Drivers of Nutrition Transition in Thailand: An Analysis using Night-time Lights

Chutarat Noosuwan[1], Christopher Gan[2], Baiding Hu[3]

Abstract

This study examines factors influencing changes in dietary patterns (nutrition transition) in Thailand. We applied the Quadratic Almost Ideal Demand System (QUAIDS) model to food expenditure data. We also include urbanisation as a shifter of food preferences, and use night-time light intensity to proxy for urbanisation. The results suggest that nutrition transition has occurred in Thailand, with food preferences moving towards animal-source foods, sugary products, and ready-cooked food. Nutrition transition is specifically linked to dynamic changes in household demographics and geographic characteristics including household size, household composition, and women's labour force participation. Interestingly, women participating in the labour force increases the frequency of home-cooked meals. Moreover, urbanisation is reshaping the shift in food preferences. As a shift variable, urbanisation stimulates demand for ready-cooked food. Our results give practical findings that can be used to implement public health policy in Thailand.

Keywords: *nutrition transition; night-time lights; food demand; Thailand; Quadratic Almost Ideal Demand System.*

JEL classifications: D12; O12; Q18.

[1] PhD Candidate, Lincoln University, chutarat.noosuwan@lincolnuni.ac.nz
[2] Professor, Lincoln University, christopher.gan@lincoln.ac.nz
[3] Associate Professor, Lincoln University, baiding.hu@lincoln.ac.nz

1. Introduction

Dietary patterns are shifting in countries worldwide. As described by Popkin (1993), food consumption patterns have shifted towards processed food, which is high in fat and sugar. In recent years, this shift in dietary pattern has been increasing in developing countries, especially in Asia, Latin America, Northern Africa, and the Middle East, which are all growing and developing economically (Popkin, 2001). Increases in income and urbanisation in these countries have contributed significantly to changes in dietary patterns and physical activity (Popkin, 1993). These changes drive the increasing prevalence of excess weight and obesity in lower-income countries, leading to chronic diseases related to poor life choices (Popkin, 1993). Chronic disease among the poor can lead to inequities in healthcare, as they may struggle to access health services. Therefore, understanding the factors influencing nutrition transition is important so that strategic policies can address changes in dietary patterns.

This study identifies the drivers influencing dietary patterns in the context of consumer behaviour. In economic analysis, nutrition transition is evident in changing food preferences (Dong & Fuller, 2010; Law et al., 2019; Moro & Sckokai, 2000). However, food preferences are hard to identify and measure (Law et al., 2019). According to Law et al. (2019), possible approaches to capture changing food preferences include using a time variable or time-varying demographics in the empirical analysis, or considering a structural change in parameters. Conversely, we use an alternative method to investigate changes in food tastes and preferences — we add a demand shifter.

In the literature, adding a demand shifter is another way to observe changes in food preferences. Food tastes and preferences shift gradually with time, influenced by many factors. To acknowledge this shift, previous studies have included a demand shifter. For example, Brester and Schroeder (1995) use advertising spending as a continuous shifter of meat demand.

This approach seems to be plausible for identifying changes in food preferences (Dong & Fuller, 2010). Therefore, using a demand shifter is chosen in this study.

We incorporate urbanisation as a demand shifter because, as a dynamic process, urbanisation seems to be a major factor influencing the transition in diet in developing countries (Kosulwat, 2002; Madanat et al., 2008; Subedi et al., 2017). In this study, the degree of urbanisation is proxied by night-time light intensity derived from satellite imagery from two sources: the Defense Meteorological Satellite Program's Operational Linescan System (DMSP-OLS), and the Soumi National Polar-orbiting Partnership satellite's Visible Infrared Imaging Radiometer Suite (NPP-VIIRS). Since the value of night-time light intensity is continuous, it allows us to capture gradual shifts in food preferences (Dong & Fuller, 2010). To estimate food demand, we use the Quadratic Almost Ideal Demand System (QUAIDS). Developed by Banks et al. (1997), the QUAIDS model is a more comprehensive approach, providing us with new insights into the empirical investigation of the determinants of nutrition transition.

We choose Thailand as a case study. An upper-middle income country, Thailand's economic structure has changed significantly from agriculture to non-agriculture as urbanisation has increased over the last 60 years. Urbanisation in Thailand has increased rapidly: according to The United Nations (2018), 8.3% of the Thai population lived in urban agglomerations of more than 1 million in 1960. This had increased to 20.4% in 2019. More importantly, we include ready-cooked food in the analysis. Ready-cooked food is a key feature of nutrition transition and has become more readily available in Thailand. Previous studies have not included this category as data were not readily available, so our findings may differ from the literature.

The paper is organised as follows. Section 2 reviews the literature on the determinants of food demand. Section 3 presents the theoretical framework, the QUAIDS model, and the endogeneity test. Section 4 describes data used in estimating the food demand system. Section

5 presents the model estimates and discusses the drivers of nutrition transition in Thailand. Section 6 concludes the paper.

2. Literature review

To investigate household consumption behaviour, previous studies in the classical Almost Ideal Demand System (AIDS) model include household characteristics such as household size and household composition (Deaton & Muellbauer, 1980). Recently, other characteristics have been included in the demand system such as living area characteristics. In the literature, the definitions of these factors differ, as well as the varying relationship between the dependent variable and the control variables in developing countries.

Apart from price and expenditure, demographic characteristics have been identified in the food demand system. Demographic characteristics include family size, the composition of children and seniors in the family, household head's specific characteristics (i.e., education, age, marital status, and employment), refrigerator ownership, vehicles, dwelling unit, and female labour force participation (Akbay et al., 2007; Akinbode, 2015; Lippe, Isvilanonda, et al., 2010; Zheng & Henneberry, 2009). Previous studies have shown that household characteristics play a role in explaining households' food demand. Although households have similar income and price levels, their patterns of food consumption may differ because of different demographic characteristics (Akbay et al., 2007; Faharuddin et al., 2017).

Family size can be positively or negatively associated with food demand depending on food types. Demand for cheap, low-quality food (i.e., cereal, cassava flour, and tubers) increases with household size, while demand for fruit, vegetables, animal products, and beans decreases (Akbay et al., 2007; Akinbode, 2015; Elijah Obayelu et al., 2009; Lippe, Seebens, et al., 2010). The ratio of children in the family has a positive effect on demand for macronutrients such as cereal, dairy products, and meat products, which are necessities for young people (Akbay et al., 2007; Elijah Obayelu et al., 2009; Gould & Villarreal, 2006; Zheng & Henneberry, 2009).

Households with a higher ratio of old people tend to spend less on fruit but more on rice (Gould & Villarreal, 2006; Zheng & Henneberry, 2009).

Household head characteristics also significantly influence food consumption patterns. The more educated the household head, the more the household spend on meat products, fats, fruit, and vegetables (Akbay et al., 2007; Elijah Obayelu et al., 2009; Lippe, Seebens, et al., 2010; Zheng & Henneberry, 2009). Households with an older head spend less on beef, poultry, and fruit because these are not the main food when older heads grow up (Gould & Villarreal, 2006). Households with a head who participates in agricultural employment, with higher levels of physical activity, seem to spend more on root crops (Elijah Obayelu et al., 2009). The labour force participation of women is negatively associated with demand for meat (Akbay et al., 2007; Lippe, Isvilanonda, et al., 2010), but has a positive effect on preserved fruit and vegetables (Lippe, Isvilanonda, et al., 2010). This is consistent with the concept of nutrition transition that changes in women's family roles influence changes in the diet structure as women spend less time cooking (Popkin, 1993).

In developing countries, owning a refrigerator, a vehicle, and a home can help explain food demand. Owning a refrigerator is related to the type of food purchased and purchase frequency. Gould and Villarreal (2006) suggested that households that own a refrigerator spend more on perishable food such as meat products, fruit, and dairy products, but less on non-perishable food such as rice, fats, and oils.

Analysis of food demand can include geographic factors such as city population density, city size, province and region. In the literature, city population density and city size refer to the degree of urbanisation, resulting in significant differences in food consumption patterns (Akbay et al., 2007). In particular, urbanisation causes urban-rural differences in dietary patterns in low-income countries (Popkin, 2002). For example, urban households are more likely to consume bread, dairy products, sugary products and non-alcoholic drinks than rural

households (Akbay et al., 2007). Moreover, migration seems to be a driver of urbanisation in developing countries, resulting in changes in diet towards urban cuisine among migrants (Popkin, 1993).

Regional characteristics (i.e., province and region) also determine households' food choices. Differences in food preferences across locations are linked to religion, caste, and social groups (Atkin, 2016). Many studies suggest the importance of regional factors in food demand patterns in developing countries (Akbay et al., 2007; Gould & Villarreal, 2006; Zheng & Henneberry, 2009). In China, due to regional differences in economic development, households in more-developed areas consume more oils and fats than in less-developed areas (Zheng & Henneberry, 2009).

3. Methodology

3.1. Three-stage budgeting of food demand system

To identify the determinants of nutrition transition, this study assumes weak separability and a three-stage budgeting decision (Deaton & Muellbauer, 2009). This allows us to estimate the food demand system independently at each stage (Ecker & Qaim, 2011). The first stage explains how households spend on food and non-food goods. The second stage captures household spending on two groups of food: food at home (FAH) and food away from home (FAFH). In the third stage, this study considers 10 food subgroups: (1) grain and cereal products, (2) meat and fish, (3) milk, dairy, and eggs, (4) oils and fats, (5) fruit and nuts, (6) vegetables, (7) sugar and sweets, (8) spices and condiments, (9) non-alcohol beverage consumed at home, and (10) ready-cooked food consumed at home[4]. As this study investigates

[4]In this study, ready-cooked food indicates rice and curry/packed rice, fried rice, papaya salad, Thai salad, noodles, hamburger/sandwich, semi-prepared noodles, canned food, frozen food, and snacks and others.

changes in food preferences associated with nutrition transition, we focus primarily on the third stage budgeting using the QUAIDS model.

3.2. Quadratic Almost Ideal Demand System (QUAIDS)

To examine the factors determining nutrition transition, we use the QUAIDS model. Following Banks et al. (1997), the QUAIDS model based on the Price-Independent Generalised Logarithmic (PIGLOG) preference is given as:

$$w_i = \alpha_i + \sum_{j=1}^{j} \gamma_{ij} \ln p_j + \beta_i \ln \left[\frac{m}{a(\mathbf{p})}\right] + \frac{\lambda_i}{b(\mathbf{p})} \left\{\ln \left[\frac{m}{a(\mathbf{p})}\right]\right\}^2 \quad (1)$$

where w_i is the budget share of food subgroup i expressed as $w_i = \frac{p_i q_i}{m}$, p_i is the price of food subgroup i for $i = 1, \ldots, n$, q_i is the quantity of food subgroup i, m is monthly household expenditure on FAH per capita, and $a(\mathbf{p})$, $b(\mathbf{p})$, and $\lambda(\mathbf{p})$ are the functions of prices $(\mathbf{p})$ expressed as:

$$\ln a(\mathbf{p}) = \alpha_0 + \sum_{i=1}^{n} \alpha_i \ln p_i + \frac{1}{2} \sum_{i=1}^{n} \sum_{j=1}^{n} \gamma_{ij} \ln p_i \ln p_j \quad (2)$$

$$b(\mathbf{p}) = \prod_{i=1}^{n} p_i^{\beta_i} \quad (3)$$

$$\lambda(\mathbf{p}) = \sum_{i=1}^{n} \lambda_i \ln p_i \quad (4)$$

The restrictions on adding-up, homogeneity, and Slutsky symmetry are imposed in equation (1) as follows:

Adding up

$$\sum_i \alpha_i = 1, \quad \sum_i \gamma_{ij} = 0, \quad \sum_i \beta_i = 0, \quad \sum_i \lambda_i = 0 \quad (5)$$

Homogeneity

$$\sum_j \gamma_{ij} = 0 \quad (6)$$

Slutsky symmetry

$$\gamma_{ij} = \gamma_{ji}, \ \ \forall i \neq j \tag{7}$$

To illustrate the effects of related factors on the variation in food preferences, we include a vector of control variables (Z_k) in equation (1): (1) household characteristics (i.e., family size, education, age, marital status, and employment), (2) living area characteristics (i.e., province, and region), (3) urbanisation proxied by the night-time light intensity, and (4) time as follows:

$$w_i = \alpha_i + \sum_{j=1}^{n} \gamma_{ij} \ln p_j + \beta_i \ln \left[\frac{m}{a(\mathbf{p})}\right] + \frac{\lambda_i}{b(\mathbf{p})} \left\{\ln \left[\frac{m}{a(\mathbf{p})}\right]\right\}^2 + \sum_k z_{ik} Z_k \tag{8}$$

The adding-up restriction can be imposed as $\sum_i z_i = 0$.

The conditional expenditure elasticity for food subgroup i is calculated as follows:

$$E_i = \frac{\mu_i}{w_i} + 1 \tag{9}$$

where $\mu_i = \frac{\partial w_i}{\partial \ln m} = \beta_i + \frac{2\lambda_i}{b(\mathbf{p})} \left\{\ln \left[\frac{m}{a(\mathbf{p})}\right]\right\}$

3.3. Endogeneity test

Due to measurement error in food expenditure, the endogeneity issue can occur in estimating food demand (Abdulai & Aubert, 2004; Banks et al., 1997). To test this, we use the Durbin-Wu-Hausman (DWH) test as follows:

$$\text{DWH} = (B_{2SLS} - B_{OLS})' \left(var(B_{2SLS}) - var(B_{OLS})\right)^{-1} (B_{2SLS} - B_{OLS}) \tag{10}$$

where B_{2SLS} and B_{OLS} are parameters and $var(B_{2SLS})$ and $var(B_{OLS})$ are covariance metrics of the 2SLS and OLS estimators, respectively. The distribution of DWH is the chi-square $\left(\lambda^2(g)\right)$ where g is the number of parameters of the endogenous model. We also check the validity of instrumental variables by using the Shea's adjusted partial R^2 in this study.

4. Data

4.1. Food expenditure data

Food expenditure data are obtained from the Thailand Socio-Economic Survey (SES) in 2007 and 2019. These data are compiled by the National Statistical Office (NSO) of Thailand, using two-stage stratified sampling in 76 provinces of Thailand. Two groups of data include household demographics, expenditure and income data. The data are expressed at the household level, consisting of approximately 52,000 households over the year. In this study, we exclude 11% to 22% of observations because of missing values or outliers. Table 1 shows the descriptive statistics of SES data for the years 2007 and 2019.

4.2. Market price data

We use retail price data in the QUAIDS model because food price and quantity data are not available in the SES data. Retail prices are published monthly by the Bureau of Trade and Economic Indices, Ministry of Commerce. Contrary to unit value, retail prices may not suffer from measurement errors since they are market prices. However, to tackle some problems with using market prices as an indicator of prices that households face in their markets, we make two adjustments as follows. First, in this study, retail prices are obtained from 76 provinces in both urban and rural areas. Since prices are likely to be similar across a province, retail prices at the province level may reflect regional effects in the demand system (Hoang, 2009). Second, following Burger et al. (2017), we treat time as an independent variable to reflect seasonal variation in food prices.

The price of food subgroup i in province c (P_{ic}), following Brubakk (1997), is calculated as follows:

$$P_{ic} = \frac{1}{n_{ic}} \sum \frac{p_{ric}}{\bar{p}_{ri}} \tag{11}$$

where p_{ric} and $\bar{p}_{ri}$ are the market prices of food item r in food subgroup i in province c and the arithmetic mean of prices of food item r in food subgroup i, respectively; and n_{ic} is the number of food items in food subgroup i in province c. If the market price is unavailable, the mean price of each region observed in the same month is used. On average, this affects about 1% of the retail price data during the study period. Table 2 shows the average retail prices of ten food subgroups, obtained from 150 food items in 2007 and 2019.

Table 1

Definition of variables used in the QUAIDS model and their descriptive statistics

Variables	Descriptions	2007	2019
Total observations	-	33784	40426
Missing data and outliers	-	21.53	11.32
Household characteristics			
Income, Baht/month	Monthly household income per capita	7977.11 (7067.64)	10113.75 (8257.23)
Family size	Number of household members	3.09 (1.56)	2.73 (1.50)
Children	Ratio of children under 15 years to total household members	0.16 (0.20)	0.11 (0.18)
Seniors	Ratio of older people above 60 years to total household members	0.16 (0.29)	0.28 (0.37)
Education	Year of education of household head	9.91 (4.65)	9.82 (4.50)
Age	Age of household head	49.41 (14.00)	54.59 (14.28)
Female labour	Ratio of women participated in the labour force to total household members	0.46 (0.26)	0.30 (0.29)
Marital status	The marital status of household head		
	- Married	70.52%	63.77%
	- Otherwise	29.48%	36.23%
Employment	The employment sector of household head		
	- Agriculture	16.31%	23.46%
	- Non-agriculture	83.69%	76.54%
Refrigerator	The presence of a refrigerator		
	- Refrigerator	90.24%	92.57%
	- Otherwise	9.76%	7.43%
Vehicles	The presence of vehicles		
	- Vehicles	3.05%	4.93%
	- Otherwise	96.95%	95.07%
Dwelling unit	Ownership of dwelling unit		
	- Dwelling unit	66.87%	74.53%
	- Otherwise	33.13%	25.47%

Variables	Descriptions	2007	2019
Living area characteristics (The Central region is the base category of dummy variables for region)			
Bangkok	Household living in Bangkok	6.78%	6.04%
North	Household living in the North region	22.90%	22.76%
North-east	Household living in the North-east region	23.88%	26.03%
East	Household living in the East region	8.28%	8.03%
South	Household living in the South region	14.65%	15.85%
Time (The 4th quarter of the year is the base category of the dummy variable for time)			
1st quarter	The 1st quarter of the year	25.12%	24.81%
2nd quarter	The 2nd quarter of the year	24.75%	25.12%
3rd quarter	The 3rd quarter of the year	24.75%	25.12%

Note: Standard deviations are shown in parentheses.
Source: Authors' calculations based on SES 2007 and 2019

Table 2

Average retail prices of food subgroups in Thailand

(Unit: Thai Baht per kilogram/litre/meal served)

Food subgroups	2007	2019
Grain and cereal products	43.16	58.89
	(18.79)	(24.06)
Meat and fish	113.67	170.82
	(9.04)	(14.84)
Milk, dairy, and eggs	67.71	72.12
	(10.48)	(8.12)
Oils and fats	30.65	39.16
	(2.91)	(3.17)
Fruit and nuts	26.42	49.37
	(4.30)	(7.90)
Vegetables	38.83	60.15
	(5.19)	(6.47)
Sugar and sweets	61.57	72.78
	(30.61)	(38.62)
Spices and condiments	53.87	61.19
	(4.17)	(7.00)
Non-alcohol beverages	91.27	100.09
	(21.50)	(35.05)
Ready-cooked food	47.00	67.14
	(13.66)	(9.93)

Source: Authors' calculations based on retail prices data published by Ministry of Commerce (2020)

4.3. Night-time light data

This study includes urbanisation as one of the major factors influencing nutrition transition in estimating food demand. The degree of urbanisation is measured by the satellite-derived night-time light intensity, gathered from two main sources: the Defense Meteorological Satellite Program's Operational Linescan System (DMSP-OLS) and the Soumi National Polar-orbiting Partnership satellite's Visible Infrared Imaging Radiometer Suite (NPP-VIIRS). DMSP-OLS records light images covering -180° to 180° longitude and -65° to 75° latitude where the spatial resolution is 2.7km (National Oceanic and Atmospheric Administration, 2019). The average light intensity is represented by the digital number (DN) values between 0 (unlit area) and 63.

DMSP-OLS was launched between 1992 and 2013 (National Oceanic and Atmospheric Administration, 2019). The second night-time light is from NPP-VIIRS, which was launched from 2011. The average monthly and annual night-time light data from NPP-VIIRS are released to the public from 2012 on. NPP-VIIRS offers better night-time light data than DMSP-OLS since it has a higher spatial resolution of approximately 500m and provides on-board calibrated night-time light images (Zhu et al., 2017).

Night-time light data used in this study are annual average DMSP-OLS data of 2007, while for the NPP-VIIRS data of 2019, we use the annual average of monthly data because annual data are not available (National Oceanic and Atmospheric Administration, 2020). In addition, we remove the light detections of monthly NPP-VIIRS data, using the threshold method suggested by Ma and Li (2018), and erase gas flares, suggested by Lowe (2014). Due to a lack of continuity in the DMSP-OLS data with two different satellites, namely F15, and F16, data intercalibration is employed in this study using the invariant region method (Zhu et al., 2017). Moreover, since DMSP-OLS and NPP-VIIRS are different data sources, we intercalibrate these data, suggested by Zhu et al. (2017). Figure 1 shows the urbanisation in Thailand, classified by

the local administration. In 2007 and 2019, the average night-time light intensities for Thailand are 2.6 and 2.9, respectively, which increased by 11.5% between these two years.

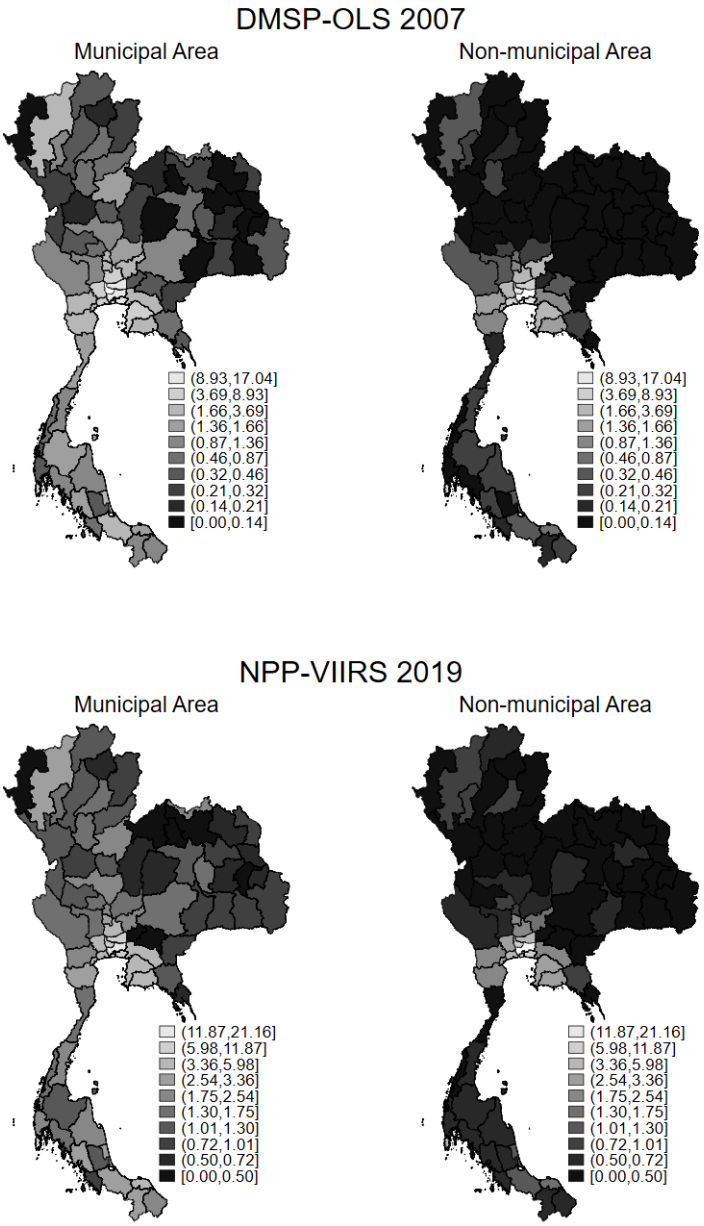

Figure 1. Calibrated average night-time light data of Thailand, 2007 and 2019.

Source: Author's calculation based on DMSP-OLS 2007 and NPP-VIIRS 2019

5. Factors behind nutrition transition

Based on equation (10), the DWH test suggests the endogeneity problem exists (see Table 3). Thus, we estimate the QUAIDS model using the iterated linear least-squares (ILLS) technique[5] to address the endogeneity issue. Using Shea's adjusted partial R^2, income and the total number of assets are proper instruments for expenditure (Beznoska, 2019).

Table 3

Tests for Endogeneity and the Validity of Instrumental Variables in Food Demand

Test	2007	2019
λ^2 value of the DWH Test under the null hypothesis of exogeneity	2157.23***	2418.37***
Shea's adjusted partial R^2 value		
ln(food at home expenditure)	0.01	0.01
square of *ln*(food at home expenditure)	0.01	0.01

Note: Instrument variables are the logarithm of income, the square of logarithm of income, and the total number of households' assets. *** denotes $p \leq 0.01$.

Source: Authors' calculations based on SES 2007 and 2019

To explore the determinants affecting nutrition transition, this study estimates the food demand system using the QUAIDS model of ten food subgroups. We discuss only the five subgroups that are related to the nutrition transition framework: (1) grain and cereal products, (2) meat and fish, (3) fruit and nuts, (4) sugar and sweets, and (5) ready-cooked food. According to Engel and Bennett's laws, we include grain and cereal products and meat and fish. We examine the estimates of fruit and nuts to highlight nutritional inequality since the poor seem to have less access to healthy food than the rich (Aekplakorn et al., 2014). Sugary products and ready-cooked food are the key transitional food under nutrition transition and their

[5]The Stata routine "aidsills" is used in this study, introduced by Lecocq and Robin (2015).

consumption is rising in Thailand (Boonchoo et al., 2017; Kelly et al., 2010; Kosulwat, 2002; Tsuchiya et al., 2017; Winichagoon, 2013). Figure 3 shows the QUAIDS estimates for five food subgroups based on equation (8). Overall, the figure shows that over 80% of the estimated parameters are statistically significant. We provide the parameter estimates from the QUAIDS model and explore the important implications of these results next.

5.1. Household size

Figure 3 shows that larger households (*Family size*) spend less on grain and cereal products, but more on meat and fish, and fruit and nuts, statistically significant at the 0.01 level. These results contradict previous studies that larger households tend to spend more on cheaper food such as grain and cereal products (Akbay et al., 2007; Akinbode, 2015; Elijah Obayelu et al., 2009; Lippe, Isvilanonda, et al., 2010). This difference can possibly be explained by the benefit derived from economies of scale (Deaton & Paxson, 1998). Deaton and Paxson's study found a negative relationship between the expenditure share of food and family size, which is called "the Deaton-Paxson paradox". Given the level of expenditure, the proportion of total expenditure spent on food decreases with household size. This confirms economies of scale in food consumption since larger-sized households purchase in bulk, resulting in a lower food cost per person.

To see this, we compute the correlation coefficients between household size and total expenditure of some food subgroups per household (see Table 4). As household size increases, households purchase more grain and cereal products in total, even though they purchase less per head in expenditure shares, based on the QUAIDS estimates. This indicates an advantage over larger households on buying grain and cereal products because of economies of scale by purchasing larger packages or inexpensive grain and cereal products. We classify grain and cereal products as public goods where a larger household is better off as a result of economies of scale (Logan, 2011).

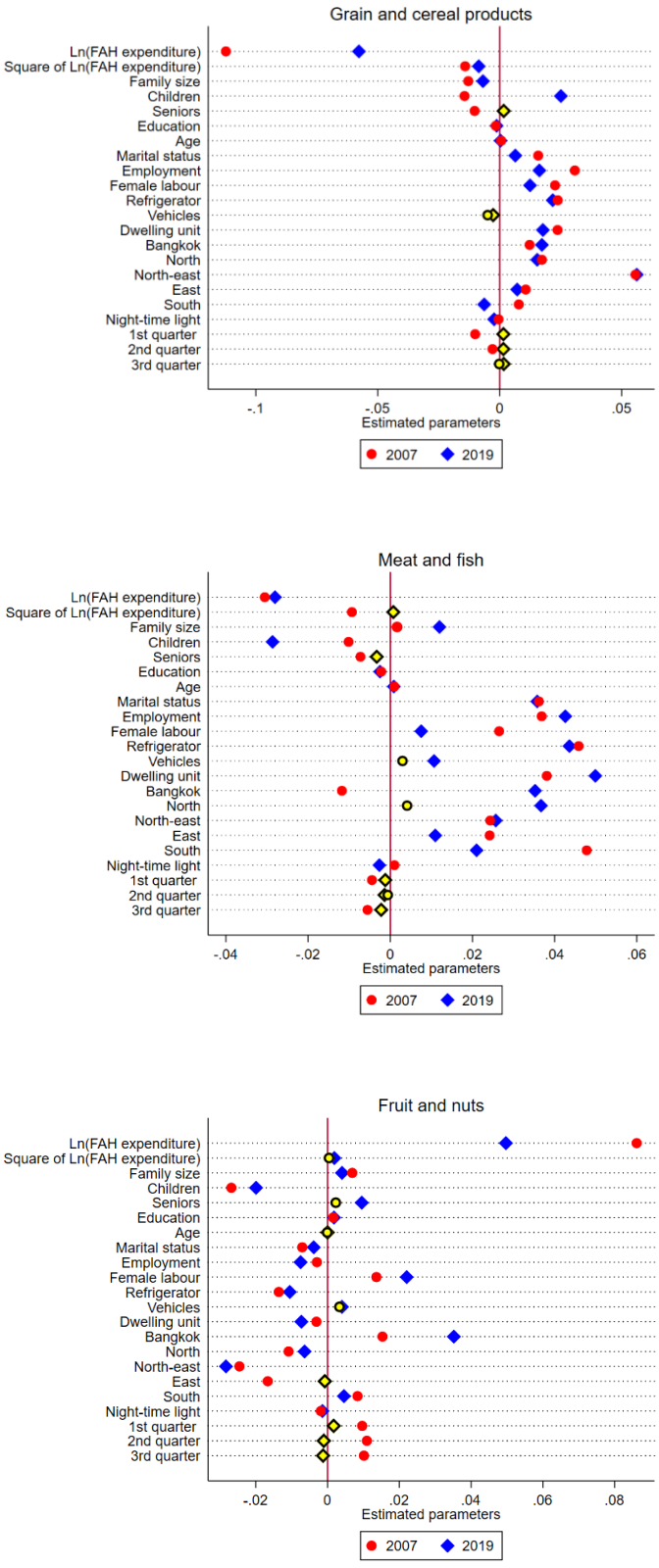

Figure 2. Estimated demand parameters of five food subgroups.

Note: O and ◇ mean the results are insignificant. Instrument variables are the logarithm of income, the square of logarithm of income, and the total number of households' assets.

Source: Authors' calculations based on SES 2007 and 2019.

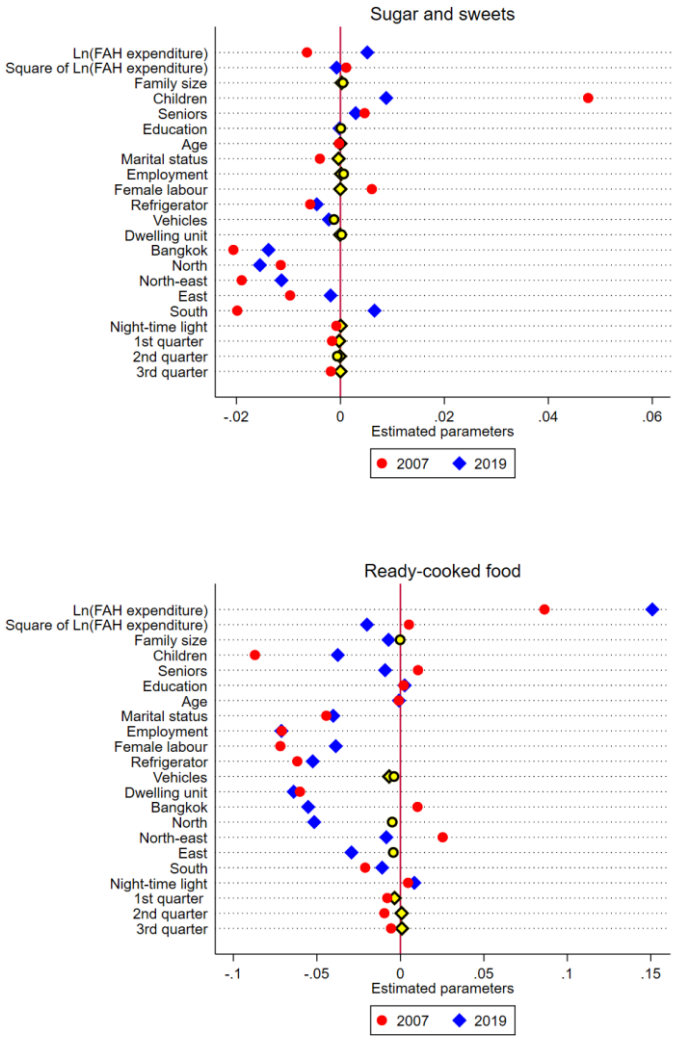

Figure 3. (Continued)

In contrast to grain and cereal products, the expenditure shares of meat and fish and fruit and nuts increase with household size. Table 4 also shows the positive relationship between total expenditure on meat and fish, and fruit and nuts per household and household size. The increasing expenditure shares of these two food subgroups indicate that larger households may not experience economies of scale. This result may be influenced by meat and fish, and fruit and nuts that are not shared between household members for reasons such as different tastes (Salcedo et al., 2012). As a result, larger households are unlikely to purchase these foods in larger quantities. We thus conclude that meat and fish, and fruit and nuts display characteristics

of private goods. In general, these findings suggest that the effect of household size on nutrition transition varies significantly due to the difference in foods' public or private properties.

Our result reflects a substitute effect between home cooking and ready-cooked food. In 2019, as household size increased, households allocated proportionally less additional expenditure on ready-cooked food. The reason for this result may be changes in food and eating habits of Thai people. In traditional Thai dining, different dishes are shared communally by a family. Packaged foods are designed in single servings, which discourages a family from eating communally (Isaacs et al., 2010). In general, households with more members tend to shift away from ready-cooked food towards food ingredients, although this requires preparation time (Crossley & Lu, 2018). Therefore, as more Thai households reflect a nuclear family structure, dietary patterns may shift towards ready-cooked food.

Table 4

Correlation coefficients between household size and total expenditure of food subgroups per household

Food subgroups	2007	2019
Grain and cereal products	0.492***	0.531***
Meat and fish	0.456***	0.526***
Fruit and nuts	0.218***	0.205***

Note: *** denotes $p < 0.01$.

Source: Authors' calculations based on SES 2007 and 2019

5.2. Household composition

Figure 3 demonstrates that the ratio of children to total household members (*Children*) is negative and statistically related to the shares of meat and fish, fruit and nuts, and ready-cooked food in FAH expenditure, and positively related to sugar and sweets (at the 0.1 level).

Households with more children appear to allocate their FAH budget away from more expensive foods such as animal products, healthy foods and convenience foods. This finding contradicts previous studies that show households with more children spend proportionally more on meat and fish (Akbay et al., 2007; Elijah Obayelu et al., 2009; Gould & Villarreal, 2006; Zheng & Henneberry, 2009). When the ratio of children in the household increases, the decline in expenditure share of meat and fish does not necessarily imply less total expenditure.

We next consider the correlation coefficients between the ratio of children to household members and total expenditure on meat and fish. The result shows that households with more children exhibit higher total expenditure on meat and fish per household (with a positive correlation coefficient of 0.19 in 2007 and 0.24 in 2019) but lower expenditure share of meat and fish.

Importantly, the result shows that households with a higher ratio of children tend to consume more sugar and sweets. This finding supports Boonchoo et al.'s (2017) study. Thai children consume sugary drinks such as flavoured milk, provided by parents, leading to increases in excess weight and obesity (Boonchoo et al., 2017). This finding does cast light on changes in household composition shift food expenditure decisions.

5.3. Education

The coefficient of household head years of education (*Education*) is negative and statistically related to the expenditure shares of grain and cereal products and meat and fish at the 0.01 level; however, it is positively related to the expenditure shares of fruit and nuts and ready-cooked food (see Figure 2). Household heads with higher levels of education tend to spend less on home-cooked food (i.e., grain and cereal products and meat and fish) but more on ready-cooked food. This finding contradicts previous studies, which suggest that the expenditure share of animal products has a positive relationship with the educational levels of household heads (Akbay et al., 2007; Elijah Obayelu et al., 2009; Lippe, Isvilanonda, et al., 2010; Zheng

& Henneberry, 2009). Unlike other studies, this study includes ready-cooked food, which gives insight into nutrition transition. Better-educated household heads might have influenced a decrease in demand for food ingredients, but an increase in demand for ready-cooked food. This may be because better-educated heads have less time for food preparation and cooking due to spending longer hours at work. Moreover, the majority of Thai household heads are men. The higher educated men seem to be less aware of obesity risks (Aekplakorn et al., 2014). Households with a better-educated head seem to easily spend more on ready-cooked food. The educational level of household heads has increased over time; thus, Thai households are more likely to desire ready-cooked food. Generally, the inclusion of ready-cooked food in the analysis might highlight shifts in consumers' food spending behaviours, which differs from previous studies.

This study supports evidence on fruit and nuts from previous studies (Akbay et al., 2007; Elijah Obayelu et al., 2009; Zheng & Henneberry, 2009). They show that household heads with higher education levels spend more on high-value foods such as fruit and nuts, suggesting that education motivates households towards healthier diets in Thailand (Kelly et al., 2010; Lippe, Isvilanonda, et al., 2010; Lippe, Seebens, et al., 2010). As a result, an increase in years of education may have contributed to diets becoming more diverse, including fruit.

5.4. Employment

As expected, Figure 3 shows that households with agricultural household heads (*Employment*) are likely to cook at home with higher expenditure shares of grain and cereal products, and meat and fish, but lower shares of fruit and nuts, and ready-cooked food (statistically significant at the 0.1 level). This implies that household heads who work in the agricultural sector tend to spend proportionally more on grain and cereal products. This result is similar to Elijah Obayelu et al.'s (2009) study. Those doing more physical work require more calories, so they increase spending on energy-dense foods (i.e., grain and cereal products). Therefore, changes in

Thailand's employment structure towards non-agriculture sectors might divert food expenditure patterns away from grain and cereal products.

5.5. Women's labour force participation

Figure 3 shows that households with a higher ratio of females in the labour force (*Female labour*) spend more on grain and cereal products, meat and fish, and fruit and nuts, but less on ready-cooked food (statistically significant at the 0.01 level). This result is unexpected. Female participation in the labour force has a positive impact on home cooking. Lippe, Isvilanonda, et al. (2010) found that women's participation in the labour force is negatively related to the expenditure share of meat products. In contrast, our result shows that households with a higher ratio of female participation in the labour market tend to purchase more food ingredients (i.e., grain and meat products), but less ready-cooked food.

This difference may be explained by this study using data obtained from the national survey covering households in rural and urban areas, unlike Lippe, Isvilanonda, et al.'s (2010) study that used the urban household survey. Women are the main food preparers in Thai families (Banwell et al., 2013). In rural areas, women's participation in the labour force does not alter their likelihood to cook. Thai women in rural areas are responsible not only for working on the farm, but also for cooking and preparing food, including growing their own food in gardens (Moreno-Black et al., 1996). In urban areas, particularly in Bangkok, Thai women in the labour force seem to be relatively well educated and wealthy, so they tend to have better food choice and access, and are consequently more willing to cook (Aekplakorn et al., 2014; Rimpeekool et al., 2017). This implies that women's labour force participation might improve healthy food selection and awareness of diet-related health problems. The finding suggests that as the ratio of woman in the labour force increases, home-cooking is expected to increase in Thailand.

5.6. Other characteristics of household heads

Households with older heads (*Age*) spend higher shares of FAH expenditure on grain and cereal products and meat and fish, and less on ready-cooked food (statistically significant at the 0.01 level) (see Figure 2). This suggests that older household heads tend to consume home-cooked meals. Older Thai household heads may well prefer home-cooked food because they or their families are able to cook their favourite meals (Bubpa & Nuntaboot, 2018; Rittirong et al., 2014), or they are aware of the ingredients used in ready-cooked food (Thanakwang et al., 2012).

5.7. Ownership of property

Figure 3 shows having a refrigerator (*Refrigerator*) is positively related to the expenditure share of food ingredients such as grain and cereal products and meat and fish, but negatively related to fruit and nuts, sugar and sweets, and ready-cooked food (all statistically significant at the 0.01 level). Consistent with the literature, we show that households with a refrigerator spend more on meat and fish. According to Gould and Villarreal (2006), having a refrigerator allows more perishable food purchases such as meat and fish, which are commonly bought by all Thai households.

Households owning their home (*Dwelling unit*) is positively related to the expenditure share of food ingredients such as grain and cereal products and meat and fish, and negatively related to expenditure shares of fruit and nuts, and ready-cooked food (all statistically significant at the 0.1 level). This result suggests that households owning their home tend to spend more on home-cooked meals such as grain and cereal products and meat and fish, but less on ready-cooked food. In general, home ownership reflects the economic status of households, leading to higher spending on ready-cooked food. Our data shows that almost 70% of households own a dwelling (see Table 1), and housing affordability is high in Thailand (Novianto et al., 2015).

This suggests that owning a house in Thailand does not reflect households' economic status. In fact, owning a house in Thailand indicates the potential use of cooking facilities. Previous studies suggest that tenants prefer ready-cooked food because tenant-occupied houses (i.e., a serviced apartment) do not provide cooking facilities (Pongsapich & Wongsekiarttirat, 1994; Yasmeen, 2000). Thus, households with an owner-occupied house seem to cook meals more than households with a tenant-occupied house.

5.8. Living area characteristics

Households in Bangkok province (*Bangkok*) spend more on grain and cereal products, and fruit and nuts in their FAH expenditure than other provinces (statistically significant at the 0.01 level) (see Figure 2). Conversely, Bangkok residents seem to spend less on sugar and sweets (all statistically at the 0.1 level). Contrary to expectations, living in Bangkok province is positively associated with the expenditure share on grain and cereal products, indicating that Bangkok households seem to increase their spending on grain products as expenditure increases. This may be because demand for some grain products, such as bakery products, is increasing in Thailand (Isaacs et al., 2010). Bakery products (i.e., bread) are more expensive than other grain and cereal products, but are becoming common sources of energy-dense food among households in Bangkok. Supermarkets and convenience stores in Bangkok stock bakery products, so they are easy to find (Banwell et al., 2013). Moreover, with higher income and better education, Bangkok residents spend more on fruit and nuts than other provinces, especially purchased from modern retail stores, which offer higher quality but higher prices (Lippe, Seebens, et al., 2010).

Food demand differs between regions. Households in the North, Northeast, and East regions spend relatively more on grain and cereal products and meat and fish than the Central region, but less on fruit and nuts and sugar and sweets (all statistically significant at the 0.1 level).

Households in the South region spend more on meat and fish, and fruit and nuts than the Central region, and less on ready-cooked food (statistically significant at the 0.1 level).

5.9. Night-time light

Food demand seems to be influenced by urbanisation. Figure 3 shows that most estimated parameters of night-time light intensity (*Night-time light*) are statistically significant at the 0.01 level, suggesting that urbanisation is an appropriate shifter in food demand. In particular, night-time light intensity is negatively related to the expenditure shares of grain and cereal products and fruit and nuts, and positively related to the share of ready-cooked food (statistically significant at the 0.01 level). Households in the more night-time light-intensive areas spend proportionally more on ready-cooked food. This result is in line with previous studies (Tsuchiya et al., 2017; Winichagoon, 2013). Residents in urbanised cities consume more ready-cooked meals, which are more easily available in Thailand (Tsuchiya et al., 2017; Winichagoon, 2013). This suggests that urbanisation in Thailand contributes to dietary changes towards ready-cooked food.

5.10. Time

Figure 3 shows the first quarter (*1st quarter*) is negatively related to most food subgroups in 2007 except for fruit and nuts (statistically significant at the 0.1 level). This suggests that in the first quarter, households appear to spend less on these food subgroups than in the fourth quarter of the year. However, most of the time dummies are insignificant. This result may be explained by flavoured foods. Thai people prefer regional food made with seasonally local ingredients (Banwell et al., 2013). We conclude that there are no seasonal differences in food demand in Thailand.

6. Conclusions

This study identifies the drivers of nutrition transition in Thailand. We employed the QUAIDS model to investigate changes in dietary patterns between 2007 and 2019, using food expenditure data. Because urbanisation shapes dietary patterns, we include urbanisation as a demand shifter in the food demand system, proxied by the night-time light intensity obtained from the National Oceanic and Atmospheric Administration (NOAA).

Our major findings confirm that nutrition transition is happening in Thailand towards animal products, sugar and ready-cooked food. In particular, urbanisation is leading the shift in food demand, although food preferences vary over time with changes in household and living area characteristics. Unexpectedly, the participation of women in the labour force does not affect home cooking, which contributes to better health and wellbeing for Thai families. This study highlights that demographics and geographic characteristics are equally significant in the analysis, so our empirical analysis should help to improve our awareness of changes in dietary patterns due to a range of factors.

This study offers two major academic implications. First, we include ready-cooked food in the QUAIDS model, unlike previous studies. Ready-cooked food is the main feature of nutrition transition. Our findings show the role of ready-cooked food in households' expenditure allocations. For example, households with a better-educated head or a nuclear family seem to spend more on ready-cooked food than on animal products. This finding has not been reported in other studies. Thus, this contributes to a better understanding of nutrition transition in developing countries where ready-cooked food has become more readily available.

Second, we use an alternative measurement of urbanisation in analysing food demand. Using night-time lights derived from satellite images can further explain distinguishing differences in food demand. Local variation in urbanisation influences food demand, as the estimated

parameters of night-time light intensity are statistically significant. Night-time lights allow us to better understand why dietary patterns change with increased urbanisation.

There are a number of practical implications of this study. First, the findings show an increase in demand for sugary products, especially in households with children, which has implications for policy development. Taxes on sugar products might decrease their purchases. However, taxation will not necessarily improve household purchase and consumption behaviour if the preferences for sugar are strong. Policies targeted at particular groups might be more effective: e.g., higher taxes on sugar products sold at school, or a campaign focused on parents' understanding of how diet and health affect children's lifelong eating habits. This is because good eating habits in early children are essential for promoting healthy eating practices later in life. Importantly, Thailand has a policy mismatch arising from its agricultural subsidies for sugar, which conflicts with promoting good health and nutrition. Subsidising the Thai sugar industry lowers sugar prices, leading to an increased demand. Agricultural subsidy policies for sugar should be reconsidered if Thailand is to promote healthy nutrition.

Second, demand for ready-cooked food is increasing among Thai households, especially households with a well-educated head and nuclear families. Since ready-cooked meals are easily purchased, cheap, and convenient, it is difficult to encourage home cooking among these sub-populations to improve their diet. This study provides several policy implications. First, campaigns on how to prepare healthy food and encouraging healthier food purchases (i.e., convenient fruit and vegetable innovations) might improve nutrition among households. Second, and more importantly, previous research suggests that information on ready-cooked food (i.e., the amounts of ingredients) are limited (Tsuchiya et al., 2017; Winichagoon, 2013); thus, public health campaigns on increasing knowledge and awareness of food quality standards among food vendors would be more beneficial to improve nutritional status in Thailand. For example, food quality and safety training programmes for the vendors and a

campaign called ‘Clean Food Good Taste’ could promote food quality in food establishments. Under the ‘Clean Food Good Taste’ campaign, the certificate and logo are awarded to the restaurants and food vendors that pass the food hygiene and sanitation criteria. The inclusion of food quality criteria in this campaign could improve food quality and increase consumers’ confidence in ready-cooked food.

This study offers a deeper insight into the nutrition transition framework in developing countries, where economic, demographic, and social changes are accompanied by changes in diet, but our study has some limitations. Food expenditure might not necessarily be the same as food consumption because food may be wasted or stored, particularly in high-income households or young families. Moreover, this study does not consider food quality, although previous research suggests that food quality affects dietary patterns. We include household demographics and living area characteristics in the estimation as a measure of food wastage and food quality, which may mitigate these limitations.

Supporting Information

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

Appendix S1 and S2. Estimated parameters of the QUAIDS model, 2007 and 2019, respectively.

Acknowledgements

The authors wish to thank the National Statistical Office (NSO) of Thailand for providing the relevant data in our study. We also thank to the Faculty of Agribusiness and Commerce, Lincoln University, and the Department of Applied Economics, Faculty of Economics at Sriracha, Kasetsart University Sriracha Campus for their financial supports.

References

Abdulai, A., & Aubert, D. (2004). A cross-section analysis of household demand for food and nutrients in Tanzania. *Agricultural Economics*, *31*(1), 67-79. https://doi.org/10.1016/j.agecon.2003.03.0Ol

Aekplakorn, W., Inthawong, R., Kessomboon, P., Sangthong, R., Chariyalertsak, S., Putwatana, P., & Taneepanichskul, S. (2014). Prevalence and trends of obesity and association with socioeconomic status in Thai adults: National Health Examination Surveys, 1991-2009. *Journal of Obesity*, *2014*. https://doi.org/10.1155/2014/410259

Akbay, C., Boz, I., & Chern, W. S. (2007). Household food consumption in Turkey. *European Review of Agricultural Economics*, *34*(2), 209-231. https://doi.org/10.1093/erae/jbm011

Akinbode, S. O. (2015). A linear approximation almost ideal demand system of food among households in South-West Nigeria. *International Journal of Social Economics*, *42*(6), 530-542. https://doi.org/10.1108/ijse-08-2014-0165

Atkin, D. (2016). The caloric costs of culture: Evidence from Indian migrants. *American Economic Review*, *106*(4), 1144-1181. https://doi.org/10.1257/aer.20140297

Banks, J., Blundell, R., & Lewbel, A. (1997). Quadratic Engel curves and consumer demand. *The Review of Economics and Statistics*, *79*(4), 527-539.

Banwell, C., Dixon, J., Seubsman, S. A., Pangsap, S., Kelly, M., & Sleigh, A. (2013). Evolving food retail environments in Thailand and implications for the health and nutrition transition. *Public Health Nutrition*, *16*(4), 608-615. https://doi.org/10.1017/S1368980012004223

Beznoska, M. (2019). *Do couples pool their income? Evidence from demand system estimation for Germany*. Free University Berlin, School of Business and Economics. https://www.econstor.eu/bitstream/10419/193000/1/1049477251.pdf

Boonchoo, W., Takemi, Y., Hayashi, F., Koiwai, K., & Ogata, H. (2017). Dietary intake and weight status of urban Thai preadolescents in the context of food environment. *Preventive Medicine Reports*, *8*, 153-157. https://doi.org/10.1016/j.pmedr.2017.09.009

Brester, G. W., & Schroeder, T. C. (1995). The impacts of brand and generic advertising on meat demand. *American Journal of Agricultural Economics*, *77*(4), 969-979.

Brubakk, L. (1997). *Estimation of price elasticities from Norwegian household survey data*. Statistics Norway Research Department. https://www.ssb.no/a/publikasjoner/pdf/DP/dp202.pdf

Bubpa, N., & Nuntaboot, K. (2018). Diversity of foods among older people in northern communities of Thailand. *Journal of Health Research*, *32*(1), 95-104. https://doi.org/10.1108/jhr-01-2018-028

Burger, R. P., Coetzee, L. C., Kreuser, C. F., & Rankin, N. A. (2017). Income and price elasticities of demand in South Africa: An application of the linear expenditure system. *South African Journal of Economics*, *85*(4), 491-514. https://doi.org/10.1111/saje.12167

Crossley, T. F., & Lu, Y. (2018). Returns to scale in food preparation and the Deaton-Paxson puzzle. *Review of Economics of the Household*, *16*(1), 5-19. https://doi.org/10.1007/s11150-017-9399-4

Deaton, A., & Muellbauer, J. (1980). An almost ideal demand system. *The American Economic Review*, *70*(3), 312-326.

Deaton, A., & Muellbauer, J. (2009). *Economics and consumer behavior*. Cambridge University Press.

Deaton, A., & Paxson, C. (1998). Economies of scale, household size, and the demand for food. *Journal of Political Economy*, *106*(5), 897-930. https://doi.org/10.1086/250035

Dong, F., & Fuller, F. (2010). Dietary structural change in China's cities: Empirical fact or urban legend? *Canadian Journal of Agricultural Economics/Revue canadienne d'agroeconomie*, *58*(1), 73-91. https://doi.org/10.1111/j.1744-7976.2009.01159.x

Ecker, O., & Qaim, M. (2011). Analyzing nutritional impacts of policies: An empirical study for Malawi. *World Development*, *39*(3), 412-428. https://doi.org/10.1016/j.worlddev.2010.08.002

Elijah Obayelu, A., Okoruwa, V. O., & Ajani, O. I. Y. (2009). Cross-sectional analysis of food demand in the North Central, Nigeria. *China Agricultural Economic Review*, *1*(2), 173-193. https://doi.org/10.1108/17561370910927426

Faharuddin, F., Mulyana, A., Yamin, M., & Yunita, Y. (2017). Nutrient elasticities of food consumption: The case of Indonesia. *Journal of Agribusiness in Developing and Emerging Economies*, *7*(3), 198-217. https://doi.org/10.1108/jadee-02-2016-0008

Gould, B. W., & Villarreal, H. J. (2006). An assessment of the current structure of food demand in urban China. *Agricultural Economics*, *34*(1), 1-16. https://doi.org/10.1111/j.1574-0862.2006.00098.x

Hoang, L. V. (2009). *Estimation of food demand from household survey data in Vietnam*. Development and Policies Research Center (DEPOCEN). http://depocenwp.org/modules/download/index.php?id=64

Isaacs, B. A., Dixon, J., & Banwell, C. (2010). Fresh market to supermarket: Nutrition transition insights from Chiang Mai, Thailand. *Public Health Nutrition*, *13*(6), 893-897. https://doi.org/10.1017/S1368980009993260

Kelly, M., Banwell, C., Dixon, J., Seubsman, S.-A., Yiengprugsawan, V., & Sleigh, A. (2010). Nutrition transition, food retailing and health equity in Thailand. *Australasian epidemiologist*, *17*(3), 4-7.

Kosulwat, V. (2002). The nutrition and health transition in Thailand. *Public Health Nutrition*, *5*(1A), 183-189. https://doi.org/10.1079/PHN2001292

Law, C., Fraser, I., & Piracha, M. (2019). Nutrition transition and changing food preferences in India. *Journal of Agricultural Economics*, *71*(1), 118-143. https://doi.org/10.1111/1477-9552.12322

Lecocq, S., & Robin, J.-M. (2015). Estimating almost-ideal demand systems with endogenous regressors. *The Stata Journal*, *15*(2), 554-573. https://doi.org/10.1177/1536867x1501500214

Lippe, R. S., Isvilanonda, S., Seebens, H., & Qaim, M. (2010). Food demand elasticities among urban households in Thailand. *Thammasat Economic Journal*, *28*(2), 1-29.

Lippe, R. S., Seebens, H., & Isvilanonda, S. (2010). Urban household demand for fresh fruits and vegetables in Thailand. *Applied Economics Journal*, *17*(1), 1-26.

Logan, T. D. (2011). Economies of scale in the household: Puzzles and patterns from the American past. *Economic Inquiry*, *49*(4), 1008-1028. https://doi.org/10.1111/j.1465-7295.2009.00240.x

Lowe, M. (2014). *Night lights and ArcGIS: A brief guide*. Massachusetts Institute of Technology. https://darrylmcleod.com/wp-content/uploads/2016/06/Night-Lights-and-ArcGIS-A-Brief-Guide.pdf

Ma, W., & Li, P. (2018). An object similarity-based thresholding method for urban area mapping from visible infrared imaging radiometer suite day/night band (VIIRS DNB) data. *Remote Sensing*, *10*(2), 263. https://doi.org/10.3390/rs10020263

Madanat, H. N., Troutman, K. P., & Al-Madi, B. (2008). The nutrition transition in Jordan: The political, economic and food consumption contexts. *Promotion & Education*, *15*(1), 6-10. https://doi.org/10.1177/1025382307088092

Ministry of Commerce. (2020). *Retail prices*. https://data.moc.go.th/OpenData/CPIIndexes

Moreno-Black, G., Somnasang, P., & Thamathawan, S. (1996). Cultivating continuity and creating change: Women's home garden practices in northeastern Thailand. *Agriculture and Human Values*, *13*(3), 3-11. https://doi.org/10.1007/bf01538222

Moro, D., & Sckokai, P. (2000). Heterogeneous preferences in household food consumption in Italy. *European Review of Agricultural Economics*, *27*(3), 305-323.

National Oceanic and Atmospheric Administration. (2019). *Version 4 DMSP-OLS nighttime lights time series*. https://www.ngdc.noaa.gov/eog/dmsp/downloadV4composites.html

National Oceanic and Atmospheric Administration. (2020). *Version 1 VIIRS day/night band nighttime lights*. https://www.ngdc.noaa.gov/eog/viirs/download_dnb_composites.html

Novianto, D., Gao, W., & Kuroki, S. (2015). Review on people's lifestyle and energy consumption of Asian communities: Case study of Indonesia, Thailand, and China. *Energy and Power Engineering*, *7*, 465-476. https://doi.org/10.4236/epe.2015.710045

Pongsapich, A., & Wongsekiarttirat, W. (1994). Urban household energy consumption in Thailand. *Energy*, *19*(5), 509-516.

Popkin, B. M. (1993). Nutritional patterns and transitions. *Population and Development Review, 19*(1), 138-157. https://doi.org/10.2307/2938388

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

Popkin, B. M. (2002). The dynamics of the dietary transition in the developing world. In B. Caballero & B. M. Popkin (Eds.), *The Nutrition Transition* (pp. 111-128). Academic Press. https://doi.org/10.1016/B978-012153654-1/50008-8

Rimpeekool, W., Kirk, M., Yiengprugsawan, V., Banwell, C., Seubsman, S. A., & Sleigh, A. (2017). Nutrition label experience and consumption of transitional foods among a

nationwide cohort of 42,750 Thai adults. *British Food Journal*, *119*(2), 425-439. https://doi.org/10.1108/BFJ-07-2016-0327

Rittirong, J., Prasartkul, P., & Rindfuss, R. R. (2014). From whom do older persons prefer support? The case of rural Thailand. *Journal of Aging Studies*, *31*, 171-181. https://doi.org/10.1016/j.jaging.2014.10.002

Salcedo, A., Schoellman, T., & Tertilt, M. (2012). Families as roommates: Changes in U.S. household size from 1850 to 2000. *Quantitative Economics*, *3*(1), 133-175. https://doi.org/10.3982/qe76

Subedi, Y. P., Marais, D., & Newlands, D. (2017). Where is Nepal in the nutrition transition? *Asia Pacific Journal of Clinical Nutrition*, *26*(2), 358-367. https://doi.org/10.6133/apjcn.112015.10

Thanakwang, K., Soonthorndhada, K., & Mongkolprasoet, J. (2012). Perspectives on healthy aging among Thai elderly: A qualitative study. *Nursing & Health Sciences*, *14*(4), 472-479. https://doi.org/10.1111/j.1442-2018.2012.00718.x

The United Nations. (2018). *World Urbanization prospects: The 2018 revision*. https://population.un.org/wup/

Tsuchiya, C., Amnatsatsue, K., Sirikulchayanonta, C., Kerdmongkol, P., & Nakazawa, M. (2017). Lifestyle-related factors for obesity among community-dwelling adults in Bangkok, Thailand. *Journal of International Health*, *32*(1), 9-16.

Winichagoon, P. (2013). Thailand nutrition in transition: Situation and challenges of maternal and child nutrition. *Asia Pacific Journal of Clinical Nutrition*, *22*(1), 6-15. https://doi.org/10.6133/apjcn.2013.22.1.17

Yasmeen, G. (2000). Not 'From Scratch': Thai food systems and 'public eating'. *Journal of Intercultural Studies*, *21*(3), 341-352. https://doi.org/10.1080/07256860020007494

Zheng, Z., & Henneberry, S. R. (2009). An analysis of food demand in China: A case study of urban households in Jiangsu province. *Review of Agricultural Economics*, *31*(4), 873-893.

Zhu, X., Ma, M., Yang, H., & Ge, W. (2017). Modeling the spatiotemporal dynamics of Gross Domestic Product in China Using extended temporal coverage nighttime light data. *Remote Sensing*, *9*(6), 626. https://doi.org/10.3390/rs9060626