Differences in Household Food Demand by Income Category As Evidenced in Rural Thailand*

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Abstract:

This research investigated the response of food demand to changes in price and income, as well as to determine how demographic variables make an impact on food demand of Thai rural households. Quadratic Almost Ideal Demand System (QUAIDS) was used to obtain parameter estimates of the food demand for 13 food commodities. Findings shows households with more family members tended to purchase high calorie and necessary foods instead of the more expensive and unnecessary one. The percentage of adults aged over 65 had caused negative impact on the demand for rice, starches and pulses, meats and poultry. Signs of expenditure elasticities and own-price elasticities were found consistent with the consumer demand theory. Increase in household food budget led to an increase in demand of eggs and dairy products, rice, ready-to-eat foods, oils and fats, and alcoholic beverage and tobacco. Additionally, all own-price elasticities were negatively related to the budget shares of household food consumption. The households at low level of income are likely to change their budget shares toward the major food groups that provide basic nutrients (e.g., rice, fruits, vegetables, and ready-to-eat products) more than middle-and high-income groups. Estimated income elasticities with respect to rice, eggs and dairy products, fruits, ready-to-eat and instant products, and alcoholic beverage and tobacco were above 0.5 while the income elasticity of rice was in the same range for all household groups.

keywords: expenditure elasticity, food demand, own-price elasticity, poverty, Thailand

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1. Introduction

In less than a generation, Thailand has made remarkable progress in social and economic development, moving from a low-income country to a middle-income country. The country has enjoyed annual growth rate averaging 4.83 percent from 1981 until 2020 and indeed has become an upper middle-income country from 2011 onwards. In 2019, gross national income per capita was 7,260 USD. Thai economy has been transformed from an agricultural society to modern industrial society. Economic poverty has continually improved. The country's poverty incidence based on national poverty lines has dramatically dropped from 42.2% in year 2000 to 16.4% in 2010 and 6.2% in 2019 (World Bank, 2021). Economic growth has diverged the Thai economy into a rural subsistence sector (i.e., traditional agriculture) and modern urban sector (i.e., industrial, commercial, and service). Modern economic structures have created jobs and generated income as well as, accelerated rural-urban migration. From 2010 to the recent year, 30-35 percent of Thai population is living in urban areas and working in the manufacturing, commercial, and service sectors (World Bank, 2021). In the meanwhile, more than 30 percent of Thai labor force is still working in the rural-agricultural sector (Thailand National Statistics Office, 2020). The average wage of agricultural workers was 5,000 baht per month (1 THB approximately equals to 0.032 USD, January, 2022), which accounted to only one third of non-farmworker wage rate (Bank of Thailand, 2018). By contrast, the annual income of non-poor farmworkers averaged 3,542 USD, which was 6 times higher than the low-income workers (Office of Thailand Agricultural Economics, 2019). Additionally, farmworkers who are living below the national poverty line (993 USD/year) during the 2013/14 crop year had an annual income of only 576 USD. The northeastern region of Thailand had the highest proportion of poor-agricultural households at 37.27 percent, followed by households in the northern, central and southern regions, at 26.09, 13.86 and 9.57 percent, respectively.

Population in developing countries have tendency to spend 60 to 80 percent of their household income on food (World Food Programme, 2019). Private consumption expenditure is also the largest component of the overall Thai national income. The private consumption share of the country GDP accounted for the 49 to 59 percent during 1998 to 2019; however, it annual growth rate has declined from 7.0% in year 2000 to 5.5% in 2010 and 4.0% in 2019. Further, the growth rate of Thai private consumption has dramatically decreased during the covid-19 pandemic. The annual growth rate averaged -1% in 2020 and has improved to 0.3%

in the fourth quarter of 2021 (Office of National Economic and Social Development Council, 2022). The economic development could has an impact on household socio-economic status and commodity demand. The poor is more experiencing severe economic distress, forcing them to cut back on non-essential goods such as school books, medicines, shelter and clothes (World Food Programme, 2019). Rising food prices would have stronger effect to low-income households than higher-income households.

Although the portion of the total Thai population living below the national poverty line has decreased, an unequal distribution of income in Thailand still remains as the country aims to become an upper-income country. Between years 2000 to 2019, Gini coefficient (an aggregate inequality measures) of Thailand was ranked above 0.36 (World Bank, 2021). The greater degree of inequality of income distribution has caused economic and social problems especially for the low-income households such as low standard of living, unaffordable health care and education. Food insecurity as a lack of financial resources to provide enough food in terms of quantity and quality for every member in the household, results in unhealthy and inactive life for adults, and child malnutrition. Households with income below and above the poverty line may respond to changes in food prices and income differently. Therefore, estimates of elasticity in prices and income under groups categorized by income, give a better understanding of household food demands.

Several previous studies have analyzed food consumption behavior of the households using either linear expenditure system (LES) or linear approximation of an almost ideal demand system (LA/AIDS) (Park et al. (1996), Henneberry et al. (1999), and Shiptsova et al. (2004)). Due to their disadvantages on the linearity of expenditure, Quadratic Almost Ideal Demand System (QUAIDS) proposed by Banks, Blundell, and Lewbel (1997) has been widely used for researchers in recent years to analyze the demand system (e.g., Abdulai and Aubert (2003), Zheng and Henneberry (2010), and Faharuddin et al. (2019)). The QUAIDS model allows food expenditure share to be a quadratic term which represents a flexible demand system. In addition to literatures on demand analysis, there are several studies showing estimate of own-price and income elasticities for food items in both developed and developing countries. However, none of the studies focused on the change in food consumption at different levels of household income, specifically for Thailand. This research, therefore, is emphasized to investigate the response of food demand to changes in price and household income, as well as to determine how demographic variables make an impact on food demand by using the QUAIDS. The

remaining sections of the study proceed as follow: (*a*) description of data and analysis used in the study, (*b*) outline of methods and procedures for food demand model, (*c*) presentation of results of demand elasticities, and (*d*) discussion and implication.

2. Data

Data used for this study is a portion of the 1998-2014 Townsend Thai monthly panel data, collected from rural households in four provinces of Thailand (i.e., Chachoengsao, Lopburi, Buriram and Srisaket). The Townsend Thai survey provides a sample of duplicated 261 households for a period of 16 years. Due to limitations on price data, only samples from year 2002 to 2014 (13 years) were included in this study. The data set hence consisted of 3,390 observations. In addition, household expenditures for some food groups were recorded as zero, which could be due to non-purchases in food commodities, or missing values from the interview. The zero-expenditure problem, i.e. censoring of dependent variables, caused biased parameter estimates. Thus, observations of households with zero expenditures exceeding five food groups were necessarily removed. On net, the data set consisted of 2,687 observations. Tables 1 and 2 present number of samples and average annual income of the households in the four provinces during the 13 years.

Table 1: The Number of Household Samples by Province and Year

Year	Number of samples (household/ (Percent))				
	Chachongsao	**Buriram**	**Lopburi**	**Srisaket**	**All provinces**
2002	75	24	33	57	189
	(39.68)	(12.70)	(17.46)	(30.16)	(100)
2003	88	21	32	61	202
	(43.56)	(10.40)	(15.84)	(30.20)	(100)
2004	91	29	26	67	213
	(42.72)	(13.62)	(12.21)	(31.46)	(100)
2005	87	27	28	64	206
	(42.23)	(13.11)	(13.59)	(31.07)	(100)
2006	82	27	31	62	202
	(40.59)	(13.37)	(15.35)	(30.69)	(100)
2007	85	23	32	68	208
	(40.87)	(11.06)	(15.38)	(32.69)	(100)
2008	87	18	31	55	191
	(45.55)	(9.42)	(16.23)	(28.80)	(100)
2009	91	26	36	58	211
	(43.13)	(12.32)	(17.06)	(27.49)	(100)
2010	96	24	44	66	230
	(41.74)	(10.43)	(19.13)	(28.70)	(100)
2011	96	22	35	63	216
	(44.44)	(10.19)	(16.20)	(29.17)	(100)
2012	95	25	27	62	209
	(45.45)	(11.96)	(12.92)	(29.67)	(100)
2013	95	22	29	53	199
	(47.74)	(11.06)	(14.57)	(26.63)	(100)
2014	96	22	34	59	211
	(45.50)	(10.43)	(16.11)	(27.96)	(100)
All years	**1,164**	**310**	**418**	**795**	**2,687***

Table 2: The Average per Capita Income of Households by Province and Year

Year	Chachungsao	Burirum	Lopburi	Srisaket	All			
	Mean/(S.D.)	Mean/(S.D.)	Mean/(S.D.)	Mean/(S.D.)	Mean	S.D.	Min	Max
2002	193370	63939.56	140307.6	64753.08	128880.3	169554.4	-439203	1010424
	(218374.7)	(79389.0)	(115881.3)	(107683.5)				
2003	190076.7	114127.8	171675.9	56201.01	138838.2	187155.9	-51476	1546941
	(226285.9)	(220080.2)	(123249.2)	(86708.09)				
2004	170295.3	161843.9	184556.8	70851.39	139605	225844.7	-207408	2750918
	(147776.8)	(505087.2)	(141765.7)	(105378.5)				
2005	178101.4	60980.02	188458	65077.66	129044.1	142016.8	-81672.9	625520
	(150985.9)	(85612.12)	(153241.8)	(101910.6)				
2006	188434.6	48671.58	175438.8	71422.5	131844.4	139369.6	-33399	676694
	(147493.7)	(77652.91)	(126567.1)	(112358.7)				
2007	220450.7	85625.19	249557.8	65260.53	159284.9	195016.5	-15807	1474152
	(218446.9)	(84388.91)	(229269.6)	(107426)				
2008	301324.5	118857.1	311239.9	80470.81	222141.3	260831.1	-28027.9	1744768
	(302027.6)	(136393.6)	(253168.3)	(118220.9)				
2009	335537.9	79502.39	403436.4	109898.7	253549	412585.2	-7245.69	4835160
	(316177.9)	(110280.5)	(791767.1)	(138923.4)				
2010	342370.3	174769.9	373690.2	121885	267603.5	408380.2	-4139.35	4883139
	(318267.8)	(208666.3)	(740389.3)	(144393.7)				

Table 2: (cont'd)

Year	Chachungsao	Burirum	Lopburi	Srisaket	All			
	Mean/(S.D.)	Mean/(S.D.)	Mean/(S.D.)	Mean/(S.D.)	Mean	S.D.	Min	Max
2011	364226.4	167728.2	385308.1	126462	278280.8	298455	-837.581	1625988
	(307742.8)	(194532.8)	(377991.5)	(164151)				
2012	481079.4	198686.9	540274.9	100827.5	342145.6	450629.3	-2505.07	4062975
	(553023.7)	(206539.5)	(428834.9)	(104451.4)				
2013	398790.3	195192.8	365823.4	166658.5	309653.8	320535.7	-31177	2095753
	(359178)	(153937.9)	(397361.8)	(144070.1)				
2014	365398.3	239142.2	351266.7	141772.8	287426.7	315696.4	-182029	1653474
	(338648.8)	(297932.7)	(313910)	(223358.7)				
Total	291803.7	129574.9	298715.8	94537.67	215797.7	301483.6	-439202.8	4883139
	(316185.4)	(225237.3)	(421760.1)	(134776)				
All Provinces								
Mean	291803.7	129574.9	298715.8	94537.67				
S.D.	316185.4	225237.3	421760.1	134776				
Min	-439202.8	-81672.94	-4139.351	-102460.7				
Max	4062975	2750918	4883139	1653474				

***Note*:** Estimated from 2,687 observations.

The annual income in this study was calculated as total revenue minus total cost of the production and other production activities. In some years, the households had invested in their production causing them a minus annual income. Therefore, the observations with a large outlier of the per capita income and expenditure were removed from the analysis. And, some households had a negative value of the quality-adjusted prices. This set of observations were also removed from the analysis. The final set of data used in our food demand system consisted of 2,370 observations.

This particular research was aimed to determine the effect of income level on household food consumption, therefore, data was divided into 5 equally sized groups based on the quintile of income: low income, lower middle-income, middle income, upper middle-income, and high-income households. Table 3 reports the summary statistic for the household per capita income for the 5 quintiles.

Table 3: Summary Statistics for Household per Capita Income by Quintile

	Per capita income (baht/year)				Number of samples
Quintile	**mean**	**S.D.**	**min**	**max**	**(household)**
1	16,634	11,271	0	36,551	405
2	63,820	16,672	36,551	94,380	494
3	136,382	25,888	94,425	182,077	494
4	263,851	52,342	182,085	363,232	494
5	673,367	442,362	363,727	4883139	483
Total	236,799	310,231	0	4883139	2,370

Note: Quintiles 1 to 5 are low income, lower middle-income, middle income, and upper middle-income, and high-income households.

Table 4 presents descriptive statistics of demographic variables for households. The family size, number of adults, and educational level of household heads was lower in low and lower middle-income families while their ages were higher as compared to the upper middle-income and high-income households. The low-income households showed a larger youth dependency ratio, percentage of children under age 18, and percentage of adults aged over 65 was compared with those high-income households as our expectation.

Table 4: Descriptive Statistics of Demographic Variables

Demographic Variables	Income Category Mean/ (S.D.)					All				
	Q1	Q2	Q3	Q4	Q5	Mean	Median	S.D.	Min	Max
Age of head of household (year)	68 (12)	63 (12)	60 (13)	61 (13)	59 (12)	62	63	13	30	94
Gender of head of household (1=male, 0= female)	1.9 (0.99)	1.8 (0.97)	1.8 (0.98)	1.6 (0.91)	1.6 (0.9)	1.7	1	0.96	1	3
Educational level of household heads (year)	4.4 (2.5)	4.2 (2.2)	4.6 (2.4)	5 (2.5)	5.8 (3.7)	4.8	4	2.8	0	16
Family size (person)	3.9 (2)	4.3 (1.7)	4.4 (1.7)	4.6 (1.7)	4.9 (2.1)	4.4	4	1.9	1	15
Number of adults (person)	1.8 (1.4)	2.3 (1.3)	2.7 (1.2)	2.9 (1.2)	3.3 (1.4)	2.6	3	1.4	0	9
Number of children under age 18 (person)	0.78 (1.1)	0.74 (1)	0.71 (1)	0.53 (0.74)	0.43 (0.73)	0.63	0	0.94	0	7
Number of adults aged 65 and above (person)	0.99 (0.76)	0.76 (0.82)	0.63 (0.73)	0.72 (0.79)	0.73 (0.84)	0.77	1	0.8	0	3
Youth dependency ratio	0.35 (0.55)	0.34 (0.53)	0.28 (0.43)	0.21 (0.33)	0.15 (0.28)	0.27	0	0.44	0	4
Average percentage of children under age 18	15 (20)	15 (19)	14 (18)	10 (14)	7.7 (13)	12	0	17	0	100
Average percentage of adults aged 65 and above	36 (35)	20 (23)	16 (20)	16 (18)	15 (18)	20	17	25	0	100
Average percentage of households	20.02	19.99	20.02	19.99	19.99					

Note: Q1 to Q 5 are low income, lower middle-income, middle income, upper middle-income, and high-income households.

Details on household expenditures for both food and non-food items, and food items purchased over a one-month period were recorded and included in the survey. Household food consumptions were composed of 13 aggregate food groups: rice, starches and pulses, meats and poultry, aquatic products, eggs and dairy products, oils and fats, seasoning and others, fruits, vegetables, sugar and sweet products, ready-to-eat and instant products, non-alcoholic beverage, and alcoholic beverage and tobacco. Prices of commodities were not available in the Townsend Thai monthly survey thus were obtained from the Office of Provincial Affairs, Ministry of Commerce (2021). A geometric mean was subsequently applied to calculate the price of a particular food group.

Special differences in prices between households, however, could exist as a result of consumer's choice of a product quality and quantity of the composite good. The cross-sectional price variation can be adjusted by using hedonic regression (Cox and Wohlgenant 1986; Gao, Wailes, and Cramer 1994; Park et al. 1996; Zheng and Henneberry, 2010). Following the approach discussed by Cox and Wohlgenant, the quality-adjusted prices were regressed on gender of household head, household location, income, and size as

$$p_{it} = \delta_0 + \delta_1 LB + \delta_2 BR + \delta_3 SK + \sum_{k=4}^{6} \delta_j x_{it} + \delta_7 x_{it}^2 + \varepsilon_{it} \quad (1)$$

where p_{it} is the quality-adjusted prices of the *i*th food group in year *t*; *LB*, *BR*, and *SK* are a binary variable representing household location (i.e., Lopburi, Buriram, and Srisaket province, respectively); x_i is the *k*th demographic variables that consist of income, household size, gender of household head, and quadratic term of household size; and ε_{it} is the error term.

Figure 1 (a)-(d) presents the comparison of computed price from historical data and quality-adjusted price of example commodities for period 2002-2014.

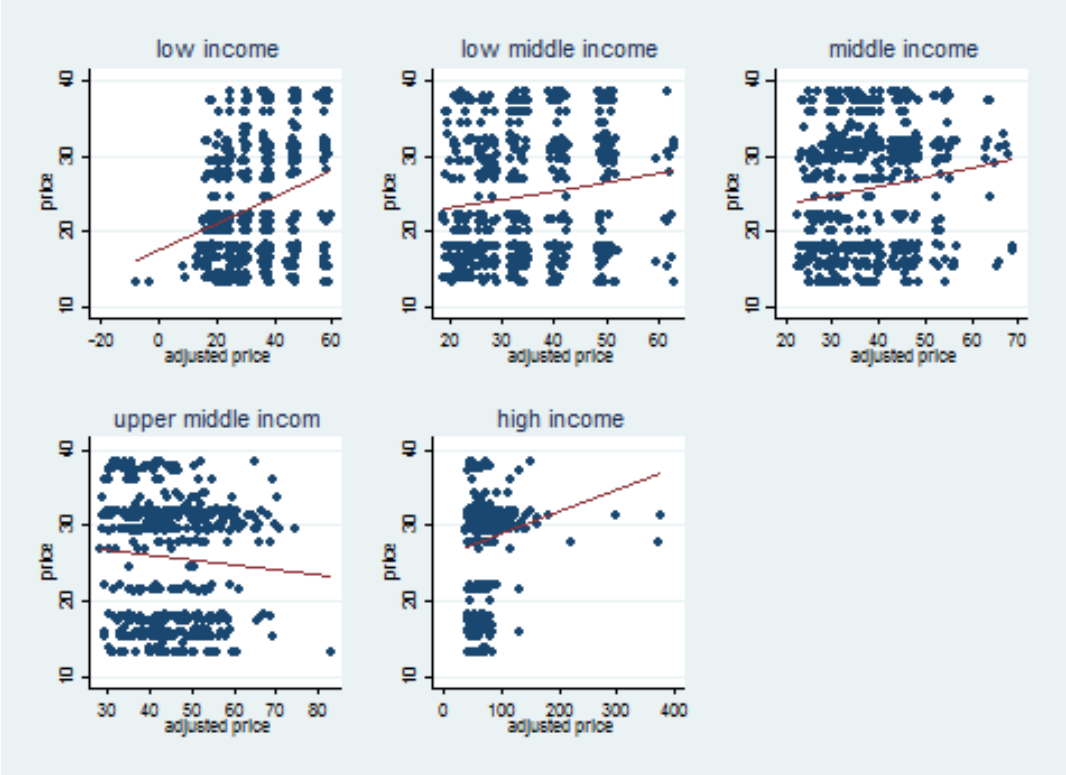

Figure 1 (a): Rice

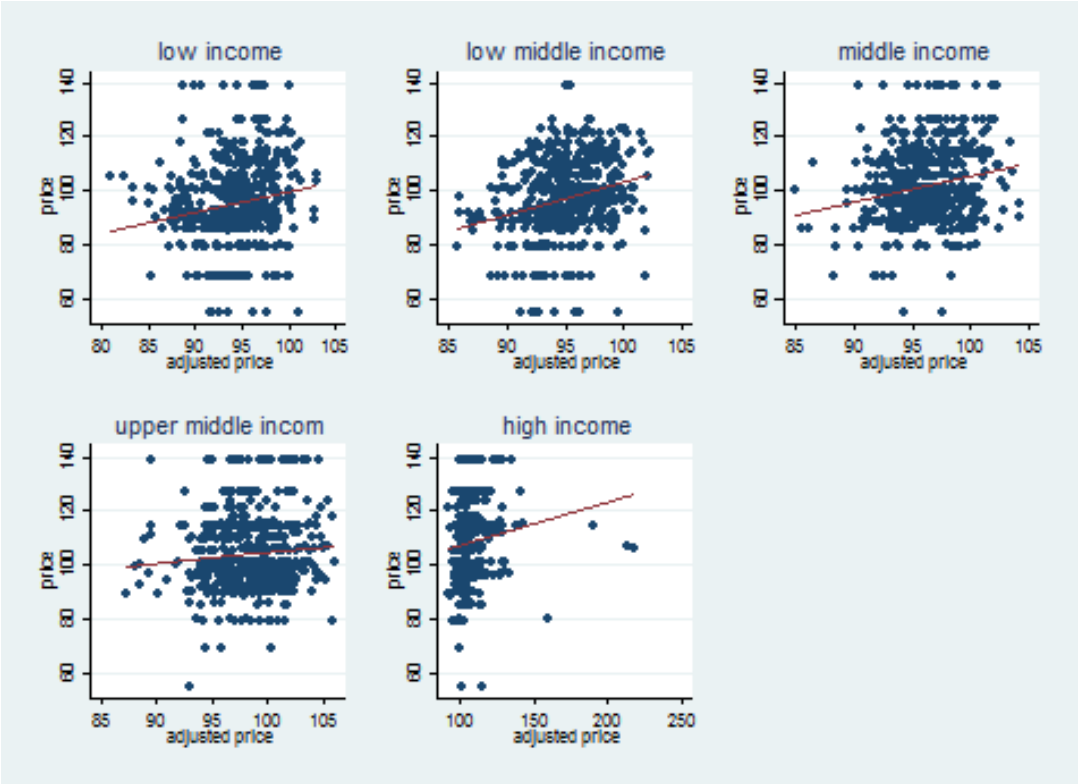

Figure 1 (b): Meats and Poultry

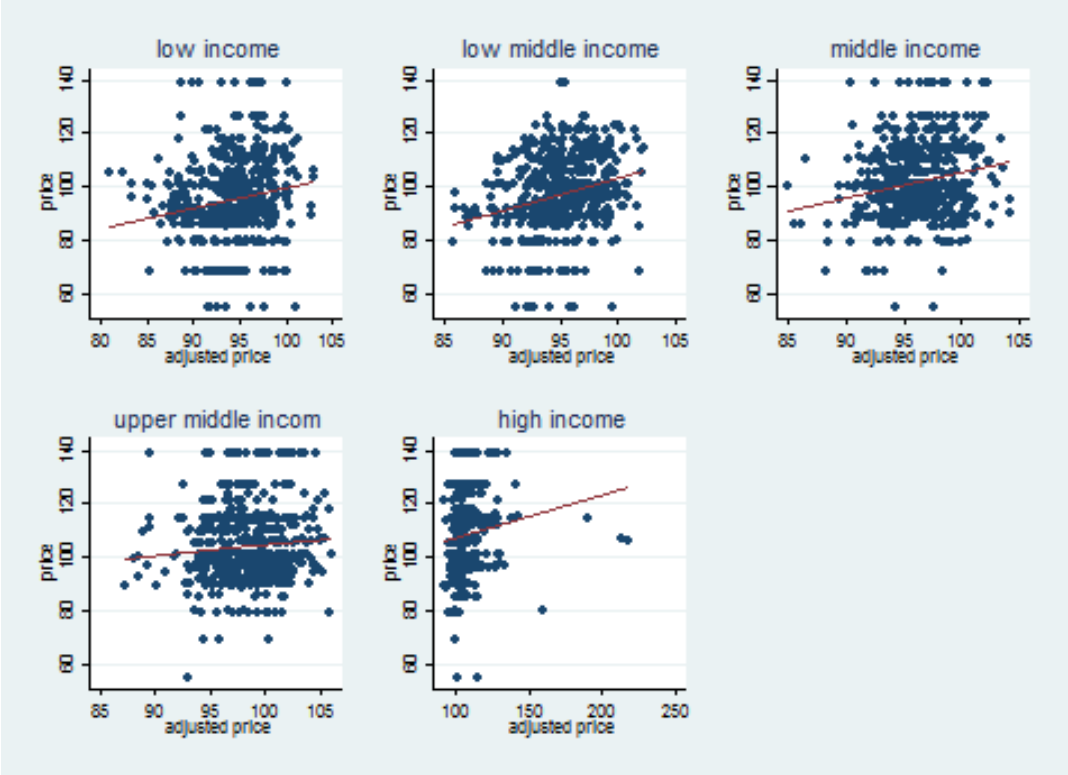

Figure 1 (c): Egg and Daily Products

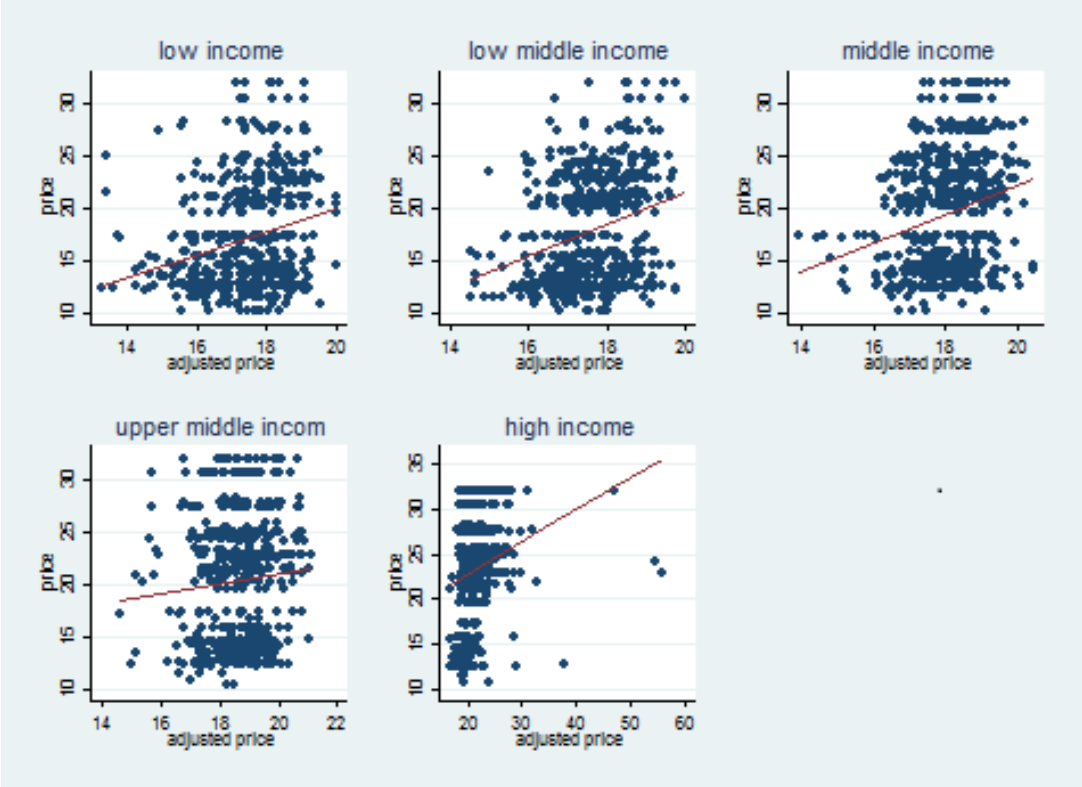

Figure 1 (d): Fruits

The continuing data within a long period assisted in visualizing the composition of household expenditures and consumption pattern. Table 5 reports per capita income and total expenditure of the study households among the five income categories. The low-income households showed a higher proportion of the expenditures for both food and non-foods than the high-income group (Table 6).

Table 5: Per Capita Income and Expenditure of Households during 2002 to 2014

	Total income Mean					Total expenditure Mean				
Year	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**
2002	18,515	58,970	132,272	266,204	566,281	39,912	41,635	72,778	90,993	107,236
2003	17,208	65,162	138,400	257,740	617,199	38,412	56,218	72,414	104,145	173,479
2004	17,987	59,987	131,183	269,748	653,510	43,406	49,495	82,716	103,008	116,717
2005	16,105	63,111	136,098	265,862	482,492	45,690	59,158	84,185	128,589	134,554
2006	17,664	62,701	129,331	261,060	482,196	43,109	58,748	80,631	119,590	136,260
2007	15,978	61,058	134,675	271,450	577,122	46,840	64,840	76,634	142,728	149,253
2008	15,226	66,155	137,077	261,140	628,626	53,640	61,174	101,327	133,281	165,549
2009	16,108	63,253	138,551	263,845	719,104	52,551	67,730	86,205	119,098	158,738
2010	14,229	69,077	142,262	264,165	730,527	46,958	78,203	72,161	105,601	229,026
2011	16,526	65,047	142,798	261,773	666,180	67,294	59,649	84,993	121,461	192,905
2012	17,388	60,075	131,745	256,718	810,396	60,449	50,245	73,079	134,477	183,972
2013	21,269	70,837	138,581	263,455	659,154	70,383	52,588	88,160	108,936	169,945
2014	9,313	68,932	141,442	267,772	668,815	38,626	46,766	58,782	79,130	113,634
All										
Mean	16,634	63,820	136,382	263,851	673,367	47,712	57,753	79,268	114,052	166,223
S.D.	11,271	16,672	25,888	52,342	52,342	41,175	40,002	49,194	71,034	140,522
Max	36,551	94,380	182,077	363,232	363,232	221,806	313,335	448,340	658,079	2064623
Min	0	36,551	94,425	182,085	182,085	2,889	8,185	5,426	18,680	28,093

Note: 1. Per capita income and expenditures are measured in nominal terms.
2. Estimated from 2,370 observations.

Table 6: Proportion of Expenditure to Total Income and Composition of The Food and Non-Food Expenditures during 2002 to 2014

Year	Proportion of expenditure (Mean)					Proportion of food expenditure (Mean)					Proportion of Non-food expenditure (Mean)				
	Q1	**Q2**	**Q3**	**Q4**	**Q5**	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**
2002	5	0.74	0.58	0.35	0.19	2.7	0.39	0.24	0.15	0.073	2.3	0.36	0.34	0.21	0.12
2003	13	0.87	0.55	0.41	0.31	4.3	0.41	0.25	0.16	0.093	8.3	0.46	0.31	0.26	0.22
2004	25	0.84	0.63	0.4	0.23	14	0.39	0.28	0.18	0.092	11	0.45	0.35	0.22	0.13
2005	9.2	0.94	0.63	0.5	0.29	3.5	0.5	0.29	0.19	0.11	5.7	0.45	0.34	0.31	0.17
2006	6.4	0.99	0.65	0.47	0.29	3.4	0.48	0.34	0.19	0.11	3	0.51	0.31	0.27	0.19
2007	12	1.2	0.59	0.52	0.27	6.1	0.52	0.29	0.19	0.11	5.8	0.67	0.3	0.33	0.17
2008	12	0.98	0.75	0.49	0.28	6	0.48	0.36	0.22	0.11	5.8	0.49	0.39	0.27	0.17
2009	16	1.1	0.67	0.46	0.27	9.6	0.53	0.29	0.21	0.11	6.5	0.61	0.38	0.24	0.16
2010	47	1.2	0.52	0.42	0.33	25	0.52	0.28	0.21	0.12	22	0.65	0.24	0.21	0.21
2011	170	0.97	0.59	0.47	0.33	111	0.47	0.3	0.21	0.13	59	0.5	0.29	0.26	0.2
2012	10	0.89	0.56	0.53	0.26	7.6	0.42	0.3	0.23	0.11	2.8	0.46	0.27	0.31	0.15
2013	13	0.73	0.65	0.42	0.27	8.6	0.39	0.32	0.19	0.11	4.3	0.34	0.33	0.23	0.16
2014	20	0.78	0.41	0.3	0.19	16	0.53	0.26	0.21	0.12	4	0.25	0.16	0.089	0.074
Average	**21**	**0.95**	**0.6**	**0.44**	**0.27**	**12**	**0.46**	**0.29**	**0.2**	**0.11**	**8.9**	**0.49**	**0.31**	**0.24**	**0.16**

Note: The households with negative per capita income were excluded from analysis. Thus, proportion of expenditure were computed from 2,370 observations.

An average expenditure share of the studied food groups to the annual income for the five status households are reported in Table 7. Expenditures for rice, ready-to-eat and instant products, and meats and poultry were found to be the first, second, and third largest components of the total household income. On per capita basis, the low-income households were found to have a larger proportion of expenditures on all food groups more than those higher-income households.

Table 7: An Average Expenditure Share of The Studied Food Groups to The Annual Income

Food Groups	An Average Expenditure Share by income Category (%)				
	Q1	Q2	Q3	Q4	Q5
rice	**2.17**	0.062	0.037	0.024	0.015
starches and pulses	0.17	0.0093	0.0067	0.0043	0.0026
meats and poultry	**1.15**	0.064	0.035	0.021	0.011
aquatic products	0.93	0.044	0.025	0.016	0.0084
eggs and dairy products	**1.01**	0.052	0.029	0.019	0.011
oils and fats	0.23	0.013	0.0076	0.0049	0.0028
seasoning and others	0.62	0.018	0.011	0.007	0.0045
fruits	0.86	0.027	0.018	0.012	0.007
vegetables	0.65	0.027	0.019	0.013	0.0074
sugar and sweet products	0.48	0.026	0.015	0.0094	0.0055
ready-to-eat and instant products	**2.62**	0.068	0.048	0.038	0.021
non-alcoholic beverage	0.19	0.018	0.012	0.0078	0.0043
alcoholic beverage and tobacco	0.99	0.036	0.026	0.019	0.011
All food groups	**12.07**	**0.4643**	**0.2893**	**0.1954**	**0.1115**

Note: The proportion of expenditure were computed from 2,370 observations.

3. Methods and Procedures

To investigate the demand for food commodities by Thai rural households under the price and income conditions, a Quadratic Almost Ideal Demand System (QUAIDS) model proposed by Banks, Blundell, and Lewbel (1997) was used to obtain parameter estimates. The main advantage of QUAIDS model over AIDS model is that it can accommodate a non-linear functional form of

food expenditure budget shares. There are 13 food groups considered in the demand analysis for this study, along with socio-economic and demographic characteristics of households.

Assume consumers maximize utility and food groups are weakly separated from one another. The QUAIDS model for the food budget shares is written as:

$$\omega_{it} = \alpha_i + \sum_{j=1}^{n} \gamma_{ij} lnP_{jt} + \beta_i ln\left\{\frac{m_t}{a(p)}\right\} + \left(\frac{\lambda_i}{b(p)}\right) \cdot \left[ln\left\{\frac{m_t}{a(p)}\right\}\right]^2 \quad \textbf{(2)}$$

After incorporating demographic characteristic variables into the model, the equation (2) became:

$$\omega_{it}^{*} = \alpha_i + \sum_{j=1}^{k} \gamma_{ij} lnp_{jt} + \left(\beta_i + \theta_i' z\right) \cdot ln\left\{\frac{m_t}{\bar{m}_0(z) \cdot a(p)}\right\} + \left(\frac{\lambda_i}{b(p) \cdot c(p,z)}\right) \cdot \left[ln\left\{\frac{m_t}{\bar{m}_0(z) \cdot a(p)}\right\}\right]^2 \quad \textbf{(2)'}$$

where ω_{it} is budget share of *i*th food group in year *t*, p_{jt} is quantity-adjusted prices of *j*th food group (*j*=1,2,3,…,n) in year *t*, m is the total household food expenditures on all studied food groups, z is the vector of demographic variables (i.e,. gender, age and education of household heads, income, household size, percentage of children under age 18, and percentage of adults aged 65 and above), $a(p)$ is a price index, $\overline{m_0}(z)$ is the households' expenditure as a function of z, $b(p)$ are functions of the vector of prices, $c(p,z)$ are functions of the vector of relative prices and household demographic variables, ε_{it} is an error term, and α_i, γ_{Ij}, β_i, θ_i, and λ_i are parameters to be estimated.

The price index, $a(p)$, can be specified as

$$lna(p) = \alpha_0 + \sum_{j=1}^{n} \alpha_j \cdot lnp_j + \frac{1}{2} \sum_{i=1}^{n} \sum_{j=1}^{n} \gamma_{ij} lnp_i lnp_j \quad \textbf{(3)}$$

The $b(p)$ is a Cobb-Douglas price aggregator functions of the vector of prices p, which is:

$$b(p) = \prod_{i=1}^{n} p_i^{\beta_i} \quad \textbf{(4)}$$

Folling Ray's method (Ray, 1983 in Poi, 2012), $\overline{m_0}(z)$ and, $c(p,z)$ are defined as:

$$\bar{m}_0(z) = 1 + \rho' z \quad \textbf{(5)}$$

$$c(p,z) = \prod_{j=1}^{n} p_j^{\theta_j' z} \quad \textbf{(6)}$$

To reduce the number of parameter estimates, adding-up, homogeneity, and Slutsky symmetry properties were theoretically imposed by restricting the parameters of the demand system as follows:

Adding-up restriction is restricted as:

$$\sum_{i=1}^{n} \alpha_i = 1, \ \ \sum_{i=1}^{n} \gamma_{ij} = 0, \ \ \sum_{i=1}^{n} \beta_i = 0, \ \ \sum_{i=1}^{n} \theta_i = 0, \ \sum_{i=1}^{n} \lambda_i = 0 \quad \textbf{(7a)}$$

Homogeneity for the expenditure share is imposed as:

$$\sum_{j=1}^{n} \gamma_{ij} = 0 \qquad \text{for any } j \quad \textbf{(7b)}$$

Slutsky Symmetry is:

$$\gamma_{ij} = \gamma_{ji} \text{ , for any } i \text{ and } j, \text{ and } \ i \neq j \quad \textbf{(7c)}$$

The two-step estimation procedure developed by Shonkwiler and Yen (1999) was also employed to circumvent sample selection bias. In the first step of the estimation procedure, a probit model was used to model market participation of households for the studied food groups. Purchasing decision of foods generally depended on the household's specific characteristics. The demographic variables in the probit model were interpreted as marginal effects that corrected for the heteroscedasticity. In the second step, the normal probability density ($\emptyset(Z_{ih}' \, \hat{\tau}_\iota)$) and the cumulative distribution ($\Phi(Z_{ih}' \, \hat{\tau}_\iota)$) were calculated for each household and incorporated into the equations (2)' for the food groups with zero observations. The estimation of food demand functions was carried out as a system of equations using the Iterated Seemingly Unrelated Regression (ITSUR).

Based on the QUAIDS model with demographic variables, the uncompensated own and cross price elasticity, and the expenditure elasticity coefficients were computed at the sample means. If the elasticity was less than one, equal to one, or greater than one, this was considered as inelastic, unit elastic, and elastic, respectively. The uncompensated price elasticities (η_{pi}) was calculated as

$$\eta_{pij} = \left(\frac{\mu_{ij}}{\omega_i^*}\right) - \delta_{ij} \quad \textbf{(8)}$$

where δ_{ij} is the Kronecker delta that equals to 1 if $i = j$, and equals to 0 if $i \neq j$.

The μ_{ij} is:

$$\mu_{ij} = \frac{\partial \omega_i^*}{\partial ln P_j} = \begin{pmatrix} \gamma_{ij} - \left[\beta_i + \theta_i^{'} z + \frac{2\lambda_i}{b(p)c(p,z)} ln\left\{\frac{m}{\overline{m_0}(z)\cdot a(p)}\right\}\right] x \\ \left(\alpha_j + \sum_k \gamma_{jk} lnp_k\right) - \frac{\left(\beta_i + \theta_i^{'} z\right)\lambda_i}{b(p)c(p,z)}\left[ln\left\{\frac{m}{\overline{m_0}(z)\cdot a(p)}\right\}\right]^2 \end{pmatrix}$$

The expenditure elasticity (η_{mi}) was calculated as Equations 9.

$$\eta_{mi} = 1 + \left(\frac{\mu_i}{\omega_i^*}\right) \quad \textbf{(9)}$$

where

$$\mu_i = \frac{\partial \omega_i^*}{\partial lnm} = \left[\beta_i + \theta_i^{'} z + \frac{2\lambda_i}{b(p)c(p,z)} \cdot ln\left\{\frac{m}{\overline{m_0}(z)\cdot a(p)}\right\}\right]$$

The income elasticity for each food consumption, unfortunately, could not be directly obtained from the QUAIDS estimation. It could be calculated as the product of the expenditure elasticity (η_{mi}) and income elasticity for total food consumption (η_y) (Park et al. (1996), Zheng and Henneberry, 2010; and Abdulai and Aubert, 2003), denoted as:

$$E_{yi} = \eta_{mi}\eta_y \quad (10)$$

The Engel function for estimating the response of food expenditure to the change in income was derived follow Zheng and Henneberry (2010) as:

$$\ln(m) = a_0 + a_1 \ln(y) + a_2[\ln(y)]^2 \quad (11)$$

where $\ln(m)$ is a quadratic double-log Engel function, and *y* is the level of household income. Hence, the income elasticity for the total food expenditure is given by:

$$\eta_y = \frac{\partial \ln(m)}{\partial \ln(y)} = a_1 + 2a_2 \ln(y) \quad (12)$$

In the last step, the expenditure elasticity from Equation (9) and income elasticity for the total food consumption from Equation (12) were compiled to obtain the income elasticity for each food expenditure as defined in Equation (10).

4. Estimation results

4.1 Impact of Demographic Variables on Food Demand

The parameters estimates for demographic variables including education, age and gender of household head, household size, percentage of children under age 18, and percentage of adults aged 65 and above, were obtained for all household samples (Table 8). Results showed the impact that household characteristics had on types of food consumption. The education of household head positively impacted budget shares for starches and pulses, fruits, vegetables, and seasoning and others. Furthermore, highly educated household heads showed less expenditures of their household budgets on five food groups (i.e., meats and poultry, aquatic products, oils and fats, ready-to-eat and instant products, and alcohol beverage and tobacco). This implied that households with highly educated heads were more likely to invest their budget on nutritious foods (e.g., pulses, fruits, and vegetables) rather than on oils and fats, ready-to-eat and instant foods, and alcohol beverage and tobacco. Also, age of household heads indicated negative impacts on the household budget shares for meats and poultry, aquatic products, oils and fats, seasoning and others, ready-to-eat and instant products and alcoholic beverage and tobacco.

In the meantime, gender of household heads showed positive and significant impact on several food consumptions such as starches and pulses, meats and poultry, oils and fats, vegetables, and non-alcoholic beverage. The male headed households were found to have a significantly negative impact on the budget share for aquatic products, eggs and dairy products, sugar and sweet products, and alcoholic beverage and tobacco. This result was consistent with the study of Abdullah et al. (2019) that determined food security status of the household in Pakistan, which showed that households with older- headed household are more food secure and consume less amount of aquatic products, fruits, and alcoholic beverage and tobacco, due to the health reasons. Given these results, it could be seen that household heads with higher age and education had reduced share of alcoholic beverage and tobacco.

In addition, household size, percentage of children under age 18, and percentage of adults aged 65 and above were found to have an impact on food consumption. Family size indicated

positive impacts on all food budget shares on meats and poultry, aquatic products, oils and fats, fruits, and non-alcoholic beverage except for eggs and dairy products, ready-to-eat and instant products, alcoholic beverage and tobacco. This finding indicated that households with more family members tended to purchase other low-cost products of high calorie and necessary foods instead of the more expensive and unnecessary one such as ready-to-eat and instant products, alcoholic beverage and tobacco. In the meantime, the households with older leader have a lager budget shares for meats and poultry and non-alcoholic beverage.

Percentage of adults aged 65 and above exerted negative impact on the demand for rice, starches and pulses, meats and poultry, aquatic products, and oils and fats while causing positive impacts on the demand for vegetables, seasoning and others, ready-to-eat and instant products, and alcoholic beverage and tobacco.

The percentage of children under age 18 exerted negative impact on the demand for alcoholic beverage and tobacco while causing positive impacts on the demand for the four food groups, i.e., aquatic products, eggs and dairy products, oils and fats, and non-alcoholic beverage. Unexpectedly, the households with larger percentage of children under age 18 exerted negative impact on the demand for sweet products and dairy products.

Table 8: Parameter Estimates of Demographic Variables for Food Demand

Food Groups	Demographic Variables					
	Education of household head (years)	Age of household head (years)	Gender of household head (1 = male)	Household size (numbers)	Percentage of children under age 18	Percentage of adults aged 65 and above
rice	0.0002	-0.00006	0.0003	0.00015	0.00270	-0.00273**
	(0.0002)	(0.00004)	(0.0005)	(0.00012)	(0.00232)	(0.00125)
starches and	0.0003**	0.00001	0.0010**	0.00001	-0.00015	-0.00026*
pulses	(0.0002)	(0.00001)	(0.0004)	(0.00002)	(0.00020)	(0.00015)
meats and poultry	-0.0013***	0.00008***	0.0022**	0.00017***	-0.00044	-0.00107***
	(0.0004)	(0.00002)	(0.0009)	(0.00004)	(0.00039)	(0.00037)
aquatic products	-0.0008***	-0.00005***	-0.0008**	0.00031***	0.00155***	-0.00075**
	(0.0002)	(0.00001)	(0.0004)	(0.00005)	(0.00043)	(0.00032)
eggs & dairy	-0.0003	-0.00001	-0.0008**	-0.00056***	-0.00277***	0.00023
products	(0.0003)	(0.00002)	(0.0004)	(0.00008)	(0.00062)	(0.00049)
oils and fats	-0.0003***	-0.00001**	0.0010***	0.00006***	0.00028**	-0.00028***
	(0.0001)	(0.00001)	(0.0003)	(0.00001)	(0.00011)	(0.00010)
seasoning &others	0.0005***	-0.00011**	0.0001	0.00011***	-0.00002	0.00057***
	(0.0002)	(0.00001)	(0.0005)	(0.00002)	(0.00020)	(0.00018)
fruits	0.0005***	0.00001	-0.0004	0.00012***	-0.00023	-0.00026
	(0.0002)	(0.00001)	(0.0004)	(0.00003)	(0.00034)	(0.00022)
vegetables	0.0005***	0.00001	-0.0013***	0.00009***	0.00054*	0.00069***
	(0.0002)	(0.00001)	(0.0005)	(0.00003)	(0.00031)	(0.00027)

Table 8: (cont'd)

Food Groups	Demographic Variables					
	Education of household head (years)	Age of household head (years)	Gender of household head (1 = male)	Household size (numbers)	Percentage of children under age 18	Percentage of adults aged 65 and above
sugar & sweet	-0.0001	0.00001	-0.0028***	-0.00002	-0.00202***	-0.00001
products	(0.0002)	(0.00001)	(0.0006)	(0.00003)	(0.00040)	(0.00024)
ready-to-eat and	-0.0014***	-0.00004*	0.0001	-0.00017**	-0.00107	0.00246***
instant products	(0.0005)	(0.00003)	(0.0011)	(0.00008)	(0.00122)	(0.00082)
non-alcoholic	0.0001	0.00002**	0.0013***	0.00004*	0.00057*	0.00016
beverage	(0.0002)	(0.00001)	(0.0004)	(0.00002)	(0.00029)	(0.00021)
alcoholic beverage	-0.0006***	-0.00007***	0.0003	-0.00030***	-0.00219***	0.00263***
and tobacco	(0.0001)	(0.00002)	(0.0002)	(0.00007)	(0.00075)	(0.00069)

Note: (***) significant at 1% level, (**) significant at 5%level, and (*) significant at 10% level.

4.2 Expenditure Elasticities by Income Category

The expenditure elasticities of all food groups showed a positive sign, which were in accordance with the theoretical principles, confirming that an increase in household food expenditure would lead to an increase in demand for all food products. The parameter estimates of expenditure elasticity are reported in Table 9.

The expenditure elasticities for all samples of the 6 food groups were found to be elastic (i.e., rice, eggs and dairy products, oils and fats, seasoning and others, ready-to-eat food and instant foods, and alcoholic beverage and tobacco). The results also showed expenditure elasticities for these 6 food groups to be greater than one for all household status. Eggs and dairy products of all households had the highest value of expenditure elasticity (2.065) followed by rice (1.858), ready-to-eat food and instant foods (1.707), and alcoholic beverage and tobacco (1.685). Although the magnitude of alcohol beverage and tobacco elasticity in this study was quite high, it was still similar to the result reported by Pangaribowo and Tsegai (2011).

For the rest of food groups, the expenditure elasticities for vegetable was equal to one while starches and pulses, meats and poultry, aquatic products, fruits, sugar and sweet products, and non-alcoholic beverage were less than one. The results indicated that the share of eggs and dairy products, rice, ready-to-eat food and instant foods, and alcoholic beverage and tobacco expenditure were more responded to changes in household food budget than the protein products (starches and pulses, meats and poultry, aquatic products), fruits, vegetable, and non-alcoholic beverage. The expenditure elasticity of the protein products were ranged between 0.65-0.94. In addition, the high-income households are more likely to spend their food budget share toward the eggs and dairy products than the households at the bottom 40 percent (low income and lower- middle income groups).

Table 9: Expenditure Elasticities for Households by Income Category

Food Groups	Household Category					ALL
	Low Income	Lower Middle Income	Middle Income	Upper Middle Income	High Income	
rice	1.825	1.956	1.915	1.861	1.758	1.858
starches and pulses	0.725	0.945	0.742	0.779	0.648	0.763
meats and poultry	0.776	0.770	0.748	0.706	0.686	0.740
aquatic products	0.892	0.891	0.877	0.862	0.852	0.876
eggs and dairy products	1.897	1.909	2.080	2.199	2.314	2.065
oils and fats	1.418	1.417	1.453	1.477	1.494	1.451
seasoning and others	1.490	1.467	1.478	1.536	1.478	1.488
fruits	0.545	0.587	0.435	0.399	0.450	0.475
vegetables	1.139	1.085	0.983	0.966	0.884	1.000
sugar and sweet products	0.104	0.021	0.092	0.136	0.089	0.086
ready-to-eat food and instant foods	1.710	1.778	1.731	1.651	1.672	1.705
non-alcoholic beverage	1.382	1.164	0.820	0.801	0.803	0.950
alcoholic beverage and tobacco	1.786	1.685	1.669	1.634	1.688	1.685

4.3 Own-Price Elasticities by Income Category

Table 10 shows the uncompensated own-price elasticities. Results showed that all own-price elasticities were negatively related to the budget shares which were consistent with the consumer demand theory. The own-price elasticities for starches and pulses, meats and poultry, aquatic products, oils and fats, and fruits were inelastic while own-price elasticities for rice, eggs and dairy products, vegetables, sugar and sweet products, ready-to-eat and instant products, non-alcoholic and alcoholic beverages were greater than one.

The disaggregation of own-price elasticities based on showed an interesting finding that the magnitude of elasticities were slightly different among household income categories except for fruits, and non-alcoholic beverage. The households at the bottom 40% (low and lower-middle income groups) are more responsive to changes in price of fruits, vegetables, non-alcoholic beverage, and alcoholic beverage and tobacco than the top 20% of the sample

households. Furthermore, the own-price elasticities for non-alcoholic beverage were higher than alcoholic beverage for all income groups.

Table 10: Own-Price Elasticities for Households by Income Category

Food Category	Household Category					ALL
	Low Income	Lower Middle Income	Middle Income	Upper Middle Income	High Income	
rice	-1.665	-1.616	-1.470	-1.530	-1.514	-1.515
starches and pulses	-0.180	-0.198	-0.173	-0.174	-0.160	-0.176
meats and poultry	-0.336	-0.336	-0.360	-0.411	-0.430	-0.372
aquatic products	-0.346	-0.357	-0.399	-0.439	-0.461	-0.397
eggs and dairy products	-1.140	-1.138	-1.162	-1.178	-1.195	-1.160
oils and fats	-0.287	-0.281	-0.297	-0.309	-0.315	-0.298
seasoning and others	-1.541	-1.444	-1.445	-1.597	-1.398	-1.480
fruits	-1.008	-1.010	-0.895	-0.862	-0.886	-0.925
vegetables	-2.120	-2.012	-1.878	-1.837	-1.747	-1.904
sugar and sweet products	-2.046	-1.843	-1.941	-2.003	-1.918	-1.944
ready-to-eat food and instant foods	-1.375	-1.468	-1.358	-1.192	-1.224	-1.314
non-alcoholic beverage	-1.842	-1.624	-1.339	-1.305	-1.299	-1.442
alcoholic beverage and tobacco	-1.944	-1.807	-1.780	-1.736	-1.797	-1.803

4.4 Income Elasticities by Income Category

Income elasticities of demand for food consumption were calculated as the product of expenditure elasticity and income elasticity for total food expenditures as explained in Equation (10). The income elasticities for food groups across income category are presented in Table 11. The estimated income elasticity of all samples for most of the food commodities are considerably small (less than 0.5) except rice, eggs and dairy products, fruits, ready-to-eat and instant products, and alcoholic beverage and tobacco. Estimated income elasticities with respect to these 5 food groups were above 0.5. Specially, the estimated income elasticities for

ready-to-eat and instant products, and alcoholic beverage and tobacco were large in all household groups. The income elasticity of the ready-to-eat and instant products were ranged between 0.68-0.72 followed by alcoholic beverage and tobacco (0.60-0.66).

When comparing food consumption behavior of the households, it was found that the bottom 40% of the sample households were more responsive to changes in income for sugar and sweet products, non-alcoholic beverage, and alcoholic beverage and tobacco than the high-income households. On the other hand, the income elasticity for eggs and dairy products was larger for the high-income group. The income elasticity of rice was in the same range for all household groups. Hence, an increase in income would affect the demand of eggs and dairy products for the high-income households.

Table 11: Income Elasticities for Households by Income Category

Food Groups	Household Category					ALL
	Low Income	Lower Middle Income	Middle Income	Upper Middle Income	High Income	
rice	0.528	0.566	0.554	0.538	0.509	0.537
starches and pulses	0.254	0.331	0.260	0.272	0.227	0.267
meats and poultry	0.202	0.200	0.194	0.184	0.178	0.192
aquatic products	0.223	0.223	0.219	0.216	0.213	0.219
eggs and dairy products	0.483	0.487	0.530	0.560	0.590	0.526
oils and fats	0.422	0.422	0.432	0.439	0.445	0.432
fruits	0.515	0.507	0.511	0.531	0.511	0.514
vegetables	0.232	0.250	0.185	0.170	0.191	0.202
sugar and sweet products	0.451	0.430	0.389	0.383	0.350	0.396
seasoning and others	0.037	0.008	0.033	0.049	0.032	0.031
ready-to-eat and instant products	0.693	0.720	0.701	0.669	0.678	0.691
non-alcoholic beverage	0.632	0.532	0.375	0.366	0.367	0.434
alcoholic beverage and tobacco	0.658	0.620	0.614	0.602	0.621	0.620

5. Discussion and Implication

In this study, economic development showed an impact on household socio-economic status and commodity demand. However, lack of financial resources to provide enough food for every member in the household on a day to day basis could result in unhealthy and inactive life for adults and child malnutrition. Rising food prices and income would have different effect on the consumption behavior of households with different levels of income. This study examined the expenditure, own-price, and income elasticities of the rural households at different categories of income.

The household characteristics had an impact on types of food consumption. Households with more family members tended to purchase other low-cost products of high calorie and necessary foods instead of the more expensive and unnecessary one such as ready-to-eat and instant products, alcoholic beverage and tobacco. The percentage of adults aged over 65 had caused negative impact on the demand for several food groups (i.e., rice, starches and pulses, meats and poultry, aquatic products, and oils and fats) while causing positive impacts on the demand for vegetables, seasoning and others, ready-to-eat and instant products, and alcoholic beverage and tobacco.

The results of expenditure elasticities showed that eggs and dairy products of all households had the highest value of expenditure elasticity (2.065) followed by rice (1.858), ready-to-eat food and instant foods (1.707), and alcoholic beverage and tobacco (1.685). In addition, the high-income households are more likely to spend their food budget toward the eggs and dairy products than the households at the bottom 40 percent (low income and lower-middle income groups).

Own-price elasticities for starches and pulses, meats and poultry, aquatic products, oils and fats, and fruits were inelastic (<1) while own-price elasticities for rice, eggs and dairy products, vegetables, sugar and sweet products, ready-to-eat and instant products, non-alcoholic and alcoholic beverages were greater than one. This indicates that households are less responsive to the changes in price of starches and pulses, meats and poultry, aquatic products, oils and fats, and fruits.

The magnitude of own-price elasticities of rice, fruits, vegetables, and ready-to-eat and instant products for low-income households appeared to be larger than the high-income households. The changes in price of these 4 groups had a larger impact on the budget share of the low-income households than the high -income households. In our analysis, the ready-to-eat and instant products includes prepared food, food away from home, and instant product. This

result suggested the low-income households are more responsive to changes in price of rice, fruits, vegetables, and ready-to-eat and instant products, which are the major food groups recommended in food guide pyramid of the USDA (Marcus.J.B.(2013)). Furthermore, the households at the bottom 40% income are more responsive to changes in price of both non-alcohol beverage and alcoholic beverage and tobacco.

The estimated income elasticity of all samples with respect to 5 food groups (i.e., rice, eggs and dairy products, fruits, ready-to-eat and instant products, and alcoholic beverage and tobacco) are considerably large. And, the income elasticity of rice was in the same range for all household groups, which suggested an increase in income would have a similar effect on the demand for rice consumption of the household in all categories. This indicates that rice, eggs and dairy products, and fruits still remain a necessary foods for Thai rural households. In the meantime, the estimated income elasticity for alcoholic beverage and tobacco were large in all household groups and range between 0.60-0.66.

Overall, the results suggest that households with all income categories respond to changes in food prices, expenditure, and income differently. The households at low level of income are more likely to change their budget shares toward those basic and necessary foods (i.e., rice, eggs and dairy products, ready-to-eat and instant products, fruits, vegetable, non-alcoholic beverage, and alcoholic beverage and tobacco) than the top 20% of sample households. This evidence ensures that disaggregated policy on food for the poor is considerably important. Suitable programs supported by the government is important in providing the basic food nutrients for low-income households. Such as restrict prices on major foods for household consumption to help the poor. However, in the long run transferring knowledge and skill of farming and/or food productions for community leaders and household heads would be a better alternative method in terms of food stability and availability. Additionally, the estimated income elasticity for alcoholic beverage and tobacco were large in all household groups, and the households with high percentage of adults aged over 65 have a tendency to increase the demand for alcoholic beverage and tobacco. Resulting data could be disseminated to local government agencies involved in the extension of nutrition and diet, to apply this set of information from the study, as part of health extension in specific sites under their own supervision in order to provide guidance about health, food nutrition, and family financial management to household members.

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References

Abdullah, Zhou, D., Shah, T., Ali, S., Ahmad, W., Din, I.U., Ilyas, "A. Factors Affecting Household Food Security in Rural Northern Hinterland of Pakistan." *Journal of the Saudi Society of Agricultural Sciences*, 2017. Available at doi:http://dx.doi.org/10.1016/ j.jssas.2017.05.003

Bank of Thailand, 2018. *Economic Analysis Monetary policy: agricultural innovation and the solution of Thai inequality section 1 Year 2018.* Bangkok.

Cox, Thomas L. and Wohlgenant, Michael K. "Prices and Quality Effect in Cross-Sectional Demand Analysis." *American Journal of Agricultural Economics*, 1986. V.68 (4): 908-919.

Faharuddin, F., Yunita., Andy., M., and Muhammad Y. "Agricultural Households' Food Demand: Evidence from Indonesia." *Asian Journal of Agricultural and Development*, 2019. V.16(2): 46-60.

Gao, X.M., Wailes, Eric J., and G.L. Cramer. "A Two-Stage Rural Household Demand Analysis: Microdata Evidence from Jiangsu Province, China." *American Journal of Agricultural Economics*, 1996. V.78 (4): 604-613.

Henneberry, S. R., Piewthongngam, K., and H. Qiang. "Consumer Food Safety Concerns and Fresh Produce Consumption." *Journal of Agricultural and Resource Economics*, 1999. V.24(1):98-113.

Marcus, J. B. "Nutrition Basics: What Is Inside Food, How It Functions and Healthy Guidelines: The Nutrients in Foods and Beverages in Healthy Cooking and Baking." *Culinary Nutrition*, 2013. Chapter 1: 1-50.

Office of Agricultural Economics Thailand, 2014. *Poverty of agricultural households, crop year 2013/14.* Bangkok.

Office of National Economic and Social Development Council, 2022. *Expenditure on gross domestic product. Bangkok*. Retrieved April 1, 2022, from https://www.nesdc.go.th/ main.php?filename=qgdp_page.

Pangaribowo, Evita Hanie and Tsegai, Daniel W. Food Demand Analysis of Indonesian Households with Particular Attention to the Poorest (August 1, 2011). *ZEF-Discussion Papers on Development Policy* No. 151, Available at SSRN: https://ssrn.com/ abstract=1945226

Park, John L., Holcomb, Rodney B., Raper, Kellie C., and Capps Jr, Oral. "A Demand Systems Analysis of Food Commodities by U.S. Households Segmented by Income." *American Journal of Agricultural Economics*, 1996. V.78(2): 290-300.

Poi, Brian. P. "Easy Demand-system Estimation with QUAIDS." *The Stata Journal*, 2012. V.12: 433-446.

Research Institute for Policy Evaluation and Design, 2018. *Thai Panel Data for Economic and Social Research (Townsend Thai Monthly Survey), 1997 - 2012.*

Shiptsova, R., H.L.Goodwin, Jr., and Holcomb, Rodney B. "Household Expenditure Patterns for Carbohydrate Sources in Russia." 2004. V.29(2): 296-307.

Shonkwiler, J. S. and Yen, S.T. "Two-step Estimation of A Censored System of Equations." *American Journal of Agricultural Economics*, 1999. V.81(4):972-982

World Bank. (2021). *World Development Indicator Database (GNI per capita)*. Retrieved August 15, 2021, from https://data.worldbank.org/indicator/ NY.GNP.PCAP.PP.CD

World Bank. (2021). *The World Bank Data (Country classification)*. Retrieved August 15, 2021, from https://datahelpdesk.worldbank.org/knowledgebase/articles/378834-how-does-the-world-bank-classify-countries

World Bank. (2021). *World Development Indicator Database (Gini Index).* Retrieved November 10, 2021, from https://databank.worldbank.org/reports.aspx?source =2&series =SI.POV.GINI&country=#

World Bank. (2021). *World Development Indicator Database (Global Poverty Indicator).* Retrieved November 10, 2021, from https://data.worldbank.org/topic/11

World Bank. (2021). *World Development Indicator Database (Rural Population)*. Retrieved February 17, 2021, from https://data.worldbank.org/indicator/SP.RUR.TOTL.ZS

World Bank. (2021). *World Development Indicator Database (Urban Population)*. Retrieved February 17, 2021, from https://data.worldbank.org/indicator/SP.URB.TOTL

World Food Programme (2019). Retrieved January, 2021, from https://www.weforum.org/agenda/2017/02/global-cost-of-food-expensive countries?utm_content=buffer9730f&utm_medium=social&utm_source=facebook.com&utm_campaign=buffer

Zheng, Zhihao, and Shida R. Henneberry. "Household Food Demand by Income Category: Evidence from Household Survey Data in an Urban Chinese Province." *Agribusiness*, 2011. V. 27 (1): 99-113.