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Rural-urban diet convergence in Bangladesh

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ABSTRACT

This paper seeks to bring concepts from economic geography and human geography into closer dialogue and apply them to the analysis of food systems. We analyze temporal and spatial patterns of diet transformation in Bangladesh using data from nationally representative household surveys. We conceptualize diet transformation as a 'triangle' comprised of three elements (food purchases, diet diversification, and processed food consumption), influenced by four conditioners (time, income, non-farm employment, and space). We find that: (1) Diets are converging over time and space. food purchases, non-staples, and processed foods occupy high shares of food consumption value, irrespective of urban or rural location. Controlling for income, rural landless households and households in urban areas have very similar diets. Households in 'peripheral' and 'non-peripheral' rural areas experience similar levels of diet transformation. (2) Food purchases and processed food consumption are conditioned mainly by non-farm employment (NFE). (3) Diet diversification is positively associated with income, but not with NFE or land ownership. We characterize the spatial convergence of diets as an outcome of 'time-space compression' (the accelerating volume and velocity of economic and social transactions resulting from advances in transport and communications technology), and the distinct form of peri-urbanization under conditions of extremely high population density found in Bangladesh.

Key words: Bangladesh, Diet transformation; Economic geography; Non-farm employment; Urbanization

1. INTRODUCTION

Diet transformation - changes in demand that influence the quantity, diversity, and nutritional quality of foods consumed (Fanzo & Davis, 2021) - is an inherently spatial phenomenon. Changes in food consumption practices (such as how food is sourced, from purchase versus own-production) and diets are linked to changes in market integration, income levels, rural non-farm employment (NFE), women's labor market participation, and opportunity costs of time, that are in turn associated with urbanization and globalization (Pandey et al., 2020; Reardon et al., 2015).

Diet transformation is occurring particularly rapidly in low- and middle-income countries. At the macro-scale, globalization and associated economic development are associated with diet convergence between countries in the Global South and Global North (Bell et al., 2021; Brunelle et al., 2014; Pingali 2007). Diet convergence between rural and urban areas is also increasingly recognized to be occurring in many Global South countries as they become more closely integrated through transport and communications infrastructure (Headey and Masters, 2021; Nguyen et al., 2021; Sauer et al., 2021) and the development of agri-food value chains (Barrett et al., 2022). Dietary changes resulting from this deepening spatial connectivity and homogenization are a double-edged sword. Diet transformation may facilitate diet diversification into consumption of nutritious non-staple foods essential for reducing undernutrition, while simultaneously increasing consumption of less-healthful ultra-processed foods and meals eaten away from home (Bren d'Amour et al., 2020; Pingali et al., 2019; Seto and Ramankutty, 2016), overconsumption of which are associated with a rapidly growing 'triple burden' of malnutrition (Masters et al., 2022).

Analyses of changing diets in low- and middle-income countries typically focus on micro-economic factors such as household characteristics, incomes, and agricultural production, and sometimes, on NFE. Such analyses often feature coarse spatial categories (rural/urban) (e.g., Headey and Masters, 2021) and sometimes include spatial variables such as distance to markets (e.g. Madzorera et al., 2021). Less attention has been paid to other meso-scale spatial variables, including subcategories of urban (e.g., primary and secondary cities, peri-urban areas) and rural (e.g. more remote or less remote), or to the relationships between micro and meso variables and diet transformation (though see Sauer et al., 2021, for a recent exception). These distinctions matter because rural and urban areas are not bounded territorial spaces, but exist along a continuum of urbanicity where differences are becoming increasingly blurred (Cattaneo et al., 2022; Graham, 2024).

The collapse of clearly defined rural/urban spatial categories has been addressed extensively by human geographers, who theorize how the increasing volume and velocity of economic and social transactions resulting from advances in transport and communications technology have accelerated the movement of goods, people, capital, and information and, in doing so, effectively 'shrunk' space and time; speeding up individual subjective perceptions and experience of the pace of life. This phenomenon is referred to as 'time-space compression' (Harvey, 1991; Dodgshon, 1999; Agnew, 2001; Knowles, 2006; Warf, 2011). At the meso scale, accelerating flows of people and goods between rural and urban zones within countries result in peri-urbanization (McGee, 1991), and may ultimately lead to the breakdown of meaningful occupational, cultural, and economic distinctions between the urban and the rural (e.g., Rigg, 2019; Baird, 2022; Gillen et al., 2022).

Peri-urbanization is particularly pronounced in Asia. Qadeer (2000) coined the term 'ruralopolis' to describe a distinct form of development in the Global South characterized by chains of rural districts with small agricultural landholdings centered around towns and cities with population densities comparable to Western metropolitan areas. These zones form extended rural regions covering thousands of square kilometers. Examples include 'most of Bangladesh', West Bengal, Uttar Pradesh, and Kerala in India, Punjab and the Peshwar valley in Pakistan, the Yangtze Delta in China, the Mekong Delta in Vietnam, rural Java, the Nile Delta in Egypt, and parts of Nigeria (Qadeer, 2000, p1583).

This paper draws together the strands outlined above: the idea of diet convergence, time-space compression as a vector for diet convergence, the breakdown of traditional rural/urban binaries arising from time-space compression, and the consequent need for the application of more nuanced categories of analysis when analyzing the spatiality of diets. We use two rounds of a nationally representative household survey to evaluate temporal and spatial patterns of diet transformation in Bangladesh. We conceptualize diet transformation as a 'triangle' comprised of three elements of food consumption behavior - food purchases, consumption diversification into non-staples, and consumption of processed foods - and influenced by four conditioners (time, income, NFE, and space) (Tschirley et al., 2015; Reardon et al., 2015). Echoing Cattaneo et al. (2022) and Graham, (2024), we contend that paying closer attention to nuances in development dynamics across space along the urban–rural continuum, including intra-urban and intra-rural differences, is essential for well-informed food systems research, policies, and interventions.

Our analysis points to spatiotemporal convergence in the diet transformation triangle. Consumption of purchased foods, diet diversification, and processed food consumption are already advanced everywhere in Bangladesh, including in the most peripheral rural areas, and consumption patterns have assumed greater homogeneity over time as the economy has transformed structurally (Zhang et al., 2014). The value shares of food purchases, non-staples, and processed foods in food consumption are high, irrespective of urban or rural location. Controlling for income, rural landless households and urban households have very similar diets. Households in 'peripheral' and 'non-peripheral' rural areas also have similar levels of diet transformation. Food purchases and processed food consumption are conditioned mainly by NFE. Diet diversification is positively associated with income, but not with NFE or land ownership.

We contend that diet convergence is an expression of time-space compression which, by accelerating and extending flows of goods, people, and information, has flattened out many of the former contours of the economic landscape, leading to a profound homogenization of diets across space. These trends are compounded by extremely high rural population densities that have transformed Bangladesh into a ruralopolis. These observations lend support to calls from geographers for revaluation of the significance of commonsense analytical binaries, including rural/urban and landed/landless (Gillen et al., 2022) in relation to diet transformation in Bangladesh, and in broader geographical contexts (OECD, 2020).

2. DATA AND DEFINITIONS

Data used in this analysis are from the Bangladesh Household Income and Expenditure Survey (HIES). The HIES is the main government instrument for monitoring welfare and living conditions in Bangladesh. The survey has been conducted every five years since the 1990s. We utilize cross-sectional survey rounds from 2010 and 2016 (the most recent rounds for which data are publicly available at the time of writing). Between 2010 and 2016, the HIES sampling design changed to provide more accurate annual estimates at sub-national scales, resulting in a sample size increase of almost four times the number surveyed in 2010.

Drawing on the literature review presented in the introduction, we study four possible conditioners of diet transformation: time, income, participation in NFE, and space. Time is captured by the two survey rounds, implemented six years apart. Income is proxied by total value of annual household consumption of food and non-food items per adult equivalent (AE). The average value of daily consumption per AE is measured in constant 2011 international purchasing power parity dollars (PPP$). NFE is calculated as the sum of full-time equivalents (FTEs) worked in non-farm activities per adult (≥15 years of age) in each household, divided by the number of adult household members. For standardization, we define one annual FTE as 252 eight-hour working days, or 2016 hours. The conditioner 'space' is represented by one continuous variable (urban proximity) and three categorical geographical variables with additional sub-categories, as follows: Primary cities, secondary cities, rural households with and without land, and peripheral and non-peripheral rural areas.

Primary cities are 'Statistical Metropolitan Areas' (Dhaka, Chattogram, Rajshahi, and Khulna – Bangladesh's four most populous cities). Secondary cities are non-metropolitan urban areas. Rural households are all those not living in primary or secondary cities. We distinguish two further categories of rural households based on access to agricultural land. Households operating agricultural land are considered landed, regardless of whether they own it, and households not operating agricultural land are considered landless. Per this definition, landless households accounted for 61% of the rural population in 2016. Historically, the landless in Bangladesh have been especially vulnerable to poverty and food insecurity (Hossain and Bayes, 2010; Wood, 1994). On this basis, landless rural households might be assumed to experience lower diet diversity and consume fewer processed foods than their landed rural counterparts. However, evidence from elsewhere in Asia suggests that such distinctions are no longer as pronounced as they once were, partly due to the mediating effect of growing opportunities to participate in NFE (Heady and Masters, 2021; Belton and Filipksi, 2019). Making this distinction allows us to explore this question for Bangladesh. We also subdivide rural areas into 'peripheral' (the most remote areas) and 'non-peripheral' to explore whether there exists a 'continental shelf' effect in diet transformation, whereby inhabitants of the most remote areas have consumption patterns that are markedly different (e.g., with little market integration and correspondingly high levels of subsistence consumption) to those living closer to urban centers, as might be anticipated based on von Thünen inspired analyses, such as Fafchamps and Shilpi (2003).

Travel time to the nearest city is a proxy for urban proximity, calculated for all rural households; it assumes a value of zero for all urban households. Travel times by car to the nearest city with a population greater than 100,000 were estimated for all rural households, using Python Client for Google Map Services. Household locations were identified by mouza (the lowest-level administrative sub-division). Cities with populations above 100,000 were identified using census data from 2011[1].

We present results for consumption of purchased food, diet diversification, and consumption of processed foods. Purchased food consumption is defined here as the share of purchased food, including food purchased for home consumption and food eaten away from home, in the total value of food con-

[1] Where it was not possible to estimate a travel time from the household due to water barrier (1.2% of households) or household being too remote (0.1%), travel times were estimated from points near the household location (such as the other side of the river) with adjustments of additional travel time of 30 minutes for crossing a body of water and 60 minutes for traveling out of remote regions.

sumed. The value of food consumed includes the imputed value of any own-produced foods. We distinguish foods consumed by source, as follows; own production, purchases for home consumption, food away from home (FAFH), and gifts.

Food group consumption shares are important for understanding dietary diversification from an economic perspective, with respect to Bennett's Law. Diet diversification is here proxied by the value share of non-grains in food consumption. Diet diversification is distinct from the concept of diet diversity as deployed by nutritionists (e.g. Ruel, 2003). We assess the diversification of diets into non-staples with reference to the consumption shares of 14 food groups in total food consumption, of which three are staple grains and all others are non-staples. Consumption shares are not to be conflated with actual dietary intake, as prices vary widely among different food groups. Hence, for example, rice is consumed in much larger quantities than animal-source foods, despite each accounting for a similar share of consumption in 2016. We also compute a composite diet diversity index value using the following equation, where ω equals the consumption value shares of the following food aggregates: cereals, tubers, vegetables, fruit, meat, eggs, fish, pulses, milk, fats & oils, sugary foods, and other.

$$diet\ diversity\ index = 1 - \sum \omega^2$$

Finally, we distinguish between five processed food group aggregates: own-produced, acquired unprocessed, low-processed rice, low-processed non-rice, and high processed. The own-produced food aggregate is comprised of food items obtained from the household's own-production. The acquired unprocessed food aggregate includes all food items that do not originate from the household's production and have not undergone post-harvest processing, e.g., un-milled grains, raw meat, and raw fruit and vegetables. The low-processed rice food aggregate is comprised of purchased milled rice. The low-processed non-rice aggregate includes non-rice items that have undergone simple first-stage processing, e.g., flours, oils, dried spices. The high processed food aggregate includes items that combine multiple ingredients (e.g., biscuits) or individual food items that have undergone complex multi-stage processing (e.g., sugar).

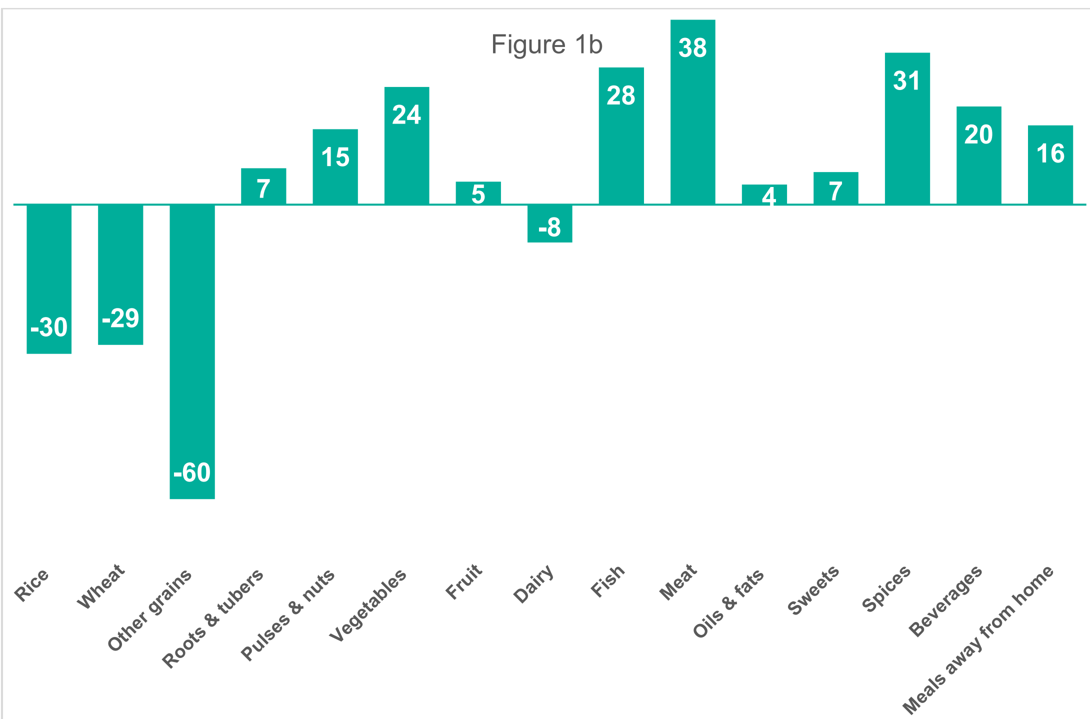
3. DESCRIPTIVE STATISTICS

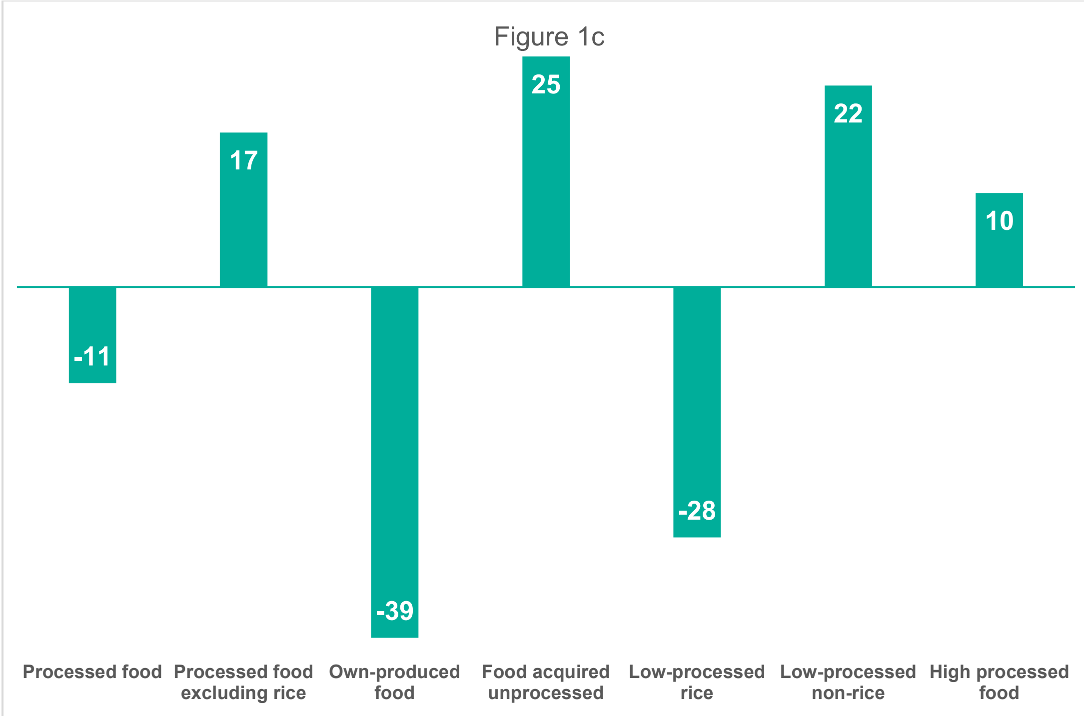
Table 1 presents data on the three elements of the diet transformation triangle: food purchases, diet diversification, and processed food consumption, by spatial category (primary city, secondary city, and rural landless and landed). Figures 1a, 1b, and 1c depict overall national level changes between survey years. The following points stand out.

Table 1: Average shares (%) of food consumption value by geography and landownership.

	2010					2016				
	National	Rural Landed	Rural Landless	Secondary Cities	Primary Cities	National	Rural Landed	Rural Landless	Secondary Cities	Primary Cities
N =	12,240	4,032	3,808	3,280	1,120	45,985	13,072	18,957	11,839	2,117
Estimated Represented Population (1,000's)	148,489	61,044	48,415	15,686	23,344	160,176	47,828	68,756	31,821	11,771
Average daily total expenditure per AE (USD)	$4.09	$3.69	$3.29	$4.86	$6.25	$5.01	$4.42	$4.42	$6.02	$7.90
Total Food Consumption in Value Shares (%)	**56.8**	**57.8**	**59.6**	**52.6**	**51.2**	**49.9**	**50.9**	**52.1**	**47.0**	**41.9**
Food Purchases (%)	**83.1**	**68.2**	**90.6**	**92.1**	**96.2**	**88.2**	**74.8**	**92.2**	**94.2**	**98.2**
Own-produced share	13.7	29.1	4.7	5.9	1.9	8.4	22.0	3.6	3.2	0.4
Purchased (for home consumption) share	80.1	65.5	87.7	87.8	92.8	84.7	71.8	89.0	90.0	92.2
Food away from home share	3.1	2.7	3.0	4.3	3.4	3.6	3.0	3.2	4.1	6.0
Gift / In-Kind share	3.2	2.6	4.7	1.9	1.9	3.4	3.2	4.2	2.6	1.4
Diet Diversification into Non-Grains (%)	**59.9**	**56.6**	**57.0**	**64.7**	**71.0**	**72.2**	**69.2**	**71.2**	**75.5**	**79.7**
Rice	37.5	41.0	40.6	32.2	26.0	26.1	29.3	27.1	22.5	18.1
Wheat	2.1	1.9	2.0	2.5	2.4	1.5	1.4	1.5	1.7	2.1
Other Grain	0.5	0.5	0.5	0.5	0.7	0.2	0.2	0.2	0.2	0.2
Roots & Tubers	2.7	2.6	3.0	2.6	2.1	2.9	3.0	3.1	2.5	2.2
Pulses & Nuts	2.6	2.3	2.5	2.9	3.5	3.0	2.8	3.1	3.0	3.0
Vegetables	10.0	9.6	10.6	9.9	9.7	12.4	12.2	12.7	12.2	12.4
Fruit	4.3	4.2	3.7	4.6	5.4	4.5	4.1	4.1	5.0	6.5
Dairy	2.6	2.9	1.9	3.1	2.9	2.4	2.6	2.1	2.6	2.6
Fish	13.6	12.5	13.1	14.4	16.6	17.4	16.2	17.6	18.0	19.0
Meat	8.5	7.8	6.6	9.6	13.4	11.7	11.2	10.6	13.8	13.7
Vegetable Oil & Animal Fats	4.9	4.6	5.1	5.1	5.3	5.1	5.0	5.3	5.0	4.5
Sweets	3.0	3.0	2.7	3.5	3.4	3.2	3.0	3.1	3.3	3.9
Spices	4.2	4.0	4.3	4.2	4.3	5.5	5.5	5.7	5.3	4.7
Beverages	0.5	0.3	0.4	0.7	1.0	0.6	0.5	0.6	0.7	1.1
Meals Away from Home	3.1	2.7	3.0	4.3	3.4	3.6	3.0	3.2	4.1	6.0
Average diet diversification index	***0.75***	***0.74***	***0.73***	***0.78***	***0.81***	***0.81***	***0.80***	***0.80***	***0.82***	***0.84***
Processed Food Share (%)	**46.2**	**36.2**	**56.9**	**48.4**	**45.3**	**41.3**	**32.6**	**46.6**	**42.0**	**41.1**
Processed Food Share - excluding rice	***17.6***	***16.0***	***17.7***	***19.9***	***19.8***	***20.6***	***19.2***	***20.7***	***21.2***	***23.1***
Own-produced share	13.7	29.1	4.7	5.9	1.9	8.4	22.0	3.6	3.2	0.4
Acquired Unprocessed share	40.1	34.7	38.4	45.7	52.8	50.3	45.4	49.8	54.8	58.5
Low processed rice share	28.6	20.2	39.2	28.5	25.5	20.7	13.3	25.9	20.8	18.0
Low processed non-rice share	9.9	9.3	10.5	9.9	9.8	12.1	11.9	12.7	11.7	10.6
High processed share	7.7	6.7	7.2	10.0	9.9	8.5	7.3	8.0	9.5	12.6

Figure 1: 2010 to 2016 relative change (%) in value shares of: (a) Consumption expenditure, and food consumption expenditure by source; (b) Exenditure by food group; (c) Expenditure by processed food group.





First, consistent with Engel's Law, there is an inverse correlation between total consumption and the share of food in total consumption. The value of real national average consumption grew almost 25% from 2010 to 2016 (from $4.09 to $5.01/AE/day). The share of food consumption fell seven percentage points percent (from 56.8% to 49.9%). As expected, consumption was highest in primary cities ($7.90/AE/day in 2016), followed by secondary cities ($6.02/AE/day), and then rural areas. More surprisingly, average consumption in 2016 for rural households with and without land were equal ($4.42/AE/day). This finding suggests that the welfare of landed and landless households may be converging, perhaps due to a combination of the very small and still declining size of average agricultural holdings, of the agricultural risks faced by small farm households (Mishra, 2017), and of the deepening participation of rural households in NFE (Sen et al., 2021).

Second, the popular image of Bangladesh is of a country of strongly subsistence-oriented farmers (e.g., Alauddin and Tisdell, 1986; Miah et al., 2020) where farm households may be net buyers or net sellers of food, depending on their productive capacity (Talukder and Chile, 2014; Bernzen et al., 2022). In contrast, we find that all categories of households purchased most of their food (in value terms). The purchase share in rural consumption rose from 83.1% nationally in 2010 to 88.2% in 2016. Food purchases by rural landless households were on par with those of urban households, with value shares over 90% in both years despite the lower incomes of the rural landless. Importantly, the value share of food purchased by landed rural households was also high, rising from 68.2% in 2010 to 74.8% in 2016, indicating a high dependence on markets for access to food among farm households. The share of food consumed away from home in total food consumption was low but increased over time, with national averages of 3.1% in 2010 and 3.6% in 2016, and, surprisingly, was only slightly higher in urban than rural areas. These findings may be explained collectively by very small average agricultural landholdings (median 0.27 ha) that are insufficient to supply the subsistence needs of most households (Niroula and Thapa, 2005), a high degree of agricultural commercialization including for staple crops (Reardon et al., 2014), and the proliferation of rural retail markets and food vendors (de Brauw et al., 2019).

Third, diet diversification, proxied by the value share of non-grains in food consumption, has proceeded rapidly. Non-grains made up 59.9% of the value of the national average diet in 2010 and 72.2% in 2016. As expected, the diets of urban consumers are more diverse than those of their rural counterparts. Consumption of rice, wheat, and other grains as a share of value decreased over time, and over space, from rural to urban. Diets have diversified away from non-staples over time. Fish and meat - relatively costly but nutritious unprocessed non-staples - accounted for a combined 22.1% of consumption value in 2010, rising to 29.1% in 2016, with higher shares of consumption in urban than in rural zones. Vegetables are also nutritious non-staples that account for a growing share of average food consumption, up from 10% in 2010 to 12.4% in 2016 nationally, with little variation across spatial zones. The increasing share of higher-value unprocessed non-staples in consumption likely reflects the growth in real incomes over the survey period, given that such products are usually income elastic (Toufique et al., 2018; Mustafa et al., 2022). The diet diversity index value increased over time in all regions. The diet diversity index score is correlated with income (shown in the regressions in Table 4 below), accounting for the similarity of the index value for both rural landed and landless households (both 0.80 in 2016).

Fourth, the value share of unprocessed food obtained from own production was similar across urban zones and for rural households without land, accounting for just 0.4-3.6% of consumption for households in these groups in 2016, suggesting a convergence of rural landless and urban dietary patterns. Conversely, as expected, landed rural households produced more of their own food than all types of other households, but this value share declined from 29.1% in 2010 to 22% in 2016. Processed (i.e., purchased) rice accounts for >90% of rice value for urban and rural households without land, and 47% for landed rural households, reflecting small individual landholdings of the latter, and their high levels of market integration.

Fifth, the value share of processed foods excluding rice increased slightly for all categories of consumer, in line with expectations, from 17.6% in 2010 to 20.6% in 2016 nationally. The value share of rice grain fell from 28.6% to 20.7%, consistent with diet diversification away from staples and increasing consumption of more highly processed foods. The value share of acquired unprocessed foods increased sharply from 40.1% nationally in 2010 to 50.3% in 2016, in line with the increasing importance of food purchases over time. The value shares of low-processed non-rice and high-processed foods both increased about 1 to 2 percent for all consumer groups from 2010 to 2016. Some of these changes are likely linked to a decline in the real price of rice, which fell 14% on average during this period, equating to extra household purchasing power. Improving access to markets and higher incomes favoring diet diversification are also likely to have contributed to these changes.

Table 2: Average shares (%) of food consumption value for non-peripheral and peripheral rural regions.

	2010		2016	
	Non-Peripheral	Peripheral	Non-Peripheral	Peripheral
N =	7,320	520	29,517	2,512
Estimated Represented Population (1,000's)	102,503	6,957	110,096	6,488
Average daily total expenditure per AE (USD)	$3.48	$3.79	$4.45	$3.82
Total Food Consumption in Value Shares (%)	**58.4**	**62.7**	**51.5**	**54.8**
Food Purchases (%)	**78.7**	**82.2**	**85.5**	**84.6**
Own-produced share	17.6	14.6	10.7	11.8
Purchased (for home consumption) share	76.1	76.9	82.4	81.5
Food Away from Home share	2.7	5.2	3.1	3.0
Gift / In-Kind share	3.7	3.2	3.8	3.7
Diet Diversification into Non-Grains (%)	**56.6**	**60.0**	**70.4**	**70.4**
Rice	41.0	37.6	27.9	28.7
Wheat	1.9	1.8	1.5	0.8
Other Grain	0.5	0.7	0.2	0.1
Roots & Tubers	2.8	3.1	3.1	2.9
Pulses & Nuts	2.4	2.8	3.0	3.4
Vegetables	10.1	10.5	12.5	12.8
Fruit	3.9	4.9	4.1	3.7
Dairy	2.4	2.0	2.4	1.2
Fish	12.7	13.2	16.9	20.7
Meat	7.3	6.6	11.0	9.1
Vegetable Oil & Animal Fats	4.9	4.3	5.2	5.2
Sweets	2.9	2.5	3.1	2.5
Spices	4.2	4.4	5.6	5.6
Beverages	0.4	0.4	0.6	0.4
Meals Away from Home	2.7	5.2	3.1	3.0
Average diet diversification index	***0.73***	***0.75***	***0.80***	***0.79***
Processed Food Share (%)	**45.9**	**50.0**	**41.2**	**41.1**
Processed Food Share - excluding rice	***16.7***	***19.1***	***20.2***	***19.5***
Own-produced share	17.6	14.6	10.7	11.8
Acquired Unprocessed share	36.5	35.4	48.2	47.1
Low processed rice share	29.2	30.9	21.0	21.6
Low processed non-rice share	9.8	10.2	12.4	13.0
High processed share	6.8	8.9	7.8	6.4

Table 2 further breaks down the rural zone into 'peripheral' and 'non-peripheral' areas to examine the effect of remoteness on rural consumption patterns, using the same variables presented in Table 1. We define rural peripheral households as those with travel times exceeding three hours to a city with a population of >100,000. These households account for only 6.5% of the sample, underlining how densely populated Bangladesh is, with numerous large urban centers. In both survey years, there were minimal differences in the consumption shares of rural households in peripheral and non-peripheral areas. This finding indicates that even the remotest areas of Bangladesh are experiencing transformation, converging with the high levels of food purchases, diet diversification, and processed food consumption once considered characteristic of urban diets.

4. EMPIRICAL ANALYSIS AND RESULTS

4.1 Econometric modelling

Our analysis follows the Engel Curve model as specified by Banks et al. (1997), where the log of consumption and the squared log of consumption are included as explanatory variables for the dependent variable of food consumption in value share (ω_i). We utilize two rounds of pooled cross-sectional data, not a panel of data, and include a dummy variable for 2016. We estimate the following equation:

$$\omega_i = f(y_i, \varphi_i, \delta_i, \theta_i)$$

Independent variables are presented in Table 3. Income (y_i), nonfarm labor (φ_i), and spatial variables (δ_i) are key variables of interest, and are as follows: total annual food and nonfood consumption per AE (a proxy for income); average full-time equivalents worked in NFE per AE; and spatial variables that include dummy variables for spatial zones and travel time to urban areas with a population >100,000 (only included for rural households). Other household control variables (θ_i) are: gender; age; education of household head (completion of secondary school dummy variable); household dependency ratio; area of agricultural land owned; number of tropical livestock units owned; and dummy variables for ownership of cars, motorcycles, bicycles, phones, TVs, radios, or refrigerators.

Table 3: Average values of independent variables.

	2010					2016				
VARIABLES	National	Rural Landed	Rural Landless	Secondary City	Primary City	National	Rural Landed	Rural Landless	Secondary City	Primary City
Total annual expenditure per AE (2011 PPP$)	1,494	1,348	1,201	1,775	2,282	1,830	1,612	1,614	2,197	2,882
Non-farm FTE per adult (age 15+)	0.49	0.32	0.52	0.58	0.73	0.49	0.32	0.50	0.60	0.77
Urban travel time (minutes)		81	84				84	83		
Adult equivalents in HH	3.9	4.3	3.6	4.0	3.8	3.6	3.9	3.5	3.5	3.5
Dependency ratio (%)	38	37	41	35	32	31	31	33	29	28
HH head is female = 1 (%)	14	8	23	13	10	13	6	18	13	12
Age of the HH head	46	47	45	46	43	44	47	44	43	41
HH head completed secondary school (%)	9	5	5	19	22	8	5	5	15	22
Hectares of land cultivated by HH	0.2	0.5		0.1	0.0	0.2	0.6		0.1	0.0
Tropical Livestock Units	1.2	2.2	0.7	0.6	0.2	0.4	0.8	0.3	0.2	0.0
HH has a car = 1 (%)	1	0	0	1	2	1	1	0	1	0
HH has a motorcycle = 1 (%)	2	2	2	7	2	3	4	2	5	1
HH has a bicycle = 1 (%)	21	35	12	23	7	19	34	15	14	4
HH has mobile phone = 1 (%)	62	60	49	76	86	89	90	86	93	97
HH owns a television = 1 (%)	36	27	23	57	72	41	32	31	62	78
HH owns a radio = 1 (%)	6	8	5	3	3	1	1	1	0	0
HH has a refrigerator = 1 (%)	12	3	5	24	40	20	11	13	36	47
Dhaka (%)	34	25	29	24	69	25	16	19	37	63
Barisal (%)	6	5	9	10		6	5	7	5	
Chittagong (%)	17	15	20	14	19	20	17	22	18	26
Khulna (%)	13	16	10	14	8	11	15	10	9	6
Mymensingh (%)	n/a	n/a	n/a	n/a	n/a	8	9	9	6	
Rajshahi (%)	14	17	14	16	4	13	15	13	11	4
Rangpur (%)	12	16	12	14		11	18	10	8	
Sylhet (%)	5	5	7	8		7	6	10	5	

Real total annual household consumption per AE increased by about 20% nationally from 2010 to 2016. The average number of adult equivalents per household fell slightly over this period, from 3.9 to 3.6 nationally, accounting for part of the increase. Participation in NFE was already high in 2010, with an average 0.49 FTEs per AE nationally, ranging from a low of 0.32 FTEs for rural households with land, the group most likely to work on-farm, to a high of 0.73 FTEs in primary cities. These figures changed little in 2016. Lastly, there was little change in travel times to the nearest city with a population >100,000 over the two survey rounds, averaging 81-84 minutes for landed and landless rural households in both years, indicating a consistently high level of urban-rural connectivity.

We utilize a fractional probit model as our estimation method, which is the appropriate method of estimation given the bounded nature of the dependent variable, the likelihood of reported zero or one-hundred percent consumption shares, and the assumption of asymptotically normal standard errors (Papke and Wooldridge, 1996; 2008). This model estimates the partial correlations at the means of the predictors of a dependent variable that takes values of a closed set of zero to one.

4.2 Regression results

Fractional probit results are presented in Table 4. The dependent variables are food consumption value shares of the diet transformation triangle of food purchases, diversification into non-grains, and processed food consumption. We present partial correlations between four sets of independent variables and the three elements of the diet transformation triangle. The independent variables are as follows: (1) Time, as expressed by correlations with survey year 2016, with the 2010 survey as the base; (2) Income, proxied by consumption per adult equivalent; (3) NFE; (4) Space, represented in two ways - first, as spatial categories (rural landless, rural landed, and secondary cities, with primary cities as the base); second, as urban the proximity of rural households, expressed as travel time to an urban area with a population >100,000.

Table 4: Summary of regression results: year, income, spatial and non-farm labor determinants only.

VARIABLES	Food purchases share	Diet diversification into non-grains share	Diet diversity index	Processed food share	Processed food excluding rice share
Year 2016 vs 2010	0.018***	0.058***	0.038***	-0.046***	0.020***
	(0.002)	(0.001)	(0.001)	(0.002)	(0.001)
Total annual expenditure per AE	0.002	0.137***	0.051***	-0.088***	0.020***
	(0.002)	(0.002)	(0.001)	(0.002)	(0.001)
Non-farm FTEs per adult	0.074***	0.003	0.002	0.055***	0.014***
	(0.003)	(0.002)	(0.001)	(0.002)	(0.001)
Secondary City	-0.048***	-0.011***	-0.013***	-0.001	-0.008***
	(0.008)	(0.003)	(0.002)	(0.003)	(0.002)
Rural Landed	-0.212***	0.007	0.000	-0.072***	0.008
	(0.027)	(0.014)	(0.009)	(0.022)	(0.009)
Rural Landless	-0.051**	0.011	0.001	0.064***	0.016*
	(0.021)	(0.014)	(0.009)	(0.022)	(0.009)
Travel time to urban center (log minutes)	-0.001	-0.006***	-0.003**	-0.003	-0.005***
	(0.002)	(0.002)	(0.001)	(0.003)	(0.001)

VARIABLES	Own-produced share	Purchased for home consumption share	Food away from home share
Year 2016 vs 2010	-0.027***	0.014***	0.003***
	(0.002)	(0.002)	(0.001)
Total annual expenditure per AE	0.005***	-0.010***	0.011***
	(0.002)	(0.003)	(0.001)
Non-farm FTEs per adult	-0.078***	0.052***	0.013***
	(0.003)	(0.003)	(0.001)
Secondary City	0.068***	-0.021***	-0.003*
	(0.009)	(0.006)	(0.001)
Rural Landed	0.228***	-0.196***	0.020***
	(0.027)	(0.027)	(0.007)
Rural Landless	0.061***	-0.035	0.022***
	(0.020)	(0.022)	(0.006)
Travel time to urban center (log minutes)	0.001	0.000	-0.005***
	(0.001)	(0.002)	(0.001)

VARIABLES	Rice share	Wheat share	Other grain share	Roots & tubers share	Pulses & nuts share	Vegeta-bles share	Fruit share
Year 2016 vs 2010	-0.081***	-0.005***	-0.003***	0.003***	0.003***	0.025***	-0.000
	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)
Total annual expenditure per AE	-0.108***	0.001***	0.002***	-0.009***	-0.002***	-0.022***	0.021***
	(0.002)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)
Non-farm FTEs per adult	-0.005***	0.001	0.000*	0.001**	-0.000	-0.000	0.001
	(0.002)	(0.001)	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)
Secondary City	0.016***	0.000	-0.000	-0.003***	-0.003***	0.000	0.003**
	(0.003)	(0.001)	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)
Rural Landed	0.017	-0.019***	0.001	-0.003	-0.003	-0.003	0.024***
	(0.013)	(0.005)	(0.002)	(0.002)	(0.003)	(0.005)	(0.008)
Rural Landless	0.008	-0.019***	0.001	-0.002	-0.002	-0.001	0.021***
	(0.013)	(0.005)	(0.001)	(0.002)	(0.003)	(0.005)	(0.008)
Travel time to urban center (log minutes)	0.004***	0.002***	-0.000**	0.000	-0.000	0.001*	-0.004***
	(0.002)	(0.001)	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)

VARIABLES	Dairy share	Fish share	Meat & eggs share	Vegeta-ble oil & animal fats share	Sugary foods share	Spices share	Bever-ages share	FAFH share
Year 2016 vs 2010	-0.005***	0.026***	0.021***	0.002***	-0.001***	0.012***	0.000	0.003***
	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)
Total annual expenditure per AE	0.016***	0.015***	0.069***	-0.009***	0.017***	-0.003***	0.004***	0.011***
	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)
Non-farm FTEs per adult	-0.005***	-0.003**	-0.004***	-0.001***	0.000	0.001	0.001***	0.013***
	(0.001)	(0.001)	(0.002)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)
Secondary City	0.008***	-0.005***	-0.009***	-0.004***	0.001	0.001	-0.002***	-0.003*
	(0.001)	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)	(0.000)	(0.001)
Rural Landed	-0.019***	-0.000	-0.020	-0.009***	-0.006	0.018***	-0.005***	0.020***
	(0.006)	(0.010)	(0.013)	(0.003)	(0.004)	(0.003)	(0.001)	(0.007)
Rural Landless	-0.022***	0.001	-0.019	-0.008***	-0.006	0.019***	-0.004***	0.022***
	(0.006)	(0.010)	(0.013)	(0.003)	(0.004)	(0.003)	(0.002)	(0.006)
Travel time to urban center (log minutes)	0.004***	0.001	-0.001	0.000	0.000	-0.001***	0.000	-0.005***
	(0.001)	(0.001)	(0.002)	(0.000)	(0.001)	(0.000)	(0.000)	(0.001)

VARIABLES	Dairy share	Fish share	Meat & eggs share	Vegeta-ble oil & animal fats share	Sugary foods share	Spices share	Bever-ages share	FAFH share

VARIABLES	Own-pro-duced share	Acquired un-processed share	Low-pro-cessed rice share	Low-pro-cessed non-rice share	High processed share
Year 2016 vs 2010	-0.027***	0.072***	-0.066***	0.021***	-0.001
	(0.002)	(0.001)	(0.002)	(0.000)	(0.001)
Total annual expenditure per AE	0.005***	0.076***	-0.107***	-0.017***	0.039***
	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)
Non-farm FTEs per adult	-0.078***	0.004**	0.039***	-0.000	0.015***
	(0.003)	(0.002)	(0.002)	(0.001)	(0.001)
Secondary City	0.068***	-0.015***	0.007**	-0.001	-0.007***
	(0.009)	(0.003)	(0.003)	(0.001)	(0.002)
Rural Landed	0.228***	-0.113***	-0.076***	0.018***	-0.010
	(0.027)	(0.015)	(0.020)	(0.005)	(0.008)
Rural Landless	0.061***	-0.079***	0.051**	0.021***	-0.005
	(0.020)	(0.015)	(0.022)	(0.005)	(0.008)
Travel time to urban center (log minutes)	0.001	0.004*	0.002	-0.002***	-0.003**
	(0.001)	(0.002)	(0.003)	(0.001)	(0.001)

Note: The marginal effect of expenditure includes the natural log of expenditure and its quadratic. The marginal effect of travel time to urban center includes the natural log of minutes to an urban center and its quadratic. The dummy variables of Secondary City, Rural Landed, and Rural Landless were interacted with total annual expenditure per adult equivalent. All results presented are the marginal effects at the means of the dependent variables.

4.2.1 Time

The partial correlation coefficients at the mean of the survey year 2016 variable, with the 2010 survey as the base, reveal transformation across all three components of the diet transformation triangle. The association of time with diet transformation is highly significant for most dependent variables, and most signs are consistent with expectations.

Relative to 2010, in 2016 households allocated significantly lower consumption shares to total food, own produced food, and grains. Conversely, relative to 2010, households in 2016 allocated significantly larger consumption shares to food purchases, non-grains, processed foods excluding rice, food eaten away from home, potatoes, pulses and nuts, vegetables, fish, meal, oils, and spices. The diet diversity index value for 2016 is also significantly greater than that for 2010. These results confirm the temporal deepening of food purchases, of diet diversification, and of some forms of processed food consumption.

A small number of results are insignificant or take a sign contrary to expectations. The correlation coefficients for consumption shares allocated to fruit, beverages, and high processed food did not change, and those for diary and sugary foods were negative and highly significant, though with a small coefficient.

4.2.2 Income

We present the partial correlation coefficients of 'total annual consumption per AE' at the mean, used as a proxy for income, and find the following results. First, there is no significant correlation between income and food purchase share. This finding confirms the descriptive results presented above, indicating that household food consumption is highly commercialized, with most food obtained from the market, not own-produced.

Second, the partial correlation coefficients of income on processed food consumption excluding rice, are positive and highly significant. This result is in line with expectations as purchasing processed food can save time, so we would expect processed food purchases to rise in line with opportunity costs of time and thus for the effect of income on processed food consumption to be positive. The correlation of income with processed food consumption changes sign when rice is included in the processed food share, becoming negative and highly significant, consistent with the falling consumption share of staples as incomes rise (Bennett's Law).

Third, also consistent with Bennett's Law, income is positively correlated with diet diversification into non-grains, and with the diet diversity index. Similarly, income has a strong negative correlation with the share of rice and tubers in total food consumption, but a positive correlation with the value shares of wheat and other grains, suggesting that wheat may be substituted for rice as incomes rise, as observed elsewhere (c.f., Timmer, 2014; Kruseman et al., 2020). As expected, income is also associated with strong positive effects on the consumption of most non-grain food groups (fruit, dairy, fish, meat and eggs, and sugary foods). Compared with results above, income is more strongly associated than is time with fruit, dairy, and sugary food consumption. More surprisingly, income is strongly negatively associated with the consumption share of vegetables, perhaps indicating substitution of higher value non-staples such as animal-source foods and fruits for some lower value vegetable varieties as incomes rise.

Fourth, as expected, income is positively and strongly significantly correlated with consumption of FAFH and beverages such as soft drinks, though the coefficients are small. Given that FAFH and beverages are often high in fats, salt, and sugars, these results may point to the onset of a nutrition transition in Bangladesh, where undernutrition co-exists with overnutrition and its associated burden of non-communicable diseases (Kahn and Talukder, 2013).

Fifth, and relatedly, the correlation coefficients of income with highly processed food are positive and highly significant. Conversely, income is negatively associated with consumption of low processed rice and low processed non-rice foods.

In sum, these results strongly support the inference, consistent with Bennett's Law, that rising real incomes have been the main conditioner of diet diversification into non-grain foods and have also contributed to increased consumption of highly-processed foods. However, income has not been a major conditioner of the share of food obtained from purchases, which was already very high by 2010.

4.2.3 Non-farm employment

Non-farm employment is the next element of the diet transformation triangle analyzed here. We find a strong association between non-farm employment and diet transformation. The key results are as follows.

First, non-farm employment is highly significant and positively correlated with the consumption shares of food purchases and food purchases for home consumption, and negatively associated with own-produced food share. (These results are similar to those found in Africa; see Dzanku et al., 2024.) These associations likely reflect time constraints that arise as household members devote more of their labor to non-farm work, the substitution of food purchased outside the home for own-produced food.

Second, there is no significant association between NFE and diet diversification, measured as either the non-grains share of the diet or the diet diversity index. Notably, correlations between NFE and the consumption shares of pulses, vegetables fruit, spices, and sugary foods are all insignificant, and correlations with the consumption shares of dairy, fish, meat and eggs, and oils, are negative and significant but small. There is also a small but significant negative correlation between NFE and rice consumption. The correlation with consumption of other staples is insignificant for wheat and positive and significant but small for other grains and tubers.

The strongest positive correlations between NFE and consumption of any food group are with FAFH, high processed foods, and purchased rice. The correlation of non-farm work with consumption of beverages and acquired unprocessed foods is also positive but small. Together these results reinforce the notion that NFE is associated with increased consumption of convenience foods outside the home while on the go due to the convenience of consuming ready-to-eat cooked meals, snacks, and prepared beverages, corresponding declines in consumption shares of unprocessed foods such as meat, fish, vegetables, as well as rice, cooked at home, and shifts from producing such foods to purchasing them. The association of NFE with a pattern of diet diversification that results in more consumption of highly processed foods and FAFH, which are often less-healthful items, without corresponding increases in consumption of other more nutrient rich food groups gives cause for concern from the standpoint of nutrition and health (c.f. Ignowski et al., 2023).

4.2.4 Space

This subsection addresses the relationships between spatiality and diet transformation. First, we present partial correlation coefficients for the main spatial categories of households in our analysis, households in secondary cities, and the rural landed and rural landless, relative to the base category of primary cities. Second, we present correlations for the proximity of households to urban areas. We find the following with respect to the first set of spatial variables.

First, the coefficient of food purchases is significantly lower in secondary cities and both sets of rural households than in primary cities. Conversely, the own-produced food share is significantly higher for the three former groups. The size of both these coefficients is largest for landed rural households, which is expected given that they have access to land for food production. The size of coefficients for secondary city households and the rural landless are very similar, reflecting their dependence on food markets for provisioning.

Second , the coefficients of both dietary diversification variables are negative and significant for secondary cities relative to primary cities, but insignificant for both types of rural household. Thus, there is an ‘U’ shaped curve of diet diversification, which, holding other factors constant, is higher in primary cities and rural areas than secondary cities. Roots and tubers, pulses and nuts, fish, and meat and eggs all follow this pattern. Coefficients for the consumption shares of fruit and spices are positive, and larger and more significant for rural households than for urban, possibly suggesting that own production, such as in home gardens, plays an important role in accessing these two food groups in rural areas (Ali, 2005).

Conversely, coefficients for dairy, wheat, oils, and beverages are more strongly correlated with urban consumption than rural. There are no significant differences across spatial categories in coefficients for vegetables, sugary foods, and other grains consumption shares. Interestingly, the coefficient for rice in secondary cities is positive relative to primary cities but is insignificant for rural households. This result corresponds with the lower observed dietary diversity in secondary cities relative to other spatial categories. Finally, holding other factors constant, the coefficient of the FAFH share is positive and highly significant for both sets of rural households, relative to urban. This result is unexpected given that urban food environments are often presumed to provide readier access to ready to eat foods than rural ones (Moustier et al., 2023).

Third, the coefficient for acquired low processed rice is positive and significant for households in secondary cities and the rural landless, relative to primary cities, but negative for landed rural households, most of which engage in rice cultivation. Coefficients for low processed non-rice are positive and larger for both sets of rural households than for urban. Coefficients for high processed foods are negative for both sets of rural households and secondary cities, but only significantly so for secondary cities. This is also a somewhat counterintuitive finding.

We now turn to the association between rural-urban travel times and diet transformation for rural households. Longer rural-urban travel times are expected to reduce food purchases, diet diversification, and processed food consumption due to lower levels of market integration and income and higher transaction costs and food prices, with correspondingly greater reliance on subsistence food production and consumption of staples in remoter rural areas (Khandker et al., 2009).

Rural travel times to urban centers averaged around 80 minutes for landed and landless rural households in both survey rounds, indicating they are co-located, and that a high level of rural-urban connectivity existed already in 2010 (Table 3). Bangladesh's rural road network is much denser than that of other countries with a similar income level due to heavy public investments in infrastructure during the 1990s and 2000s (Asadullah et al., 2014). A possible explanation for static transport times between the two survey rounds is that increasing levels of road congestion offset anticipated reductions in travel times due to the proliferation of motorized vehicles. We highlight the following key results.

First, the correlation between travel time to an urban area and the share of food obtained from purchases is negative but not significant. Similarly, correlations between travel time and own-produced food share are also insignificant. These results indicate high levels of dependence on markets for food acquisition throughout rural areas, irrespective of travel time to urban centers. Thus, there appears to be no 'continental-shelf' effect in Bangladesh, where access to food markets drops off sharply beyond a certain threshold of distance from urban centers.

Second, rural-urban travel time is significantly and negatively correlated with both indicators of diet diversification, but the correlation coefficient is small. With respect to food groups, rural-urban travel time is significantly and positively correlated with consumption of two staples rice and wheat, but with small coefficients. Distance from urban centers is insignificantly correlated or weakly correlated with consumption of other grains, roots and tubers, pulses and nuts, vegetables, fish, meat and eggs, oils, sugary foods, spices, and beverages, but positively and significantly correlated with dairy and negatively and significantly with fruit and FAFH, all with quite small coefficients. In sum, these results suggest a remarkable degree of homogeneity in rural diets, irrespective of distance to urban areas.

Finally, the coefficients of correlation of rural-urban travel time with non-rice processed foods, low processed non-rice, and high processed rice are all negative and significant to varying degrees, but coefficients are again small. The coefficient of the acquired unprocessed food share is positive, weakly significant and small.

The patterns of correlation between these spatial variables and diet transformation are less immediately intuitive than those associated with time, income, and NFE. However, they collectively reveal a set of relations between spatiality and diet transformation that upends the conventional view of sharp urban/rural distinctions between dietary patterns, or distinctions between the rural periphery and rural areas closer to towns and cities. Given that agri-food value chains intermediate the flow of food products between rural producers and urban and rural consumers this finding hints at concurrent rapid growth and structural change in agri-food value chains that has accompanied diet transformation (Barrett et al., 2022), as reported in Bangladesh for both non-staples like fish (Hernandez et al., 2018) and staples such as rice and potatoes (Reardon et al., 2014).

5. CONCLUSIONS

This paper visualizes diet transformation in the Global South as a 'triangle' of three elements of food consumption behavior: (1) Increasing consumption of purchased foods resulting from the commodification of subsistence agriculture and deepening reliance on markets for food provisioning; (2) Diet diversification into non-staples; (3) Increasing consumption of often less healthy processed foods, including highly processed foods, low processed foods such as cooking oil, sugar, and flour, and food away from home (FAFH), consistent with the widely observed 'nutrition transition' in the Global South (Popkin et al., 2012).

We hypothesized that these processes are conditioned by four factors: (1) Time, with the later survey year associated with higher food purchases, diet diversification and processed food consumption. (2) Income, with higher incomes associated, per Bennett's Law, with diet diversification. (3) Non-farm employment, which diminishes the centrality of agriculture in livelihood portfolios, increases the opportunity costs of time associated with subsistence food production and processing, and typically increases household spending power. (4) Space, where greater urban proximity and lower rural-urban travel times, and location toward the urban-most end of the rural-urban continuum were assumed to deepen market integration and access to non-farm employment, raise average incomes and increase the availability and accessibility of purchased foods. We applied the diet transformation triangle to the empirical analysis of household food consumption in Bangladesh, using data from nationally representative surveys from 2010 and 2016. Our analysis produced four key findings.

First, diets were already highly transformed and relatively spatially homogenous in Bangladesh, even in 2010. This conclusion is supported by the following descriptive results: (1) Food purchases high for all types of households, averaging 88% of consumption value nationally in 2016 and 75% for rural farm households. (2) Diet diversification into non-staples is also consistently high. Non-staples accounted for 71% of the value share of food consumed nationally in 2016, with little variation by household location.

(3) The share of processed foods in food purchases is high for all categories of households (43% nationally).

Second, econometric analysis reveals the following associations between our four hypothesized conditioners of food system transformation and three elements of the diet diversification triangle: (1) Over time, the shares of food purchases, diet diversification into non-staples, and processed foods including FAFH all increased, with corresponding declines in the value shares of own produced foods and staple grains between survey years. (2) Non-farm labor market participation is the main factor associated with consumption commercialization and consumption of processed foods. (3) Income is the main factor associated with diet diversification[2]. We interpret findings 2 and 3 to imply that non-farm work reduces the time available to participate in subsistence food production and processing, increases cash incomes with which to purchase foods, and increases opportunity costs of time and length of time spent outside the home, thereby encouraging consumption of processed foods for convenience. For Bangladesh, low-processed foods such as milled rice, flour, cooking oil, and spices are the bulk of processed food purchases. Highly processed foods, including FAFH, account for <10% of the value share of consumption. Income is linked to diet diversification because income elasticities are typically lowest for staples such as rice and highest for luxury non-staples such as meats and fruit (Barrett et al., 2022; Colen et al., 2018). (4) Diets have converged spatially. Controlling for income, households in urban areas and rural landless households have very similar diets. The diets of rural landed and landless households are also extremely similar, except for the consumption shares of purchased and self-produced rice. The extent of diet transformation is also very similar among rural households in ‘peripheral’ and ‘non-peripheral’ zones.

We interpret the spatial convergence of diets in Bangladesh as reflecting high levels of interconnectivity due to a dense rural road network (Khandker et al., 2009), high levels of participation in off-farm employment (Sen et al., 2021), and high levels of landlessness and the ‘sub-subsistence’ size of landholdings operated by most farm households (Niroula and Thapa, 2005). These inferences correspond well with the concept of Bangladesh as a ruralopolis (Qadeer, 2000). This specific spatial configuration of development under conditions of particularly high population density is closely linked with the high level of time-space compression and diet transformation observed. The convergence of diets over space also reflects the transformation of agri-food value chains, characterized by geographical lengthening, and

[2] Although diets have diversified away from staples in terms of consumption share, the quantities of nutrient-rich foods consumed in Bangladesh remain insufficient to support nutritionally adequate diets for much of the population, resulting in the persistence of high levels of undernutrition (Arsenault et al., 2013). Given their large share of the food budget and critical importance for human nutrition non-staples require higher prioritization in agricultural and food policy, in line with calls for transitioning toward nutrition-sensitive agriculture and food systems (Pingali and Sunder, 2017).

the proliferation of commercial producers, and SMEs involved in the processing, trade, retail, and transport of goods, contributing to the deepening of all three dimensions of the diet transformation triangle (Barrett et al., 2022; Reardon et al., 2015). All these processes are corollaries of the meta-trend of time-space compression, which has accelerated the circulation of goods, people, and information at global, regional, and sub-national levels, with resultant shifts in consumption practices.

Fourth, expressed slightly differently, most of Bangladesh is now essentially peri-urban in terms of population density, connectivity, mobility, market integration, and occupational composition. These factors are dissolving traditional occupational, cultural, and economic distinctions between rural and urban zones, resulting in the spatial convergence of diets, though income remains the primary determinant of dietary diversity. Similar transformations are likely to be occurring in other parts in the Global South at comparable levels of economic development, though perhaps to a less dramatic extent than in Bangladesh in areas with lower population and infrastructure densities, higher levels of landownership, and larger average landholdings. In laying bare the depth of this convergence in Bangladesh, our findings raise the question, for future research, of whether commonsense categories such as rural/urban and landed/landless remain the most relevant analytics for food systems and wider geographical transformation in such settings (c.f., Gillen et al., 2022). Our approach also speaks to the potential for bringing concepts from human geography and economic geography into closer dialogue in the analysis of food systems, and development more broadly.

6. POLICY IMPLICATIONS

Four key implications for policy stand out from the discussion above. First, many of policy makers' and development practitioners' "priors" about rural Bangladesh by may no longer hold. With the partial exception of the staple rice, farmers buy most of their food, sell most of their produce, and are thus deeply integrated into markets. Landed and landless rural households are increasingly similar by virtue of fragmented and shrinking landholdings and high participation of rural non-farm employment. Few truly peripheral rural areas remain. The fundamental characteristics of rural households, including their diets, are increasingly similar to urban ones. These patterns suggest the need for convergence in the types of development and nutrition interventions fielded in rural and urban areas, which have historically tended to be quite distinct. The emerging realities apparent in this analysis also run counter to well-worn assumptions that underpin many development interventions in Bangladesh, such as the tendency to consider rural people "farmers", and the need to "link farmers to markets".

Second, time-space compression has occurred in the context of investments in infrastructure (rural roads, bridges, and electrification), a myriad of forms of accessible transport, and mobile communications that have accelerated the circulation of goods, people, and information, in the context of extremely high population density. These conditions have enabled a ‘quiet revolution’ in agrifood value chains, by creating conditions for farm commercialization to occur; pulled by downstream demand and enabled by the proliferation of SMEs such as wholesalers and third-party logistics providers and generating substantial non-farm employment (Barrett et al., 2022). Policymakers should understand these actors as critical agents in economic development and diet transformation.

Third, processed foods are now integral to diets, but highly processed food and FAFH together account for only 10% of the average food consumption, suggesting that Bangladesh’s nutrition transition is in its early stages. This juncture presents an opportunity to plan for and seek to preemptively address though policy measures a probable deepening of the triple burden of malnutrition associated with growing consumption of highly processed foods (c.f. Popkin et al., 2012).

Fourth, future policy-oriented data collection and research on diets, food systems, and livelihoods should seek to integrate more nuanced categories of spatial analysis beyond the standard rural/urban binary, by making use of existing indicators as attempted here, or by designing and deploying purpose made metrics, as recently advocated by Cattaneo et al. (2022) and Graham (2024).

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