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Food Demand Elasticities among Urban Households in Thailand

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Abstract

Information on demand patterns for food is needed to determine food and agricultural policies. In this study, food demand elasticities are estimated for urban Thailand, based on a survey of 500 households in Bangkok and Chiang Mai. We estimate a Linear Almost Ideal Demand System (LAIDS) for 8 aggregate food items and explicitly account for censored data. As one would expect, the demand for higher-value foods such as fruits, vegetables, meat, fish and seafood rises more with increasing incomes than the demand for staple foods, especially rice. Likewise, households are more price responsiveness with respect to higher-value foods. These results suggest that economic developments and policies that foster income growth and

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competition in the farm and agribusiness sector will contribute to better nutrition and a more diverse diet.

Keywords: Food demand elasticities, Linear Almost Ideal Demand System, Two-stage budgeting, Censored data

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1. Introduction

Understanding food demand patterns and elasticities is an important prerequisite for designing food and agricultural policies and for predicting and analyzing policy impacts. Here, we estimate elasticities of food demand with respect to income and prices for a sample of urban households in Thailand. More specifically, we use comprehensive data from a recent survey of households in the Bangkok and Chiang Mai metropolitan areas. Other studies related to food demand in Thailand have been carried out in the recent past (e.g., Isvilanonda and Kongrith, 2008; Daroonpate et al., 2005; Kaennaku, 2005; Sutthipongpan, 2005; Prasertsung, 2005; Kosulwat, 2002; Schmidt and Isvilanonda, 2002). However, most of them take a partial look at certain foods or food groups, such as rice or fruits and vegetables. Moreover, they only used descriptive statistics or single-equation econometric models, which are not fully consistent with economic theory. We add to this literature by including the entire food bundle in our analysis and by using a theory-consistent demand systems approach.

A common treatment of consumer behavior is to assume two-stage budgeting, which has found wide application within the empirical literature (Menezes et al., 2008; Mergenthaler et al., 2009; Jabarin, 2005; Shiptsova et al., 2004; Piumsombun, 2003; Fan, 1995; Haden, 1990 etc.). At the first stage, the consumer decides on which group of goods to spend money, while at the second stage, group expenditure is allocated to particular items within the group, as depicted in

Appendix 1. At the core of two-stage budgeting is the assumption of weak separability, that is, preferences for items within groups are assumed to be independent of items in another group (Deaton and Muellbauer, 1980). Weak separability therefore implies that the effects of price changes in one commodity group can be modeled via a combination of intra-group expenditure elasticities and changes in the allocation of expenditure across groups (Edgerton, 1997). Due to its practicability, we employ two-stage budgeting to obtain expenditure and own-price elasticities. As we are primarily interested in patterns of food purchase for home consumption, we consider only this category at the second stage decision on expenditure allocation.

An important feature of demand data that calls for consideration is that not all households consume all goods, such that the data is subject to censoring. To account for this issue we employ the approach proposed by Shonkwiler and Yen (1999) to estimate a Linear Almost Ideal Demand System (LAIDS). The paper proceeds as follows: In section 2, the survey design and data are described, followed by a presentation of the methodology in section 3. Section 4 shows the results, while section 5 concludes.

2. Survey design and descriptive data

2.1 Survey design

For the household survey in Bangkok and Chiang Mai, a multi-stage sampling design was applied. At the first stage, six districts in Bangkok and two districts and four sub-districts in Chiang Mai were randomly chosen.[5] At the second stage, five residential roads were randomly selected per district or sub-district. Finally, within these roads households were systematic ranking selected. This procedure allowed us to obtain a representative sample in the absence of recent census data. In total, 500 households were interviewed; 300 in Bangkok and 200 in Chiang Mai. The field survey was conducted from April to July 2007, by interviewing the primary food

[5] The sample districts in Bangkok are Din Daeng, Wangthonglong, Dusit, Jom Thong, Yannawa and Kholng Toei. The sample (sub-) districts in Chiang Mai are Chang Pueak, Kawila, Nong Pa Kung, Nakorn-Ping, Meng-Rai and Sri-Vichai.

purchasers or household heads. Household respondents were asked to give information concerning consumption expenditures of food at home, food away from home and non-food items as well as on the location where the goods were purchased, their prices, quantities and household characteristics.

2.2 Descriptive statistics on household characteristics

Average annual per capita household expenditures are at 110,934 baht (3220 US dollars). The groups of goods—among which households allocate their available budget at the first stage of the two-stage budgeting process—considered here are food at home, food away from home and non-food. The average budget share of food at home is 0.23 with declining trends towards higher expenditure quartiles (table 1). In contrast, the share of food away from home shows an increasing trend to higher quartiles. Second stage budget shares of each aggregate food commodity are calculated as the ratio of expenditure on each item to total group specific expenditure. As table 1 shows, households spend most money within that group on fresh fruits followed by other preserved food and other fresh food. The average budget shares of rice and vegetables slightly decline at higher expenditure quartiles, while for the other goods the shares remain comparatively stable.

Households were asked how much fresh food such as fruits and vegetables they had purchased during the previous week. For rarely purchased items like preserved foods, longer recall periods were applied. All consumption quantities and expenditures were transformed into annual data. The consumed quantities were measured in kilograms. In case of liquor products, conversion to kilogram was done by multiplying density of liquor product with volumes purchased.

Table 1

Budget shares for different items by expenditure quartiles

Basic categories	Entire sample	Expenditure Quartiles			
		Q1	Q2	Q3	Q4
Annual per capita total household expenditure	110,934.50 (3220.16)	40,214.19 (1167.32)	66,175.81 (1920.92)	101,126.80 (2935.47)	236,221.20 (6856.93)
<u>First budgeting-stage</u>					
Food at home	0.23	0.31	0.27	0.20	0.14
Food away from home	0.15	0.13	0.15	0.16	0.16
Non-food	0.62	0.56	0.58	0.64	0.70
<u>Second budgeting-stage</u>					
Fresh fruits	0.20	0.19	0.20	0.20	0.21
Fresh vegetables	0.11	0.12	0.12	0.11	0.09
Rice and glutinous rice	0.10	0.12	0.10	0.09	0.07
Meat	0.08	0.09	0.08	0.07	0.07
Fish and Seafood	0.13	0.13	0.12	0.14	0.12
Other fresh food	0.17	0.15	0.18	0.16	0.19
Preserved F&V	0.05	0.03	0.03	0.06	0.06
Other preserved food	0.17	0.17	0.16	0.17	0.18

Source: Calculated from household survey data.

Note: Numbers in parentheses are average annual per capita expenditures in US dollars, converted by using the average exchange rate during April to July 2007 (Bank of Thailand).

The annual average per capita consumption data of aggregated food items are presented in table 2. Notably, households consumed 146.70 kg per person of fruits, differing by a factor of two between the poorest and richest quartile. Consumed rice quantities did not differ much between quartiles. In contrast, a notable increase in quantities consumed by expenditure quartiles was observed for meat, fish and seafood, other fresh food, preserved fruits and vegetables and other preserved food. In sum, the budget share of individual food by expenditure quartiles showed that high-income households tend to consume more nutritive food items.

Table 2

Annual average per capita consumption (kilogram) of aggregate food items by expenditure quartiles

Commodity	Entire sample	Expenditure Quartiles			
		Q1	Q2	Q3	Q4
Fresh fruits	146.7	97.09	150.56	137.74	201.41
Fresh vegetables	74.13	53.42	79.68	77.54	85.89
Rice & glutinous rice	70.65	65.86	72.47	70.73	73.54
Meat	20.12	14.3	19.66	18.85	27.66
Fish & seafood	28.86	21.45	26.95	30.89	36.14
Other fresh food	76.05	44.32	72.92	74.18	112.77
Preserved fruits & vegetables	26.12	10.82	19.73	28.48	45.43
Other preserved food	48.37	33.01	48.37	50.69	61.39

Source: Calculated from household survey data.

Table 3
Household compositions by expenditure quartiles

Variables	Definition	Entire Sample	Expenditure quartiles			
			Q1	Q2	Q3	Q4
	Sample size	500	125	125	125	125
Size	Household size (persons)	4.3	5.2	4.1	4.2	3.8
Age	Age (years)	49.2	50.5	51.9	49.5	44.8
Education	Years of education	10.2	8.0	9.9	10.2	12.8
Female labor	Dummy for female participation in labor force (%)	53.4	52.8	56.8	52.8	51.2
Gender	Gender of household head (%)					
	Male	25.8	24.8	24.0	24.8	29.6
	Female	74.2	75.2	76.0	75.2	70.4
Health awareness	Dummy of awareness of health problems linked to food quality (%)	93.4	91.2	91.2	94.4	96.8
Disease	Dummy for household members being affected by long-term diseases (%)	41	41.6	45.6	40.0	36.8
White collar	Dummy for white collar jobs (%)	14.2	9.6	10.4	15.2	21.6
Workers	Dummy for workers or entrepreneurs (%)	39.6	36.8	40.8	40.8	40.0
Housewife	Dummy for housewives (%)	46.2	53.6	48.8	44.0	38.4
Distance	Distance to the traditional market (kilometer)	1.8	1.6	1.8	1.7	2.1
Unit value	Fresh Fruits	29.2	24.4	27.0	31.5	34.0
(baht/kg)	Fresh Vegetables	34.2	30.5	32.2	34.1	39.9
	Rice & glutinous rice	22.2	20.1	21.3	22.3	25.0
	Meat	84.0	78.5	77.6	77.9	102.2
	Fish & Seafood	102.7	76.1	87.3	103.8	143.7
	Other Fresh Food	49.8	46.2	46.5	49.9	56.5
	Preserved Fruits & Vegetables	80.8	69.1	82.4	77.6	94.3
	Other Preserved food	76.7	67.5	70.5	80.5	88.4

Source: Calculated from household survey data.

Table 3 presents descriptive statistics on age, education of the household head and household size distinguished by expenditure quartiles. The data show that years of education increase with increasing expenditures. Average household size is small, and it continuously declines with increasing expenditure. A high level of education and modern family structure tend to increase female labor participation in the urban areas. The share of female labor participation slightly exceeds 50%, with a fairly constant pattern across all expenditure quartiles. It is possible that food consumption patterns would transform considerably as female participation in the labor force rises. The prevalence of long-term diseases in households is quite high: 41% of interviewed households respondents indicated that family members suffer from long-term diseases[6]. In addition, 93.4% of the respondents have knowledge about health problems linked to food quality. Occupation of respondents is divided into three groups. Most respondents indicated themselves to be stay-at-home housewives, though this number declined with increasing household expenditures. Interestingly, the share of housewife does not have a different direction with the share of female labor. It could be explained that the share of female labor is related to the share of female household head in each quartile with presenting the lowest share in the highest quartile. Unsurprisingly, the share of white collar jobs among the respondents increases at higher expenditure quartiles.

3. Methodology

At the first budgeting stage, a Working-Leser Model is employed to derive expenditure elasticities when prices are missing:

$$w_{gh} = \alpha_g + \beta_g \ln X_h \qquad (1)$$

where w_{gh} denotes the budget share of group *g* as a ratio of total household expenditure, X_h is annual per capita household expenditure and the index *h* denotes individual households.

[6]Respondents/household members have been chronic disease such as diabetes, cancer and high-blood pressure etc.

At the second stage, food at home expenditure is allocated to the food items fresh fruits (FF), fresh vegetables (FV), rice and glutinous rice (RG), meat, fish and seafood (FS), other fresh food (OFF), preserved fruits and vegetables (PFV) and other preserved food (OPF). The approximated Linear Almost Ideal Demand System (LAIDS) is applied to estimate within group expenditure and conditional own price elasticities. In contrast to the Almost Ideal Demand System, the LAIDS is commonly linearized by applying Stone's price index (Shiptsova, 2004; Piumsombun, 2003; Brosig, 2000; Gould, 1990 etc.). Nevertheless, recent studies indicate that Stone's price index may yield inconsistent estimates and propose the Laspeyres[7] and Tornqvist as alternatives (Buse and Chan, 2000; Moschini, 1995). The selection of appropriate price index should be carried out by examining the correlation structure of price (Buse and Chan, 2000). Due to the low level of collinearity among prices, the Tornqvist index is our preferred choice:

$$\ln P_h^T = \frac{1}{2}\sum_{i=1}^{n}(w_{ih} + w_i^0)\ln\frac{p_{ih}}{p_i^0} \qquad (2)$$

where P_h^T is the Tornqvist price index

w_{ih} is the budget share of food item *i* in each individual household *h*

w_i^0 is the mean budget share of food item *i*

p_{ih} is the price of food item *i* in each individual household *h*

p_i^0 is the mean price of food item *i*

To account for household size we employ the demographic translation approach suggested by Polak and Wales (1978; 1981). The translation parameter D^i for each good *i* is defined as:

$$D^i(\eta) = \sum_{r=1}^{n}\delta_{ir}\eta_r \qquad (3)$$

[7] Laspeyres Price index; $\ln P_h^L = \sum_{i=1}^{n} w_i^0 \ln p_{ih}$

where the δ coefficients are associated parameters and η_r are the demographic variables, with r = 1,2,…..,n. This, in combination with the price index, yields our estimation equation as follows:

$$w_{ih} = \alpha_i^* + \sum_{j=1}^{n} \gamma_{ij} \log p_{jh} + \beta_i \log\left(\frac{x_h}{P_h^T}\right) + \sum_{r=1}^{n} \delta_{ir}\eta_{rh} + \varepsilon_i \qquad (4)$$

where $\alpha_i = \alpha_i^* + \sum_{r=1}^{n} \delta_{ir}\eta_{rh}$, w_{ih} is budget share for food item *i* expressed as a ratio of food at home expenditure, p_{jh} is the price of food item *j*, x_h is annual per capita household expenditure for food at home, P_h^T is the Tronqvist price index, α_i, γ_{ij}, β_i are parameters to be estimated and ε_i is the error term assumed to have zero mean and to be independent across individuals and homoskedastic. However, correlation between error terms across equations arises because of the budget constraint restriction. This correlation is depicted more formally by error term summation of every share equation, with equal to zero for every observation (Pindyck and Rubinfeld, 1981).

As data on food prices are missing, we have to rely on the utilization of unit values, calculated from food quantities and nominal expenditures. This approach is subject to potential measurement bias, as it does not account for different qualities of item purchased (Deaton, 1997). In response to this problem, the approach proposed by Alfonzo (2006) is applied by assuming that households in the same clusters at equal point of time face similar price. Thus, regression analysis of unit value towards household income, household characteristics and cluster dummies were performed. The approximated price of each aggregate commodity follows as cluster dummy prediction. However, applying this approach did not give statistically significant results, especially the predictor variables preventing to predict the approximated market price. Hence, we decided to rely on unit quantities in order to keep the measurement error problem at reasonable levels. Missing values due to zero consumption have been replaced by the district average weighted by household expenditure. The average weighted unit value for each commodity is presented in Table 3.

To account for the problems arising from censored data, we employ the approach proposed by Shonkwiler and Yen (1999) that has frequently been used in the recent literatures (see Ecker, 2008; Yen et. al., 2006; Shiptsova, 2004; Pittman, 2004; Asatryan, 2003; Yen et. al., 2002; Su et. al., 2000). The procedure consists of two steps. First, define d_{ih} equal to 1 if household *h* consumes food item *i* and 0 otherwise and estimate the following equation:

$$d_{ih} = z_{ih}^{'}\alpha + v_{ih} \qquad (5)$$

where $z_{ih}^{'}$ denotes a vector of socio-demographic variables. This equation is estimated using a probit model, when v_{ih} are normally distributed. $\phi(z_i^{'}\hat{\alpha})$, a univariate standard normal probability function, and $\Phi(z_i^{'}\hat{\alpha})$ denoting the associated cumulative distribution function are formed using the estimated parameters from (5). The second step involves transforming the original estimation equation as follows:

$$w_{ih} = \Phi(z_i^{'}\hat{\alpha})[\alpha_i^{*} + \sum_{j=1}^{n}\gamma_{ij}\log p_{jh} + \beta_i \log\left(\frac{x_h}{P_h^T}\right) + \sum_{r=1}^{n}\delta_{ir}\eta_{rh}] + \varphi\,\hat{\phi}(z_i^{'}\hat{\alpha}_i) + \xi_i \qquad (6)$$

where $(\frac{X_h}{P_h^T})$ denotes the annual per capita food at home expenditure deflated by a Tronqvist Price Index. The error term in equation (6) differs from the original estimation as the selection mechanism interacts with the conditional mean, expressed as

$$\xi_i = \varepsilon_i + \{[\Phi(z_i^{'}\alpha_i) - \Phi(z_i^{'}\hat{\alpha})][\alpha_i^{*} + \sum_{j=1}^{n}\gamma_{ij}\log p_{jh} + \beta_i \log\left(\frac{x_h}{P_h^T}\right) + \sum_{r=1}^{n}\delta_{ir}\eta_{rh}]\} + \varphi[\,\phi(z_i^{'}\alpha_i) - \hat{\phi}(z_i^{'}\hat{\alpha}_i)]$$

with $E(\xi) = 0_i$ (7)

In the demand system equations, the error terms across equations are correlated due to the fact that the dependent variables need to satisfy the budget constraint. Therefore, the second-step will be estimated with the Seemingly Unrelated Regression (SUR) developed by Zellner (1962). It provides estimations more efficiently by using estimated the error variance-covariance matrix from OLS in the GLS estimation (Halcoussis, 2005; Sadoulet and Janvry, 1995). In the process of estimation, symmetry and homogeneity conditions across equations are imposed, following Pittman (2004), with one equation dropped from the system to preserve the adding-up property. However, because of the error terms in equation 6 are heteroskedastic, the covariance matrix of second-step estimator is incorrect. Therefore, bootstrapping estimation is used for inferences about the estimated parameters (Alfonzo et al., 2006; Su, 2000).

All elasticity estimates are evaluated at the sample mean and are calculated as follows (Green and Alston, 1990):

$$e_{g\ or\ i} = 1 + \left(\frac{\beta_{g\ or\ i}}{w_{g\ or\ i}} \right) \tag{8}$$

where *g* and *i* represent broad groups at the first and second budgeting stage, respectively. To obtain the unconditional expenditure (income) elasticity, we apply the results from Carpentier and Guyomard (2001) and Edgerton (1997) (Appendix 2).

$$E_i = e_{(g)i} \cdot e_{(g)} \tag{9}$$

where E_i is the unconditional expenditure (income) elasticity

$e_{(g)i}$ is the within-group expenditure elasticity (conditional expenditure elasticity)

$e_{(g)}$ is the expenditure elasticity for food at home expenditure from the first budgeting stage.

As no price elasticities are estimated at the first budgeting stage, unconditional own-price elasticities are not derived. The conditional uncompensated own-price elasticities are calculated as follows (Green and Alston, 1990):

$$\varepsilon_{ii} = \frac{\gamma_{ii}}{w_i} - \beta_i - 1 \tag{10}$$

4. Results

Table 4 presents the results for the first budgeting stage employing a Working-Leser model with the imposition of an adding-up restriction. Total per capita expenditure is statistically significant for the food at home equation. The derived food at home expenditure elasticity is 0.52, indicating that demand for food at home is rather inelastic among urban households in Bangkok and Chiang Mai. This result is in line with findings from other studies (e.g., Bhadrakom, 2008).

Expenditure is insignificant for food away from home, perhaps due to the variety of options to purchase it. The food away from home group consists of street food shops, which are also affordable to poorer households, and upscale restaurants, where only the relatively richer populations segments tend to eat.

The demand parameters for commodities within the food at home group are estimated at the second budgeting stage using the LAIDS model, as discussed above. The probit results needed for the Shonkwiler and Yen procedure for 4 food items[8] are presented in appendix 3, while the parameters from the LAIDS model are presented in appendix 4. The expenditure coefficients are significant for fruits, rice & glutinous rice, meat and fish & seafood. Most own-price coefficients are also statistically significant, at least at the 10% level. Household size has a statistically negative impact on the share of fresh fruits, fresh vegetables, other fresh food and preserved fruits & vegetables. In contrast, household size exhibits a statistically positive impact on rice & glutinous rice and fish & seafood. The female labor force participation variable yields a statistically significant negative impact on the share of meat and a statistically significant positive impact on the shares of other fresh foods and preserved fruits & vegetables. The level of education positively influences demand for fruits, other fresh food and preserved fruits & vegetables, which is in line with the assumption that better-educated household heads tend to consume more nutritious food products. Geographic location dummies are statistically significant in the fruits, rice & glutinous rice and meat equations, but with different signs, suggesting different preferences among households in Bangkok and Chiang Mai.

As explained above, elasticities are calculated based on the formulas provided by Green and Alston (1990). Using the estimated coefficients on the logarithm of food at home expenditure, own-price and the average budget share, all resulting expenditure and own-price elasticities have the expected sign (table 5). The unconditional expenditure elasticities for higher-value foods like

[8] Households reported very low frequencies of zero consumption for fresh fruits (1 household) and fresh vegetables (4 households), while non-zero consumption for other fresh food and other preserved food. In that sense, we would not estimate the selective estimators for those items.

fruits, vegetables, meats, fish and seafood are higher than the elasticities for rice and glutinous rice. These results suggest that urban households in Bangkok and Chiang Mai tend to spend more on nutritious food items as incomes increase, pointing at a continuous dietary diversification. For the own-price elasticities, notable differences can be seen for different food categories. As expected, absolute values are lowest for the staple food rice, while they are significantly higher for more expensive foodstuffs, especially meat and preserved fruits & vegetables. Additionally, elasticities calculated without correcting selective bias in the demand estimation are presented in Appendix 5. The two sets of elasticity estimate are slightly different for rice & glutinous rice and fish & seafoods. The most notable difference occurs for meat and preserved fruits & vegetables, which can be seen in the significance level of probability density function (Appendix 3) . This provides evidence that it is important to accommodate zero observations in these aggregate commodities.

As we rely on the use of unit values as a proxy for price information, the quality expenditure elasticity for each commodity is estimated to characterize the size of quality effect. Following Deaton (1988), unit values are equal to the sum of price and quality. The extent to which quality considerations of consumers determine demand can be assessed by regressing the logarithm of unit values on the logarithm of total expenditure, household characteristics and regional dummies (11 districts[9]) reflecting the differences between clusters in prices. The estimated percentage changes in unit values in response to percentage changes in total expenditures can be interpreted as quality expenditure elasticity (Appendix 6). An insignificant quality effect is given for meat, other fresh food and preserved fruits & vegetables. However, quality expenditure elasticities are present, though of small magnitude, for other commodities. This supports our assumption that aggregate food groups are fairly homogenous in terms of quality. Therefore, unit values are a relatively good proxies for product prices in our study.

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[9] There are 12 districts in our sample. Chang Pueak district and Nongpakung district are merged as they have fewer observations but fairly homogenous geographic location.

Table 4

Demand estimation for broad group expenditures

Variables	Food at home	Food Away From Home	Non-food
Annual per capita total expenditure	-0.1115***	0.0073	0.1042
(log)	[0.0070]	[0.0087]	
Size (log)	-0.0912***	-0.0015	0.0927
	[0.0092]	[0.0113]	
Female labor	-0.0059	-0.0089	0.0149
	[0.0093]	[0.0115]	
Education	-0.0021**	0.0007	0.0015
	[0.0010]	[0.0012]	
White collars	-0.0167	-0.0011	0.0178
	[0.0137]	[0.0168]	
Workers	-0.0228**	-0.0187	0.0415
	[0.0100]	[0.0123]	
Children (> 5 years)	-0.0074	-0.014	0.0214
	[0.0097]	[0.0119]	
Age	0.0005*	-0.0008**	0.0003
	[0.0003]	[0.0004]	
Bangkok	-0.0131	-0.0204*	0.0335
	[0.0092]	[0.0113]	
Health awareness	0.0171	-0.0816***	0.0645
	[0.0172]	[0.0211]	
Constant	1.6246***	0.2068**	-0.8314
	[0.0845]	[0.1039]	
Chi-square	452.83	28.72	
Mean budget share	0.23	0.15	0.62
Group expenditure elasticity	0.52	1.05	1.17

Source: Estimated based on household survey data.

Note: *, **, *** Estimates are significant at the 10%, 5% and 1% level, respectively. Coefficient of non-food group is calculated from the adding-up restrictions. Numbers in parentheses are standard errors.

Table 5

Demand elasticities for different food categories

Commodity	Mean Budget share	Within group expenditure elasticity	Unconditional expenditure elasticity	Uncompensated own-price elasticity	Quality elasticity
Fruits	0.20	0.85	0.44	-0.46	0.16
Vegetables	0.11	1.03	0.54	-0.63	0.09
Rice & glutinous rice	0.10	0.41	0.21	-0.27	0.08
Meat	0.08	1.37	0.71	-0.84	-0.01
Fish & seafood	0.13	1.32	0.69	-0.51	0.20
Other fresh food	0.17	0.99	0.51	-0.78	0.04
Preserved F&V	0.05	1.14	0.60	-0.95	0.05
Other preserved food	0.17	1.04	0.54	-0.37	0.09

Source: Calculated from system estimates based on household survey data

5. Conclusion

Urbanization in developing countries has been observed to be associated with changes in household food consumption patterns from staple foods towards higher-value and more nutritious food items. In Thailand, this trend occurred together with a declining trend in rice consumption, especially among high-income households. In general, however, the demand for more nutritious foods has so far received relatively little attention in the literature; related analyses have been limited to the application of restrictive Working-Leser model formulations. Addressing this gap and accounting for problems arising from censored data, we have estimated a two-stage budgeting demand system using household survey data from urban areas of Bangkok and Chiang Mai. Our estimated demand elasticities are in the same range for broad group commodities, but significantly differ from those found in other studies for the food items in the second stage (see Appendix 7). For instance, Isvilanonda and Kongrith (2008) concluded that rice is an inferior good. In our study, rice has small but positive income and expenditure elasticity. In

Sutthipongpan (2005), income elasticities for aggregate fish & seafood among urban households in Bangkok and the Northern Region ranged between 0.26 and 0.35, while being around 0.12 for meat. For both food groups, our estimates are above 0.4. Considering own-price demand elasticity, the result is only found in the recent study of Isvilanonda and Kongrith (2008), so far not for high-value food items. Moreover, most previous studies did not apply theoretically consistent demand systems. The mutual interdependence of a variety commodity depending on relative prices, household budgets and preferences were neglected, and censored data problems were not addressed. In this context, our findings are more robust and reliable. Likewise, findings of a specific household survey for a basket of foods in Bangkok and Chiang Mai strongly support the reliability of our results particularly for household food consumption patterns in metropolitan areas.

Overall, the demand for higher-value foods in urban Thailand raises more with increasing incomes than the demand for staple foods. Likewise, households are more price responsive with respect to higher-value foods. These results suggest that economic developments and policies that foster income growth and competition in the farm and agribusiness sector will contribute to better nutrition and further dietary diversification.

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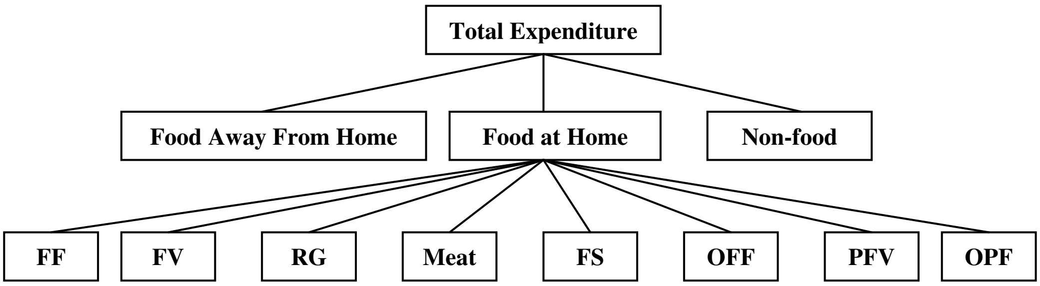
Appendix

Appendix 1 Two-stage budgeting of food demand



Source: Adapt from Deaton and Muellbauer, 1980

Appendix 2 Unconditional expenditure elasticity formula (Edgerton, 1997)

In the two-stage budgeting, weak separability assumption of the direct utility function is necessary and sufficient condition (Deaton and Muellbauer, 1980). At the first budgeting stage, total expenditure is allocated to 3 board groups. This can be formally expressed as followed:

$$x = \psi(P, y) \qquad \text{A2.1}$$

where x is 3x1 vector of board group expenditure and P is 3x1 vector of group price indices. $y = q * p$ is the total expenditure. In the second stage, food at home expenditure is allocated to *i* commodities. Considering the ith aggregate food items within the gth group (food at home), the conditional Marshallian demand function is

$$q_g = h_g(p_g, x_g) \qquad \text{A2.2}$$

As there are 8 commodities in the second stage, q_g is 8x1 sub-vector of *q*. The restriction $x_g = q_g * p_g$ holds in each board group and $\sum x_g = y$. If the two-stage budgeting is appropriate, the conditional and unconditional demand function must yield the same as followed:

$$f_g(p, y) = h_g[p_g, \varphi_g(P, y)], \qquad g = 1,....,3 \qquad \text{A2.3}$$

For the implication of the elasticity, the total expenditure of i[th] food commodity within g[th] group can be defined as $E_i = \frac{\partial \ln f_{gi}}{\partial \ln y}$. While, the conditional expenditure of commodity *i* within group *g* is $e_{(g)i} = \frac{\partial \ln h_{gi}}{\partial \ln x_g}$

For the group expenditure elasticity, Edgerton defined function $g_g = \frac{\varphi_g}{P_g}$ and the aggregate demand function is $Q = g(P, y)$, where Q and P is vector of quantity and price indices, respectively. The group expenditure elasticity therefore is defined as $e_g = \frac{\partial \ln g_g}{\partial \ln y}$

Edgerton (2001) described that unconditional expenditure (income) elasticity must be affected by both within-group expenditure elasticity and group expenditure elasticity. So, the differentiation of equation A6.3 yields

A2.4 $$E_i = \frac{\partial \ln f_{gi}}{\partial \ln y} = \frac{\partial \ln h_{gi}}{\partial \ln x_g} \cdot \frac{\partial \ln \varphi_g}{\partial \ln y} = \frac{\partial \ln h_{gi}}{\partial \ln x_g} \cdot \left(\frac{\partial \ln g_g}{\partial \ln y} + \frac{\partial \ln P_g}{\partial \ln y}\right)$$

A2.5 $$E_i = e_{(g)i} \cdot [e_{(g)} + \frac{\partial \ln P_g}{\partial \ln y}]$$

Form the two-stage budgeting, P_g is assumed to approximately independent of the level of expenditure, therefore unconditional expenditure (income) elasticity for item *i* within group g will thus be a yield of group expenditure elasticity multiplied by within group expenditure elasticity.

Appendix 3 Probit models of the decision to purchase aggregate food item of food at home

	RG	Meat	FS	PFV
Total expenditure (log)	0.1942	-0.3189**	-0.0029	0.0802
	[0.1368]	[0.1274]	[0.1157]	[0.154]
$Price^{FF}$ (log)	-0.0053	0.5867**	0.1499	-0.0146
	[0.2844]	[0.2741]	[0.2205]	[0.3024]
$Price^{FV}$ (log)	-0.0505	-0.2168	-0.5615***	-0.1521
	[0.2324]	[0.2289]	[0.1896]	[0.1728]
$Price^{RG}$ (log)	0.9153**	-0.0434	0.1532	0.0081
	[0.3710]	[0.3105]	[0.2463]	[0.2692]
$Price^{meat}$ (log)	-0.4438	-0.1479	-0.052	-0.1924
	[0.2999]	[0.2598]	[0.2272]	[0.2598]
$Price^{FS}$ (log)	-0.1007	0.0021	-0.0259	0.1554
	[0.1707]	[0.1273]	[0.1144]	[0.1429]
$Price^{OFF}$ (log)	-0.1857	-0.1715	-0.3763*	-0.2264
	[0.2828]	[0.2088]	[0.1999]	[0.2067]
$Price^{PFV}$ (log)	-0.2179	-0.2403**	-0.0156	0.0356
	[0.1834]	[0.1192]	[0.0913]	[0.0786]
$Price^{OPF}$ (log)	-0.0829	0.0174	0.144	0.2653
	[0.2491]	[0.1988]	[0.1808]	[0.2138]
Size (log)	1.3049***	0.8284***	0.6858***	0.4749***
	[0.2125]	[0.1740]	[0.1546]	[0.1618]
Female labor	-0.3386	0.0129	0.0173	-0.2923*
	[0.2059]	[0.1771]	[0.1476]	[0.1710]
Education	-0.0204	-0.0232	-0.0537***	0.007
	[0.0185]	[0.0200]	[0.0155]	[0.0162]
Bangkok	-0.1373	-0.6073***	0.1268	-0.0737
	[0.2320]	[0.2186]	[0.1740]	[0.2037]
Constant	0.2397	5.8430***	2.9372*	0.3348
	[2.3488]	[1.9769]	[1.6618]	[1.9822]
Wald chi2	69.53	73.6	49.96	22.48
N	31	48	78	43

Source: Estimated based on household survey data.

Note: *, **, *** Estimates are significant at the 10%, 5% and 1% level, respectively. N denotes the number of households that reported zero consumption. Numbers in parentheses are robust standard errors.

Appendix 4 Conditional aggregate demand system estimates for food categories

	FF	FV	RG	Meat	FS	OFF	PFV	OPF
Food at home expenditure (log)	-0.0288**	0.0036	-0.0568***	0.0282***	0.0423***	-0.0021	0.0069	0.0067
	[0.0130]	[0.0058]	[0.0087]	[0.0068]	[0.0096]	[0.0112]	[0.0058]	
$Price^{FF}$ (log)	0.1022***	-0.0188***	-0.0210***	-0.0143*	-0.0197***	-0.0217**	0.0043	-0.0164
	[0.0149]	[0.0064]	[0.0059]	[0.0082]	[0.0068]	[0.0090]	[0.0044]	
$Price^{FV}$ (log)	-0.0188***	0.0398***	-0.0007	0.0062	-0.0141***	0.0022	0.0035	-0.0194
	[0.0064]	[0.0058]	[0.0043]	[0.0064]	[0.0053]	[0.0057]	[0.0028]	
$Price^{RG}$ (log)	-0.0197***	-0.0007	0.0649***	-0.0088	-0.0099**	-0.0037	0.001	-0.0228
	[0.0056]	[0.0040]	[0.0124]	[0.0066]	[0.0044]	[0.0062]	[0.0027]	
$Price^{meat}$ (log)	-0.0129*	0.0056	-0.0085	0.0139*	-0.0055	0.0071	0.0075**	-0.0074
	[0.0074]	[0.0058]	[0.0063]	[0.0083]	[0.0054]	[0.0064]	[0.0032]	
$Price^{fs}$ (log)	-0.0166***	-0.0119***	-0.0089**	-0.0052	0.0695***	-0.0024	-0.0067	-0.0102
	[0.0057]	[0.0044]	[0.0040]	[0.0050]	[0.0083]	[0.0068]	[0.0044]	
$Price^{off}$ (log)	-0.0217**	0.0022	-0.004	0.0079	-0.0028	0.0369*	0.0015	-0.0199
	[0.0090]	[0.0057]	[0.0066]	[0.0071]	[0.0080]	[0.0209]	[0.0082]	
$Price^{pfv}$ (log)	0.004	0.0032	0.0009	0.0076**	-0.0073	0.0014	0.0028	-0.0139
	[0.0040]	[0.0025]	[0.0026]	[0.0032]	[0.0047]	[0.0075]	[0.0022]	
$Price^{opf}$ (log)	-0.0164	-0.0194***	-0.0228***	-0.0074	-0.0102	-0.0199***	-0.0139**	0.1100
	[0.0123]	[0.0056]	[0.0052]	[0.0049]	[0.0071]	[0.0071]	[0.0063]	
Size (log)	-0.0690***	-0.0101*	0.0255*	-0.0006	0.0279**	-0.0224**	-0.0257**	0.0744
	[0.0123]	[0.0059]	[0.0136]	[0.0069]	[0.0132]	[0.0088]	[0.0103]	
Female labor	-0.0024	-0.004	0.0029	-0.0122**	-0.0015	0.0239**	0.0129*	-0.0195
	[0.0101]	[0.0059]	[0.0067]	[0.0058]	[0.0114]	[0.0100]	[0.0073]	
Education	0.0028***	-0.0008	0.0002	0.0005	-0.0019	0.0011	0.0003	-0.0023
	[0.0009]	[0.0006]	[0.0005]	[0.0007]	[0.0014]	[0.0009]	[0.0006]	
White collar	-0.0108	-0.0105	0.0023	-0.0084	0.0008	0.0446**	-0.0016	-0.0164
	[0.0152]	[0.0068]	[0.0081]	[0.0084]	[0.0175]	[0.0182]	[0.0097]	
Workers	-0.0012	-0.0012	-0.0064	-0.0031	0.0077	-0.0096	-0.0044	0.0180
	[0.0104]	[0.0057]	[0.0055]	[0.0061]	[0.0113]	[0.0086]	[0.0063]	
Diseases	0.0072	0.0142***	0.0059	-0.0024	-0.0031	-0.0036	-0.0054	-0.0128
	[0.0083]	[0.0046]	[0.0055]	[0.0062]	[0.0110]	[0.0086]	[0.0047]	
Distance	-0.0027	0.0027*	-0.0001	0.0031	0.0000	-0.0005	0.0000	-0.0025
	[0.0023]	[0.0015]	[0.0010]	[0.0023]	[0.0017]	[0.0014]	[0.0013]	

Age	0.0008**	0.0002	0.0007***	-0.0001	0.0003	0.0004	-0.0004**	-0.0017
	[0.0003]	[0.0002]	[0.0002]	[0.0002]	[0.0003]	[0.0003]	[0.0002]	
Bangkok	-0.0124	-0.0142***	0.0262***	0.0208***	0.0127	-0.0165*	-0.0078	-0.0088
	[0.0089]	[0.0052]	[0.0058]	[0.0074]	[0.0106]	[0.0095]	[0.0068]	
PDF	-	-	0.0399	-0.1425***	0.0054	-	-0.2782***	0.3755
	-	-	[0.0813]	[0.0383]	[0.0844]	-	[0.0964]	
Constant	0.5727***	0.1018*	0.6221***	-0.1987***	-0.3702***	0.1813	0.0786	0.0124
	[0.1365]	[0.0607]	[0.0989]	[0.0665]	[0.1039]	[0.1147]	[0.0727]	
R-sq	0.1997	0.1623	0.462	0.103	0.2261	0.1097	0.0548	
Chi2	134.99	111.78	428.30	59.88	150.42	69.94	40.28	

Source: Estimated based on household survey data.

Note: *, **, *** Estimates are significant at the 10%, 5% and 1% level, respectively. Coefficient of other preserved food group is calculated from the adding-up restrictions. Independent variables are multiplied by cumulative distribution functions ($\Phi(z_i^{'}\ \hat{\alpha})$) as shown in equation 6. The model also included the probability density function (PDF : $\phi(z_i^{'}\ \hat{\alpha})$). Numbers in parentheses are bootstrap standard errors.

Appendix 5 Demand elasticities from demand model without and with selective bias

Commodity	budget share	Conditional expenditure elasticity		Own-price elasticity	
		Without	SY	Without	SY
Fruits	0.20	0.86	0.85	-0.47	-0.46
Vegetables	0.11	1.03	1.03	-0.61	-0.63
Rice & glutinous rice	0.10	0.38	0.41	-0.30	-0.27
Meat	0.08	1.29	1.37	-0.91	-0.84
Fish & Seafood	0.13	1.34	1.32	-0.53	-0.51
Other fresh food	0.17	0.99	0.99	-0.79	-0.78
Preserved F& V	0.05	1.22	1.14	-0.93	-0.95
Other preserved food	0.17	1.05	1.04	-0.45	-0.37

Source Estimated based on household survey data.

Note: Without means that the models were estimated without selective correction, while SY means that Shonkwiler and Yen approach has been applied in the demand estimation.

Appendix 6 The estimated regression of unit value

Variable	Logarithm of unit value of							
	FF	FV	RG	Meat	FS	OFF	PFV	OPF
Total expenditure (log)	0.1618***	0.0875***	0.0758***	-0.0107	0.2046***	0.0401	0.0475	0.0932***
	[0.0257]	[0.0322]	[0.0187]	[0.0192]	[0.0484]	[0.0256]	[0.0654]	[0.0358]
Din Daeng district	0.2229***	0.1459	0.0061	0.1157*	0.3680***	0.2419***	0.1080	-0.0428
	[0.0678]	[0.1099]	[0.0861]	[0.0644]	[0.1277]	[0.0882]	[0.2171]	[0.1233]
Dusit district	0.2031**	0.1916	0.1750**	0.1024	0.4411***	0.2429**	0.5063**	0.0273
	[0.0826]	[0.1203]	[0.0846]	[0.0690]	[0.1408]	[0.0966]	[0.2378]	[0.1350]
Jom Thong district	0.3329***	0.3051***	0.1628**	0.0679	0.4807***	0.2467***	0.3060	0.0857
	[0.0716]	[0.1081]	[0.0826]	[0.0626]	[0.1285]	[0.0868]	[0.2117]	[0.1213]
Khlong Toei district	0.4867***	0.2530**	0.1086	0.0938	0.4303***	0.3091***	0.2787	0.0251
	[0.0778]	[0.1106]	[0.0834]	[0.0624]	[0.1260]	[0.0883]	[0.2191]	[0.1234]
Wangthonglang district	0.2479***	0.3162***	0.1640*	0.0439	0.3548***	0.1642*	0.3180	0.0025
	[0.0675]	[0.1112]	[0.0844]	[0.0643]	[0.1280]	[0.0893]	[0.2216]	[0.1247]
Yannawa district	0.2819***	0.2089*	0.1911**	0.1512**	0.5259***	0.2477***	0.3138	0.0070
	[0.0697]	[0.1136]	[0.0803]	[0.0650]	[0.1107]	[0.0912]	[0.2254]	[0.1275]
Kawila sub-district	0.0345	-0.0086	0.1142	-0.0538	0.2519**	0.2417***	0.4305*	0.0728
	[0.0655]	[0.1108]	[0.0839]	[0.0634]	[0.1210]	[0.0888]	[0.2182]	[0.1240]
Meng-Rai sub-district	0.0073	-0.0522	0.2047**	-0.0461	0.2274*	0.0779	0.1757	0.0659
	[0.0663]	[0.1134]	[0.0922]	[0.0645]	[0.1298]	[0.0907]	[0.2248]	[0.1268]
Nakorn-Ping sub-district	0.0111	-0.0297	0.0348	0.0147	0.3827***	0.1939**	-0.1075	0.0496
	[0.0671]	[0.1120]	[0.0819]	[0.0634]	[0.1096]	[0.0899]	[0.2244]	[0.1257]
Sri-Vichai sub-district	-0.0104	0.0189	0.0951	-0.0059	0.2466*	0.1262	0.4346*	-0.0252
	[0.0662]	[0.1156]	[0.0879]	[0.0666]	[0.1385]	[0.0929]	[0.2277]	[0.1298]
Size (log)	0.1077***	0.0002	0.0238	-0.0056	0.1492**	-0.0315	-0.0918	-0.0006
	[0.0313]	[0.0397]	[0.0254]	[0.0240]	[0.0598]	[0.0318]	[0.0812]	[0.0444]
Female labor	-0.0503*	0.0145	-0.0075	0.0185	0.0012	-0.0570*	-0.1467*	-0.1185***
	[0.0289]	[0.0400]	[0.0259]	[0.0237]	[0.0580]	[0.0320]	[0.0812]	[0.0448]
Education year	0.0005	0.0093**	0.0030	0.0010	0.0050	0.0010	-0.0023	0.0092*
	[0.0033]	[0.0043]	[0.0025]	[0.0026]	[0.0064]	[0.0035]	[0.0088]	[0.0049]
Age	0.0009	0.0013	0.0007	0.0016*	0.0034*	-0.0014	0.0000	0.0020
	[0.0009]	[0.0014]	[0.0009]	[0.0008]	[0.0020]	[0.0011]	[0.0028]	[0.0015]
Constant	1.1017***	2.1234***	1.9874***	4.3255***	1.3311**	3.3003***	3.5635***	2.9871***
	[0.2995]	[0.3938]	[0.2287]	[0.2311]	[0.5668]	[0.3131]	[0.8009]	[0.4375]
R-square	0.3384	0.1340	0.1051	0.0750	0.1283	0.0694	0.0550	0.0553
Observation	499	496	469	452	422	500	457	500

Source: Estimated based on household survey data.

Note: *, **, *** Estimates are significant at the 10%, 5% and 1% level, respectively. Numbers in parentheses are robust standard errors for FF, RG, FS and standard error for the other commodities.

Appendix 7 The comparison of demand elasticities with the other studies

Commodity	Own estimated results		Results from previous studies		
	Unconditional expenditure elasticity	Own-price elasticity	Expenditure elasticity	Own-price elasticity	Authors/Year
Food at home	0.52	-	0.45[a]	-	Bhadrakom, 2008
			0.50[b]		
Food away from home	1.05	-	0.91[c]	-	
			1.17[d]		
Fruits	0.44	-0.46	0.85[e]	-	Daroonpate et al., 2005
vegetables	0.54	-0.63	0.18[f]	-	Schmidt and Isvilanonda, 2002
Rice	0.21	-0.27	-0.17	-0.26	Isvilanonda and Kongrith, 2008
Meat	0.71	-0.84	0.11-0.12	-	Sutthipongpan, 2005
Fish & Seafood	0.69	-0.51	0.26-0.35	-	

Note: a and b are expenditure elasticity for food prepare at home for households in Bangkok and North region, respectively. c and d are expenditure elasticity for food away from home for households in Bangkok and North region, respectively. e is total food expenditure elasticity. f is the elasticity of total vegetable expenditure with respect to food expenditure.