed categories in total food consumption in value terms: Rural households

	T1*	T2	T3	Overall
N =	1,876	1,876	1,876	5,628
Average yearly food consumption per AE (USD)	$156	$240	$420	$276
Coefficient of Variation	(.36)	(.31)	(.47)	(.55)
Yearly total expenditure per AE (USD)	$228	$426	$953	$499
Coefficient of Variation	(3.30)	(1.85)	(6.56)	(9.79)
Total Food Budget Shares				
Own-produced share[a]	47.4	36.6	24.1	37.1
Total Purchased Share	48.8	60.5	73.7	59.8
Purchased to eat at home	44.2	53.7	59.8	51.9
FAFH	4.6	6.8	13.9	7.9
Share of purchased processed food (including processed FAFH and MAFH) in total food expenditure	38.6	47.4	58.6	47.3
Unprocessed Share	30.2	29.5	26.0	28.8
Low Processed Share	58.6	56.9	52.9	56.4
High Processed Unpackaged Share	.6	1.0	1.3	1.0
Ultra-Processed Share	4.4	5.8	7.7	5.8
MAFH Share	2.5	3.9	9.9	5.1
Share of .... In total purchased food				
Purchased unprocessed	24.9	24.0	22.6	24.0
Purchased low processed	60.1	58.8	53.6	57.8
Purchased high processed unpackaged	1.1	1.4	1.6	1.4
Purchased ultra-processed	8.5	9.1	10.1	9.1
MAFH	5.5	6.6	12.1	7.7
Share of .... In total purchased processed food				
Purchased low processed	80.5	78.3	70.9	77.1
Purchased high processed unpackaged	1.5	1.9	2.1	1.8
Purchased ultra-processed	11.1	11.8	12.9	11.8
MAFH	6.8	8.0	14.1	9.2

*Refers to terciles calculated using total expenditure per adult equivalent. [a] These are the shares of each source within the total household food budget (will not exactly sum to 100 down columns due to exclusion of gifts/food aid share). Source: authors' calculations.

viewed in light of the common image of rural households in Africa depending mostly on own-farming for food, and even more striking when one notes that even the poorest tercile buys 50% of their food, just a little below the upper tercile, which buys 75% of their food. This finding of the importance of purchases in the diet of rural areas, including the rural poor, is similar to that of Sibhatu and Qaim (2017) in Ethiopia, and Tschirley et al. (2015a) for a set of Eastern and Southern African countries (Ethiopia, Malawi, Mozambique, Tanzania, and Uganda).

Third, it is not surprising that the share of own-production averages 44% of unprocessed food consumption (see Table A1 in the online supplement). The share for the lowest tercile (55%) is nearly double that for the highest tercile (30%). The poorest rely more on their own farming for raw products, and the rural upper tercile, more on purchases. The complement is that the purchased share of raw products is 71% in tercile 3 and only 45% in tercile 1.

Fourth, it is striking that even in rural areas the share of purchased-processed food in all rural food consumption is high – 47% overall, varying from 39% to 47% to 59% over the three terciles (Table 2). This is below the 78% share of processed food in urban areas shown below, but the rural share is still high compared to what we perceive as conventional wisdom regarding African rural areas. We observe that in food debates in Tanzania and Africa in general, purchased-processed food is considered an urban phenomenon, and middle class at that. Our findings show that it is neither only urban nor only middle class.

consumer price or producer price in this valuation. We interpret the value of home production as the average opportunity cost of buying the product instead of the producer price of selling the product.

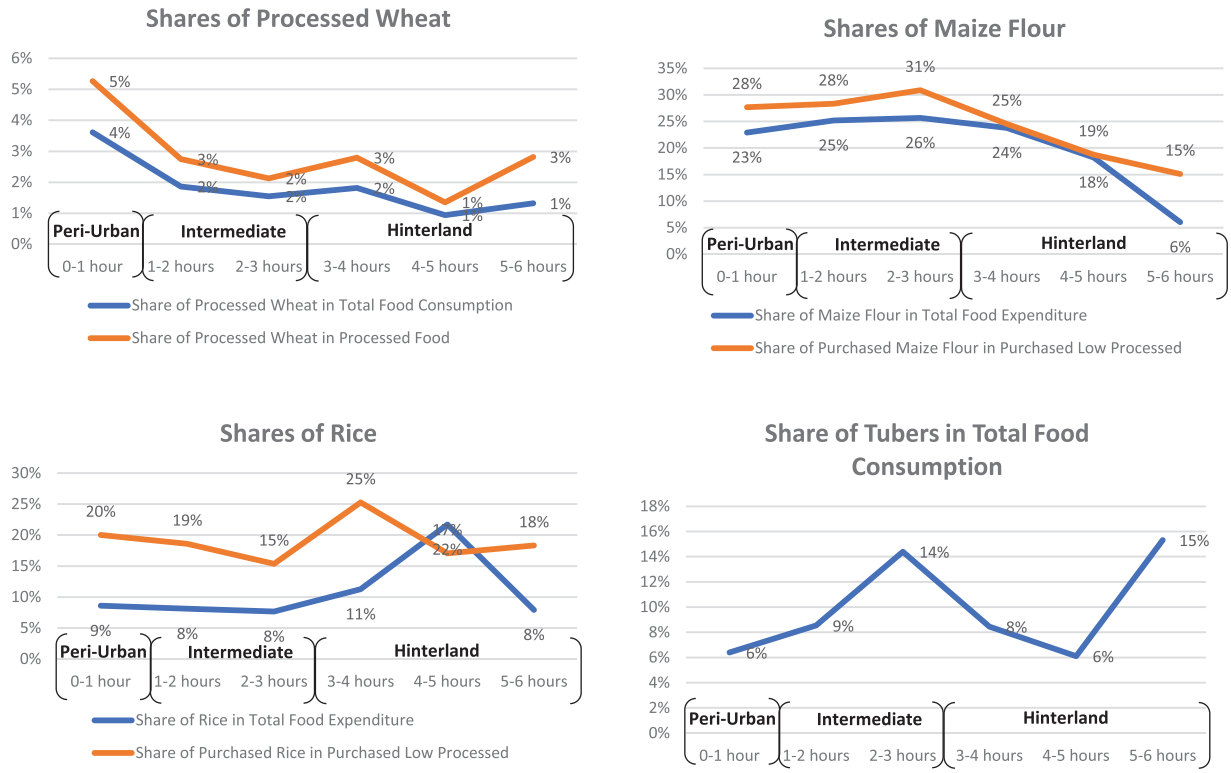

FIGURE 1 Rural average consumption shares of processed maize, rice, processed wheat, and roots and tubers by travel time to nearest urban center [Color figure can be viewed at wileyonlinelibrary.com]

Fifth, purchases of low-processed food form 77% of purchases of all processed food, and form 56% of all rural food consumption, with strikingly little variation over terciles (Table 2). The purchased low-processed food is 58% from milled grains – 34% is maize flour, 19% is milled rice, 5% is milled wheat (Table A1).

However, own-produced low-processed food is 37% of low-processed food consumption in rural areas, nearly doubling from high (24%) to low income tercile (47%) (Table A1). This implies a strong reliance on rural households to grow or purchase a raw product and then process it in a custom-milling service. The HBS consumption data have no information on how the raw product was acquired that was consumed low-processed (such as whether the household bought or grew maize grain that they then had ground to use in the main dish, ugali). The data do not show whether the household hand-processed the raw ingredient or took it to be custom-milled at the village mill. Key informants told us that it is rare now for hand-pounding of grain to occur in rural areas, so we assume most of the "home" low-processing is use of custom milling services, itself a time-saving convenience.

Figure 1 shows the shares of low-processed wheat, maize, and rice in total processed and purchased low-processed food by the rural households' distance from the nearest city. The distances are grouped into zones: peri-urban (less than 1 hour from urban areas); intermediate (from 1 to 3 hours from urban); and hinterland (3 and more hours from urban). Based on our representative sample, 30% of the rural population lives in the peri-urban, 59% in the intermediate, and 11% in the hinterland zone. The most striking result is that maize flour shares plummet 2-fold from the intermediate to the hinterland zone, from about 30% to 15%. The lower right quadrant explains what took its place: tubers. This fits with the image of the hinterland zones being mainly in the hilly and mountain areas where tuber production and consumption are much more important than in the other zones. Interestingly, the share of rice in purchased low-processed food is relatively steady at a fifth of low processed food, even into the hinterland zone where it is not being displaced by tubers.

Sixth, 18% of processed food in rural areas is high-processed, including 2% high processed unpackaged, 9% ultra-processed (high processed packaged eaten at home or at a kiosk), and 7% MAFH (Table 2). Thus, while processed food in general has become important in rural areas, the penetration of sugary/oily snacks and sweets in the rural areas sharply lags the urban areas (discussed below), at present.

The food service sector is less developed in rural areas than in urban areas, as is one of its correlates, commuting to work. Yet MAFH form 8% of purchased food in

FIGURE 2 Rural average consumption shares of processed categories (regardless of source) by travel time to nearest urban center [Color figure can be viewed at wileyonlinelibrary.com]

rural areas (Table 2). This depicts a continuity with the patterns of the towns' use of the food service sector, rather than an abrupt and large difference in patterns in rural areas. Upper tercile rural households have almost the same MAFH share in purchases (12%) as do towns and secondary cities (14% and 13% respectively, as we show below). As with urban areas, the rural poor rely less on MAFH, with their MAFH share in purchases being only 6%.

Table 3 and Figure 2 show the distribution over rural zones of consumption of processed food. Table 3 shows the composition of ultra-processed food consumption in rural areas by zone. SSBs occupy first rank in ultra-processed food, averaging a quarter of ultra-processed, with a U-shaped curve over rural space. The shares of bread and dairy products fall quickly from peri-urban to hinterland zones; perhaps this is related to greater commuting in peri-urban areas where workers rise early to go to work and have bread and coffee with milk en route. Another striking finding is the importance of alcoholic beverages, the share of which rises steeply from peri-urban (13%) to hinterland zones (around 31%). This is linked to a steep rise of the share of hard liquor as the distance from the urban areas increases. Interestingly, the share of chocolate and confectionary products is low in all the rural zones,

TABLE 3 Composition of Ultra-Processed Category by Zone (percent of each sub-category in total ultra-processed). Includes food consumed at home and away from home (but not MAFH)

	Urban				Rural						
						Intermediate		Hinterland			
	Primary City	Secondary City	Town	Overall Urban	Peri-Urban <1 hr	[1 hr, 2 hr]	[2 hr, 3 hr]	[3 hr, 4 hr]	[4 hr, 5 hr]	[5 hr, 6 hr]	Overall Rural
Share of **sugar-sweetened beverages (SSBs), including fruit juices**, in ultra-processed	32	31	33	32	28	24	21	22	33	29	25
Share of **bread**	38	33	29	37	21	12	9	9	9	8	14
Share of **tea** and **coffee**	15	17	13	15	13	13	12	11	15	19	13
Share of **biscuits, cake, and ice cream**	3	3	3	3	3	3	3	2	2	2	3
Share of **alcohol (beer, spirits/liquors, and wine)**	3	4	10	3	13	24	24	28	36	29	21
Share of **pasta**	4	4	3	4	4	2	1	1	0	4	4
Share of **chocolate, confectionery products**	1	1	1	1	1	1	1	1	2	1	1
Share of **processed meats** (beef sausage, dried or salted meat, canned fish/shellfish)	0	1	0	0	1	1	3	0	0	0	0
Share of **dairy products** (powdered milk, jibini, clotted milk, butter, margarine)	2	4	5	2	10	15	23	4	0	3	2
Share of **canned fruits and fruit jams**	0	0	0	0	0	0	0	0	0	0	0
Share of **syrup, condiments, chili sauce, vinegar**	0	0	0	0	0	0	0	0	0	0	0
Share of **baking products** (yeast, cocoa/cooking chocolate, cocoa and powdered chocolate)	0	0	0	0	0	0	0	0	1	0	0
Share of **other products** (cornflakes, unidentifiable products)	2	2	3	2	5	5	3	20	1	5	2
TOTAL	100	100	100	100	100	100	100	100	100	100	100

Source: authors' calculations.

perhaps because of the popularity of the traditional *mandazi* (local sweet donuts).

Table A3 in the online supplement focuses on the spatial distribution and levels of SSBs, showing unconditional and conditional averages of expenditure per person on SSBs in shillings and milliliters per month of SSBs. We discuss the table in terms of the equivalents of cans of Coca Cola. A can of Coca Cola is 330 ml. The table shows that SSB consumption in urban and rural areas is similar: 2.25 cans of Coca Cola per month per urban adult equivalent; a bit less than 2 cans in rural areas. However, within rural areas there is a lot of heterogeneity, with a steady decrease from the peri-urban through the intermediate zone, and then a large increase in the 3–4 hour part of the hinterland, and then a sharp fall beyond 4 hours from cities.

Figure 2 presents rural consumption shares of processed food categories over hours of distance from urban areas, grouped into zones as discussed above. The upper left quadrant shows that the share of unprocessed food stays interestingly steady at around 30% across the heterogeneous rural zones, only changing abruptly starting 4 hours from urban areas, in the hinterland zone. The complement of this is that the share of processed food stays steady at around 70%, again with the drop in processed food only in the hinterland zone, where only 11% of the rural population live. As we explained above, this is because grain as a staple gives way to roots and tubers as the main staples far from the cities, essentially in the mountain areas in the west and center south of the country.

The upper right quadrant of Figure 2 shows that low-processed food stays remarkably steady as a share of processed food over rural zones, hovering around the mid 80 percentiles after a small dip up from the peri-urban area closest to the city. This shows that the great majority of processed food consumption in rural areas is still the "first stage" of processing evolution, where women buy flour and rice and oil and cut up beef and so on and home-prepare meals. This is a step "beyond" hand pounding of cereals their mothers did 20–30 years ago, but a step behind their urban counterparts who as Table 4 shows, buy around 62% of their processed food as low processed and have thus moved to nearly 40% of their processed food as ready to eat or heat and eat, eschewing both home processing and home preparation.

The lower left quadrant shows that throughout the rural zones unpackaged high-processed food is only 1–2% of consumption and processed food. Thus, while a snack like traditional mandazi is often held up as the archetype of what rural households might buy as a snack, it is far less important than the "non-traditional" ultra-processed foods we show in the lower right quadrant – even in rural areas.

Packaged ultra-processed food shows a slight U curve over space, from 11% of processed food in peri-urban areas to a low of an average 8% in other rural areas, but interestingly jumping back to 10% in hinterland areas. That shows the reach of marketing of packaged ultra-processed foods, belying the popular image of them as urban foods. Figure 2 surprisingly shows MAFH traces a similar U curve, with around 10% in the peri-urban and hinterland areas, dipping to 5% in the middle of the U. The penetration of MAFH in even hinterland areas is fascinating.

4.2 | Urban results

Table 4 shows processed food in urban food consumption, by city type and by total expenditure tercile. Terciles are calculated within each urban category (towns, secondary cities, primary cities). Several points stand out.

First, annual total food consumption per AE is roughly 40% of total expenditure per urban category. That share is thrice higher for tercile 1 (the poorest) compared with tercile 3 (the richest) in towns, and twice higher in secondary and primary cities, as expected from Engels' Law.

Second, on average 98% of urban food consumption is purchased, with little variation over urban category and tercile. Only 2% of food comes from own-farming, whether from farms operated by urban consumers in rural areas or "urban agriculture."

Third, processed food purchases are 78% of food consumption in Tanzanian urban areas. Interestingly that share barely differs over towns and secondary cities (at 75%) and primary cities (at 80%). The corollary is that the share of food consumption acquired unprocessed (22%) is much lower than one would expect if we were in the traditional situation where households buy raw products and home-process and home-prepare them.

Fourth, purchased low-processed products form 62% of purchased-processed food in urban areas (varying from 68% in towns and secondary cities to only 54% in primary cities). Online Table A2 shows that 58% of low-processed food in urban areas is milled cereal – 21% maize flour, rice, 24%, and wheat flour, 13%. The share of maize flour drops from towns to primary cities, from 24% to 17%. The share in the lowest tercile is about twice that of the highest tercile. Those general patterns hold also for rice and wheat, but less sharply. This shows the importance of maize, but instead of buying it in grain form and then hand pounding or even custom milling, it is now common even in small towns and among the poor to buy it already milled.

Fifth, in urban areas, high-processed packaged (ultra-processed) foods, such as potato chips and sweetened beverages, are more than 4 times as important as high processed unpackaged foods, such as traditional fritters and

TABLE 4 Average shares (percentages) of processed categories in total food consumption in value terms: Urban households

	Towns				Secondary Cities				Primary Cities				
	T1*	T2	T3	Overall	T1	T2	T3	Overall	T1	T2	T3	Overall	Urban Overall
N =	107	107	106	320	338	338	338	1,014	938	939	938	2,815	4,149
Average yearly food consumption per AE (USD)	$216	$360	$636	$408	$192	$312	$540	$348	$264	$444	$708	$480	$408
(Coefficient of Variation)	(.39)	(.25)	(.73)	(.81)	(.36)	(.31)	(.82)	(.88)	(.33)	(.32)	(0.45)	(0.59)	(0.65)
Average yearly total expenditure per AE (USD)	$364	$726	$2019	$1026	$350	$655	$1473	$790	$534	$998	$2217	$1237	$1032
(Coefficient of Variation)	(3.40)	(2.02)	(9.27)	(13.25)	(3.12)	(1.90)	(5.95)	(9.50)	(3.19)	(1.81)	(6.91)	(9.94)	(2.21)
Total Food Budget Shares													
Own-produced share[a]	5.6	4.3	1.3	3.8	2.5	1.6	.9	1.7	.9	.2	0.4	0.5	2.0
Total Purchased Share	92.3	95.2	98.1	95.2	96.4	98.1	98.8	97.7	98.8	99.7	99.5	99.4	97.5
Purchased to eat at home	82.5	80.5	70.2	77.8	88.4	86.0	66.9	81.1	79.8	66.1	48.9	65.2	74.5
FAFH	9.8	14.7	27.9	17.4	8.0	12.1	31.9	16.6	19.0	33.6	50.6	34.2	23.0
Share of purchased processed food (including processed FAFH and MAFH) in total food expenditure	70.4	73.3	78.1	74.0	72.7	75.4	80.3	75.9	75.7	80.5	84.6	80.2	78.3
Unprocessed Share	25.4	23.1	20.9	23.1	26.0	23.7	19.2	23.2	23.6	19.4	15.1	19.4	21.8
Low Processed Share	54.4	53.3	44.2	50.7	59.9	57.8	45.7	54.9	48.4	41.8	33.5	41.3	48.8
High Processed Unpackaged Share	3.3	2.9	1.4	2.6	2.0	1.8	1.3	1.7	3.3	2.3	1.3	2.3	2.2
Ultra-Processed Share	6.9	9.2	11.6	9.2	5.2	6.8	8.8	6.8	10.0	11.2	11.2	10.8	9.0
FAFH – Meals share	8.0	11.0	21.2	13.4	5.8	9.5	24.8	12.8	14.4	25.2	38.9	26.0	17.6
Share of .... In total purchased food													
Purchased unprocessed	25.3	23.5	20.8	23.2	25.3	23.5	19.0	22.8	23.7	19.4	15.1	19.4	20.8
Purchased low processed	55.0	52.5	44.5	50.7	61.3	58.3	45.9	55.7	48.5	41.9	33.5	41.4	46.6
Purchased high processed unpackaged	3.6	3.0	1.5	2.7	2.0	1.8	1.3	1.7	3.3	2.3	1.3	2.3	2.2
Purchased ultra-processed	7.3	9.5	11.8	9.5	5.4	6.8	8.8	6.9	10.0	11.2	11.2	10.8	9.5
MAFH	8.8	11.5	21.4	13.8	5.9	9.6	24.9	12.9	14.5	25.3	39.0	26.1	20.9
Share of .... In total purchased processed food													
Purchased low processed	75.0	69.8	58.6	67.8	82.8	77.5	59.9	74.1	65.4	54.3	42.3	54.2	61.6
Purchased high processed unpackaged	4.8	4.0	2.1	3.6	2.7	2.4	1.8	2.3	4.3	3.0	1.6	3.0	2.9
Purchased ultra-processed	9.6	12.4	15.0	12.4	7.2	8.9	11.0	8.9	13.2	14.1	13.5	13.6	12.0
MAFH	10.6	13.8	24.3	16.2	7.3	11.2	27.3	14.6	17.1	28.7	42.6	29.3	23.5

*Refers to terciles calculated using total expenditure per adult equivalent. [a] These are the shares of each source within the total household food budget (will not exactly sum to 100 down columns due to exclusion of gifts/food aid share). Source: authors' calculations.

cakes (such as mandazi) bought mainly to eat at home. In particular, the average budget share of ultra-processed is 9%, and the average share of high processed unpackaged products is just 2%.

Table 3 examines the composition of ultra-processed food (as packaged and highly processed) in urban areas. Two product sets dominate with two-thirds of the category, each with about a third with similar distribution over urban categories. First-ranked are sugar-sweetened beverages (SSBs) that average about a third of ultra-processed food consumption. The second-ranked is bread, also about a third of ultra-processed; it is not specified as packaged in the data set but key informants noted that it is nearly always sold that way. The last third of the category is highly fragmented over a wide range of products with modest differences over urban categories.

Table A2 shows that ultra-processed (packaged) food bought away from home (not as MAFH but just from kiosks to consume at the kiosks or take back home, such as drinking a sugary soda at a kiosk) forms 35% of ultra-processed food consumption, rising from 31% in towns/secondary cities to 42% in primary cities. This attests to a shift in street kiosks selling traditional snacks to selling packaged snacks today (as found also in Namibia by Nickanor et al., 2019). Note that there is also a strong income correlation in consumption of FAFH packaged snacks and beverages, with the share nearly doubling between the lower and upper terciles in all urban categories (in the towns, 23% to 39%; in the secondary cities, 30% to 45%; in the primary cities, 28% to 55%).

Sixth, MAFH is a surprisingly developed phenomenon. In urban Tanzania, it is twice as important as high and ultra-processed packaged foods eaten at home or in kiosks (the MAFH share is 18% and the ultra-processed share is 9%) (Table 4). MAFH are fully 13% of all food consumption in towns and secondary cities and a stunning 26% in primary cities, with 18% of urban food consumption overall. The upper tercile is particularly reliant on MAFH with 21%, 25%, and 39% from MAFH over the three city types, thrice the shares for the lowest tercile. The emergence of the "*mama ntilie*" (street food vendor) is a lynchpin of the urban food system, where commuting and women's work outside the home have spurred the rise of a large food service sector.

In sum, high and ultra-processed and MAFH together, as a share of processed food, form 30% in towns/secondary cities and 49% in primary cities. The counterpart is that low-processed is 70% of processed food in towns/secondary cities and only 51% in primary cities. This makes sense as usually the first step in purchasing processed food is to acquire time-saving forms of basic ingredients like flour that form the base of home cooking. The second step is to largely replace home cooking by buying ready to eat products and meals, and that step is taken "earlier" by richer consumers and the bigger cities.

There is an interesting contrast with findings of other studies, such as for Ouagadougou, Burkina Faso, in Reardon et al. (1989), where MAFH were much more important for the lowest tercile compared with the highest. In that case, poor workers commuted and could not easily return home to lunch, while the schedules and means of transport of the upper tercile consumers allowed lunch at home. In Tanzania, it is the opposite. The richer consumers, working in office buildings, lunch near them, perhaps because the development of the food service sector has made it much easier to do that now than several decades ago.

5 | REGRESSION MODELS AND RESULTS

5.1 | Regression models and estimation methods

We estimate the following augmented Engel curve models, following Lewbel (2006). To allow for differences in the parameters between urban and rural households, we estimate the model separately for the urban and rural samples. In particular, there may be fundamental differences between urban and rural households that are not adequately captured by distance or city size dummies, such as the food environment, employment opportunities, agroclimatic conditions, and lifestyle patterns. For rural households, the regression is:

$$\begin{aligned} Share_i = {} & \alpha_0 + \alpha_1 ln\,(total\_exp) + \alpha_2 (ln\,(total\_exp))^2 \\ & + \alpha_3 dist + \alpha_4 dist^2 + \mathbf{labor}\boldsymbol{\delta} \\ & + \mathbf{other\_controls}\boldsymbol{\zeta} + \varepsilon_i \end{aligned} \tag{2}$$

- $Share_i$ is the share of the household's food consumption (from purchases plus own production) on processing category i. As discussed above, the processing categories are unprocessed, low-processed, unpackaged high-processed, ultra-processed, and MAFH.
- *ln(total_exp)* is the natural log of the household's total monthly consumption of food and non-food goods and services per adult equivalent. Total expenditure enters the model quadratically (Banks et al., 1997; Deaton & Zaidi, 2002). We hypothesize that the higher the income, the greater the share of consumption to higher processed foods because the opportunity cost of time rises with income.

- *dist* is the distance (in kilometers) from the household's village to the nearest urban area (either a town, secondary city, or primary city). Distance enters the model quadratically. We hypothesize that the greater the distance from urban areas, the lower the share of consumption to high processed foods because the food environment is less amenable to processed foods in deep rural areas and consumers tend to work nearer home.
- *labor* is a vector of four employment-related variables (FTEs in non-farm self-employment and non-farm wage work, each for men and women). We hypothesize that processed food consumption is correlated with non-farm activity, especially wage work that takes consumers further from home and thus increases the opportunity cost of returning to process, prepare, and eat food at home.
- The vector *other_controls* contains household demographics such as the age and education of the household head, a dummy variable equal to one if the household head is female, and a dummy variable equal to one if the household head is married. Also included are other dummy variables that could affect preferences including ownership of bicycle and motor vehicle (motorcycle or car), cooking appliance, and communication assets (TV, radio, mobile phone). We hypothesize that married couples eat more at home and consume less processed food. Households with easy transport access and cooking appliances could return home and cook at home easier and so may be less apt to consume processed food. Those with TVs and radios may be more exposed to advertising and consume more processed food.
- We include region dummies and dummies for the month of the interview, to control for spatial and temporal heterogeneity.

The urban model is similar, except that instead of *dist*, we include dummy variables that indicate whether the household lives in a secondary or primary city (with town as the base):

$$Share_i = \beta_0 + \beta_1 ln\,(total\_exp) + \beta_2 ln(total\_exp)^2 + \beta_3 secondary + \beta_4 primary + \mathbf{labor}\eta + \mathbf{other\_controls}\theta + u_i \quad (3)$$

The *labor* and *other_controls* vectors contain the same variables as in the rural model.

Both sets of regressions were estimated using ordinary least squares (OLS). We ran two robustness checks: we also estimated the equations using seemingly unrelated regressions (SUR), to account for correlation among the error terms across equations, and fractional multinomial logit (FMNL), to account for the fact that the dependent variables are fractional and together sum to one (Zellner, 1962; Papke and Wooldridge 1996). When each equation has the same set of explanatory variables (as is the case in our analysis), the SUR coefficient estimates are identical to the OLS estimates. The FMNL estimator ensures that the values of the predicted dependent variables lie between 0 and 1, and no adjustments are needed for observations at 0 and 1 (Papke and Wooldridge 1996). There are marginal changes in statistical significance in a handful of SUR, FMNL, and OLS estimates, but because the key takeaways (i.e., the coefficient estimates on the total expenditure, distance, and city size variables) remain unchanged, we report and discuss the OLS results.

Tables A4-A6 in the online supplement show descriptive statistics for male and female employment and other regression determinants for rural and urban households.

5.2 | Econometric results

The results of the Engel curve regressions are presented in Table 5 (for rural households) and Table 6 (for urban households).[5] Several results are salient.

5.2.1 | Total expenditure

For urban households, total expenditure (TE) is negatively correlated with the consumption shares of unprocessed, low processed, and unpackaged high processed food. These results are significant at the 1% level. TE is positively and significantly correlated with the consumption shares of ultra-processed food and MAFH. This controls for the urban household's employment profile, and thus suggests a correlation between income and opportunity cost of time and the pursuit of convenience in food consumption. The results are roughly the same in the rural sample, with the exceptions that TE is not significantly correlated with the consumption share of unprocessed food, and is positively correlated with the share of unpackaged high processed food (though the magnitude is very small).

5.2.2 | Employment, representing opportunity cost of time

Tables 5 and 6 show the correlations between a household's engagement in various types of employment and processed

[5] The SUR and FMNL results are present in tables A7-A10 in the online supplemental appendix.

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TABLE 5 Econometric results for Engel curve regressions of food budget shares, rural households

	Unprocessed	Low Processed	High Processed, Unpackaged	Ultra-Processed	Meals Away from Home
Total Expenditure					
Natural log of total household expenditure on food and non-food per adult equivalent	.369***	.094	.035***	−.019	−.478***
	(.089)	(.082)	(.010)	(.031)	(.099)
Natural log of total household expenditure, squared	−.017***	−.007*	−.002***	.002	.024***
	(.004)	(.004)	(.000)	(.001)	(.005)
Average marginal effect of ln(total expenditure)[a]	.001	−.057***	.001**	.019***	.035***
Household Demographics					
Adult equivalents	.003**	−.003**	−.000	−.000	.000
	(.001)	(.001)	(.000)	(.001)	(.001)
Dependency ratio	.008**	.013***	.000	−.006***	−.015***
	(.003)	(.003)	(.000)	(.001)	(.002)
=1 if the head of household is female	.037***	.029***	−.000	−.018***	−.048***
	(.007)	(.008)	(.001)	(.004)	(.006)
Age of the household head	.000**	.000*	.000	.000	−.001***
	(.000)	(.000)	(.000)	(.000)	(.000)
# years formal schooling of HH head	−.002**	.001	.000*	−.000	.000
	(.001)	(.001)	(.000)	(.000)	(.001)
=1 if the household head is married	.024***	.052***	.001	−.016***	−.060***
	(.007)	(.008)	(.001)	(.004)	(.007)

(Continues)

TABLE 5 (Continued)

	Unprocessed	Low Processed	High Processed, Unpackaged	Ultra-Processed	Meals Away from Home
Labor Variables					
Total FTEs of females in nonfarm wage	−.015*	−.003	−.000	.005	.013
	(.008)	(.012)	(.001)	(.004)	(.010)
Total FTEs of females in nonfarm self-employment	−.020***	.010	.005***	.004	.001
	(.006)	(.007)	(.001)	(.003)	(.006)
Total FTEs of males in nonfarm wage	−.019***	−.017**	−.000	.008***	.028***
	(.005)	(.007)	(.001)	(.003)	(.007)
Total FTEs of males in nonfarm self-employment	−.023***	.005	.001	.002	.014**
	(.004)	(.010)	(.001)	(.003)	(.006)
Other Preference-Altering Variables					
=1 if HH has gas or electric stove	.002	.040**	−.001	−.006	−.035*
	(.016)	(.018)	(.003)	(.007)	(.019)
=1 if HH has charcoal stove	−.021***	.021***	.005***	−.002	−.002
	(.005)	(.006)	(.001)	(.003)	(.004)
=1 if HH has firewood and coal stove	−.005	.021***	−.002**	−.006**	−.009***
	(.005)	(.006)	(.001)	(.003)	(.003)
=1 if HH has a refrigerator, freezer, or fridge-freezer	.026**	.016	−.008***	−.002	−.031***
	(.011)	(.014)	(.002)	(.006)	(.011)
=1 if household has either a car or motorcycle	−.022**	.053***	.007***	−.012***	−.026***
	(.010)	(.011)	(.002)	(.004)	(.010)

(Continues)

TABLE 5 (Continued)

	Unprocessed	Low Processed	High Processed, Unpackaged	Ultra-Processed	Meals Away from Home
=1 if household has a bicycle	−.001	.004	.000	−.000	−.002
	(.005)	(.005)	(.001)	(.002)	(.004)
Tropical Livestock Units	.001**	−.001*	−.000**	.000	−.000
	(.000)	(.000)	(.000)	(.000)	(.000)
Hectares of land cultivated by HH	.001*	−.001*	−.000*	.000	−.000
	(.001)	(.001)	(.000)	(.000)	(.000)
=1 if HH owns a television	−.016**	.009	.002	.003	.002

(Continues)

TABLE 5 (Continued)

	Unprocessed	Low Processed	High Processed, Unpackaged	Ultra-Processed	Meals Away from Home
	(.008)	(.010)	(.002)	(.004)	(.010)
=1 if HH owns a radio	−.071*	.017	.009*	−.017	.062
	(.039)	(.052)	(.005)	(.017)	(.045)
=1 if HH has mobile phone	−.010*	.012**	.001*	−.004*	.001
	(.005)	(.006)	(.001)	(.002)	(.004)
Spatial Variables					
Distance (in 100′s of km) to nearest urban center	−.116***	.125***	−.006***	.001	−.004
	(.014)	(.015)	(.002)	(.006)	(.009)
Distance, squared	.038***	−.039***	.002***	−.002	.001
	(.006)	(.006)	(.001)	(.002)	(.003)
Average marginal effect of distance[a]	−.046***	.054***	−.003***	−.003	−.002
Constant	−1.676***	.170	−.187***	.177	2.516***
	(.493)	(.456)	(.055)	(.173)	(.534)
Observations	5,054	5,054	5,054	5,054	5,054
R-squared	.336	.318	.249	.201	.223

Notes: Estimated with OLS. Robust standard errors in parentheses. Region and month dummies were included as regressors, but the results are not presented here. [a] Average marginal effects are calculated using the *margins* command in Stata. *** p < .01, ** p < .05, * p < .10. Source: authors' calculations.

TABLE 6 Econometric results for Engel curve regressions of food budget shares, urban households

	Unprocessed	Low Processed	High Processed, Unpackaged	Ultra-Processed	Meals Away from Home
Total Expenditure					
Natural log of total household expenditure on food and non-food per adult equivalent	−.115*	−.041	−.007	.165***	−.002
	(.060)	(.080)	(.011)	(.023)	(.125)
Natural log of total household expenditure, squared	.004	−.001	.000	−.006***	.004
	(.002)	(.003)	(.000)	(.001)	(.005)
Average marginal effect of ln(total expenditure)[a]	−.032***	−.058***	−.006***	.015***	.080***
Household Demographics					
Adult equivalents	−.001	.008***	.000	.002***	−.009***
	(.001)	(.002)	(.000)	(.001)	(.002)
Dependency ratio	.018***	.044***	.004***	−.002	−.064***
	(.003)	(.004)	(.001)	(.002)	(.005)
=1 if the head of household is female	.050***	.068***	.003	.001	−.123***
	(.006)	(.009)	(.002)	(.003)	(.011)
Age of the household head	.001***	.001***	.000***	−.000***	−.002***
	(.000)	(.000)	(.000)	(.000)	(.000)
# years formal schooling of HH head	−.000	.000	−.000*	.000	.000
	(.001)	(.001)	(.000)	(.000)	(.001)
=1 if the household head is married	.047***	.084***	.004***	−.001	−.132***
	(.005)	(.007)	(.001)	(.003)	(.010)
Labor Variables					
Total FTEs of females in nonfarm wage	−.011***	−.013***	−.002***	.001	.025***
	(.003)	(.005)	(.001)	(.002)	(.006)
Total FTEs of females in nonfarm self-employment	.008**	.004	.002*	−.001	−.012**
	(.004)	(.005)	(.001)	(.002)	(.006)
Total FTEs of males in nonfarm wage	−.009***	−.013***	−.001**	.000	.023***
	(.002)	(.003)	(.001)	(.001)	(.004)
Total FTEs of males in nonfarm self-employment	−.007**	−.007	−.001	.001	.014**
	(.003)	(.005)	(.001)	(.002)	(.006)
Other Preference-Altering Variables					
=1 if HH has gas or electric stove	.014**	.016*	−.003**	.008*	−.035***

(Continues)

TABLE 6 (Continued)

	Unprocessed	Low Processed	High Processed, Unpackaged	Ultra-Processed	Meals Away from Home
	(.007)	(.009)	(.002)	(.004)	(.012)
=1 if HH has charcoal stove	.064***	.091***	.005***	−.000	−.160***
	(.006)	(.009)	(.002)	(.004)	(.013)
=1 if HH has firewood and coal stove	.008	−.004	−.002	−.005	.003
	(.007)	(.010)	(.002)	(.004)	(.013)
=1 if HH has a refrigerator, freezer, or fridge-freezer	.021***	.027***	.001	−.003	−.046***
	(.005)	(.007)	(.001)	(.003)	(.009)
=1 if household has either a car or motorcycle	.013*	.022**	−.000	−.005	−.030**
	(.007)	(.010)	(.002)	(.004)	(.013)
=1 if household has a bicycle	−.006	−.002	.001	.005	.002
	(.005)	(.008)	(.002)	(.003)	(.010)
Tropical Livestock Units	−.000	.001	−.000	−.001	.001
	(.002)	(.003)	(.001)	(.001)	(.004)
Hectares of land cultivated by HH	.001	−.008***	−.001**	.001	.007**
	(.002)	(.002)	(.000)	(.001)	(.003)
=1 if HH owns a television	.002	.008	−.002	.001	−.009
	(.004)	(.006)	(.001)	(.002)	(.008)
=1 if HH owns a radio	.030	.039	−.001	−.031**	−.036
	(.035)	(.032)	(.011)	(.015)	(.052)
=1 if HH has mobile phone	−.005	−.007	.003**	−.003	.012
	(.006)	(.008)	(.002)	(.003)	(.010)
Spatial Variables					
=1 if HH is urban and lives in a secondary city	−.001	−.002	−.001	−.004	.007
	(.009)	(.016)	(.002)	(.006)	(.020)
=1 if HH is urban and lives in a primary city	−.010	−.071***	−.006	.016**	.070***
	(.012)	(.020)	(.004)	(.007)	(.025)
Constant	.849**	.773	.078	−.890***	.191
	(.359)	(.477)	(.071)	(.144)	(.735)
Observations	4,098	4,098	4,098	4,098	4,098
R-squared	.343	.444	.160	.191	.462

Notes: Estimated with OLS. Robust standard errors in parentheses. Region and month dummies were included as regressors, but the results are not presented here. [a] Average marginal effects are calculated using the *margins* command in Stata. *** p < .01, ** p < .05, * p < .10. Source: authors' calculations.

food category shares.[6] For nonfarm self-employment (NFSE), a marginal increase in female FTEs has few correlations with the processing categories. In the urban sample, female NFSE is positively correlated with the shares of unprocessed food and unpackaged high processed food, and is negatively correlated with the share of MAFH. This suggests that additional time spent by females on self-employment does not increase demand for more processed food, and may even decrease the share of the budget dedicated to MAFH. This makes sense because self-employment can often be from the home itself or be flexible to allow the woman to return home to cook. In the rural sample, female NFSE is negatively correlated with the consumption share of unprocessed food and positively correlated with the share of unpackaged, high processed food (such as *mandazi*).

Female non-farm wage labor (NFW) in urban areas is strongly and negatively correlated with the consumption shares of unprocessed, low processed, and unpackaged high processed food, and strongly and positively correlated with the consumption share of MAFH. This makes sense because wage work tends to be away from home and inflexible in hours, so both the woman and the rest of the family may need to eat outside the home, at least at lunchtime. However, in rural areas, female NFW work is largely insignificant in its impact on processed food consumption, likely because the sample of households with females engaged in such work is too small.

The above non-farm employment results support our hypotheses that additional female participation in the non-farm labor force is positively correlated with consumption of high processed food and MAFH, and that the association is stronger with wage work than with self-employment work.

The participation of males in the non-farm labor force is especially strongly correlated with the share of MAFH, as hypothesized. For both urban and rural households, male NFSE FTEs have a positive and significant (at the 5% level) correlation with the share of MAFH, and the magnitude of the correlation is approximately the same in urban and rural areas. Additional FTEs of male non-farm wage (NFW) work exhibit even larger positive correlations with the share of MAFH, and negative correlations with the shares of unprocessed and low-processed food. These results are consistent with our hypothesis of a link between men working away from home in enterprises and their need to commute and thus eat out.

[6] We also estimated the regressions using the share of time spent in each employment category, by gender (see tables A11 and A12 in the online supplemental appendix). The results are very similar to those using FTE levels, which are discussed in the text.

5.2.3 | Distance and city size

In the rural regressions, the average marginal effect of the distance to the nearest urban area is negative in the unprocessed and unpackaged high processed regressions, and positive in the low processed regression. This coincides with the descriptive results: the more distant a rural household is from urban areas, i.e., the more in the "hinterland," the more of their food budget is spent on the simple act of replacing laborious hand pounding of staple grains like maize by buying already milled grain, less on unprocessed food (such as fruits and vegetables), and less on buying traditional snack foods (such as sweet buns).

Importantly, distance from urban areas does not drive down ultra-processed food consumption – in fact there is no significant correlation. Recall from the descriptive section that even in the deep hinterland there was substantial consumption, in fact similar to even peri-urban areas, of SSBs, bottled beers and spirits, and packaged sweets.

For urban households, our regressions do not show a significant impact of living in a secondary city compared to living in a town. However, living in a primary city (compared with a town) is strongly, negatively correlated with the share of low-processed food, and strongly, positively correlated with the shares of ultra-processed food and MAFH. These results support our hypotheses and coincide with the descriptive results.

5.2.4 | Demographic variables

In both urban and rural regressions, an increase in the dependency ratio is associated with higher average unprocessed and low processed shares, and a lower share of MAFH. This makes sense: with more children and aged to perform home chores for, women need to stay at home more, but they also try to avoid hand-pounding of grain and so buy flour and other first-stage processed foods. Likewise as they tend to cook more, the women buy less MAFH. The same effect is seen with married household heads, who, we surmise, would have a greater tendency to eat at home at least for dinner, compared to a household head who is single.

Finally, as expected, having kitchen assets such as stoves and refrigerators is negatively associated with the consumption share of MAFH in both sets of regressions.

6 | CONCLUSIONS

In this article we sought to contribute to the literature on the penetration of processed food in diets of developing

countries with an exploration of the consumption of a continuum of processed food categories – from minimally processed to ultra-processed, and from processed food purchased and consumed at home to meals away from home (MAFH). We crossed that product perspective with a spatial continuum, from primary to secondary cities to towns, and from peri-urban to intermediate to hinterland rural areas. The processed and prepared food categories continuum has across it the commonality that all those categories are "convenience foods," as they save women's labor time in home processing and preparation, and men and women's time returning home to eat.

Moreover, the spatial categories continuum has across it the commonality that in all those spaces, men and women depend a lot on working outside the home, driving the quest for convenience; in each space there are also strata with higher incomes who have higher opportunity costs of time, and the difference between urban and rural blurs among these strata. For example, the richest households in rural areas have a similar total food budget to that of urban areas. Urban men and women are heavily engaged in work outside the home. In primary cities women's jobs tend to be wage jobs, taking them away from home; in secondary cities, many women are in self-employment, as they are in towns; in towns, many women also work on farms near the town. Rural people also have major job time commitments, not just on their farms: a quarter of rural women and a third of men work off-farm.

Using these product and spatial lenses, with a unique detailed data set from Tanzania, we had several key findings.

First, we found a deep penetration of processed food in general. Instead of processed food penetration being mainly confined to the urban middle class, we found (echoing Tschirley et al. 2015a) that it has spread well into the consumption of the rural areas, according to what seems the common image, we found it has spread well into the consumption of the rural areas where 47% of food consumption overall is purchased-processed food; even in the rural poor tercile, it is 39%. In urban areas, purchased-processed food is on average 78% of food consumption.

Second, we found that even ultra-processed food has penetrated diets beyond the urban middle class. For example, in towns, ultra-processed is 15% of processed food consumed by the upper tercile, but even 9% of the low tercile. Much of these are SSBs and packaged bread and bottled alcoholic drinks, but also a wide range of other snack foods.

Third, MAFH have penetrated surprisingly deeply into diets of urban Tanzanians in particular, where it averages 18% of food consumption and 23% of total processed food. MAFH has also penetrated rural diets, averaging 5% of food consumption and 7% of processed food consumption. In both cases MAFH consumption is correlated with income.

Fourth, processed food and prepared food (MAFH) penetration is most intense in primary cities, but has also gone far in secondary cities and is now making headway in towns. But it does not stop at city limits. It occurs over rural zones, in interesting patterns. Ultra-processed food is important in peri-urban areas, is less marked in intermediate zones, and then is again important in hinterland areas far from cities. This shows the far reach of marketing of branded SSBs in particular. MAFH are most important in urban, then second in peri-urban, then less in intermediate rural areas, and least in hinterland areas, but still present.

Fifth, as hypothesized, income, women's and men's employment outside the home, size of city, and rural distance from cities condition the purchase of processed foods and MAFH, linked with opportunity cost of time to home-process and prepare foods implied by those factors.

Our findings demonstrate that processed food supply chains provide convenience foods, both low processed and ultra-processed, where rising incomes, changing employment patterns of men and women, and tastes create demand for them. With this transformation, rooted in basic lifestyle changes similar to those experienced over the decades in developed countries, has come a rise in the consumption of unhealthy highly processed foods, even among the poor and even in hinterland areas distant from the city.

The work points to the need for further research on the nutrition effects of these trends in rural areas and the structure and conduct of supply chains providing these foods. It also points to the need for further research on the employment effects of these changes (see Tschirley et al. 2015b for one treatment of this issue) and reducing such as reducing women's home chore time to engage in off-farm employment, and men in the development of commuting patterns.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.

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