Rice demand in Vietnam: dietary changes and implications for policy

Hoa Hoang and William Meyers

Department of Agricultural and Applied Economics

University of Missouri-Columbia

hoahoang@mail.missouri.edu

meyersw@missouri.edu

Selected Paper prepared for presentation at the Southern Agricultural Economics Association's 2015 Annual Meeting, Atlanta, Georgia, January 31-February 3, 2015

Abstract

In this study AIDS and QUAIDS estimators with the 2010 VHLSS household survey show that rice is a normal good at the national level with an expenditure elasticity being 0.05. In addition, rice is found to be an inferior good for urban consumers and a normal good for rural consumers with expenditure elasticities being -0.18 and 0.14, respectively. Clearly rice is in transition from a normal good to an inferior good in Vietnam. Even for rural consumers at different income levels rice is estimated to be an inferior good for high-income consumers. In addition, robust Wald test and likelihood ratio test statistics verify that QUAIDS performs better than AIDS although both models yield similar results.

Key words: Rice, household consumption, Vietnam, AIDS, QUAIDS

JEL code: D12, C21, Q18

1. Introduction

Rice is the most important staple and one of the major agricultural commodities in Vietnam. Rice has such deep roots in Vietnamese culture that it is often equated with a meal that one eats[1]. Analyses of rice demand are important as rice consumption is directly related to food security, poverty and malnutrition policies. In a recent study, Nguyen & Winters (2011) found that cereals remain the food group that provides the majority of calories in the diets of the Vietnamese. Cereals, in which rice makes up the largest share, account for about 30% of expenditure but contribute more than 65% of calorie per capita on a daily basis.

After more than 20 years of economic reform and openness, Vietnam reached its $1,000 GDP per capita threshold in 2008 and joined the group of lower-middle income countries for the first time (Ohno, 2009). Rapid economic growth has led to dramatic changes in the economic and socio-demographic structures of the population. According to the General Statistics Office of Vietnam (GSO), real income almost doubled from $561 (4,273,200 VND) to $894 (16,645,200 VND) between 2002 and 2010[2]. The proportion of food expenditure in total income, however, fluctuated around 40% during this period (GSO, 2011b), indicating that food remains important in the consumption basket of Vietnamese consumers.

[1] In Vietnamese parlance, asking "Did you have your rice yet?" means "Did you have your lunch/dinner yet?"

[2] Adjusted for inflation using CPI (2010=100). Exchange rate is 15,297VND/$ in 2002 and 18,162VND/$ in 2010 according to the World Bank's World Development Indicators.

In food policy analysis, income and price elasticities of food demand are two important indices to measure the sensitiveness of a consumer' consumption of a particular food in response to a change in income and food price. Knowing these possible responses helps policy makers and analysts design appropriate and timely programs to reduce hunger and maintain the country's food security. In the literature, a few studies have examined Vietnam's food demand patterns using household data. However, results from these studies fail to reflect recent changes in food demand patterns induced by economic growth and the changing structure of the population during the past 10 years. In addition, literature on demand analysis applied for developing countries has shown the popularity of the Quadratic Ideal Demand System (QUAIDS) over the Almost Ideal Demand System (AIDS), Linear-Approximated Almost Ideal Demand System (LA/AIDS) and other demand models. One key strength of QUAIDS is that it can capture a non-linear Engel relationship. Thus, a good estimated in QUAIDS can switch from being a luxury to a necessity at higher expenditure levels. However, it appears that there has been no study that applied QUAIDS to fit food consumption data in Vietnam.

To bridge that gap in the literature, this study simultaneously applies both QUAIDS and AIDS models to estimate the price and expenditure elasticities of demand for rice and 6 other major food groups in the food basket of Vietnamese consumers. The Vietnam Living Standards Survey (VHLSS) conducted in 2010, one of the most recent nationally representative surveys, is used for this purpose. This research goes beyond existing studies by examining the suitability of QUAIDS over AIDS in fitting Vietnamese consumers' food demand patterns as well as providing up-to-date empirical results on demand elasticities. The analysis is disaggregated in great detail that captures elasticities by quintile class and by urban and rural areas. This disaggregation is important to our understanding of the structural shift in food consumption patterns across different demographic groups of consumers and is useful for medium and long-term food demand projections.

2. Background

Food demand studies have shown that food consumption patterns are strongly influenced by income and urbanization (Huang & Bouis, 1996). With regard to income changes, the patterns of food demand would transform in congruence with Bennett's Law and Engel's Law (P. Timmer et al., 1983). The former states that when people have higher incomes, they eat less cereals and more meat, fish, vegetables and dairy products. The latter asserts that the proportion of food expenditure in total income declines as income increases, although the total spending on food may still rise. In addition, urbanization strongly influences people's tastes and consumption patterns. People in urban areas are exposed to more food choices and their tastes become more westernized, meaning that they tend to eat more wheat-based products such as breads or pastas in place of rice as well more fast foods and pre-packaged foods. Another reason is that people in urban areas have more freedom in what they can buy while those in rural areas normally consume what they grow, especially basic staples such as rice or corn. Rural families depend on the sales of their home-produced foods to purchase other food items (Huang & Bouis, 1996). For these reasons, food consumption patterns in developing countries differ greatly among rural and urban consumers and are also affected by demographic and societal changes such as the migration of people from rural to urban areas and the speed of urbanization in the country.

There is a large body of literature analyzing food consumption patterns and trends in both developed and developing countries. Within this body of literature, QUAIDS appears to have gained popularity over AIDS and other demand models in fitting demand systems. For developing countries, recent examples include the application of QUAIDs to analyze food and nutrient demand in Malawi (Ecker & Qaim, 2011), food demand in urban China (Gould & Villarreal, 2006; Zheng & Henneberry, 2010), food demand in Nigeria (Elijah Obayelu, Okoruwa, & Ajani, 2009), fish demand in Philippines (Garcia, Mohan Dey, & Navarez, 2005), rice demand in Malaysia (Tey, Shamsudin, Mohamed, Abdullah, & Radam, 2008), food demand in Indonesia (Pangaribowo & Tsegai, 2011), a series of food demand projections using QUAIDS for Ethiopia (Tafere, Taffesse, Tamiru, Tefera, & Paulos, 2011), Bangladesh (Ganesh-Kumar, Prasad, & Pullabhotla, 2012), and India (Ganesh-Kumar, Mehta, et al., 2012) assisted by the International Food Policy Research Institute (IFPRI). Studies for food demand in developed countries are not as burgeoning as for developing countries but several studies of this kind have been conducted such as using QUAIDS to estimate food demand in Switzerland (Abdulai, 2002) or examining unit roots problems in cross-sectional data using UK expenditure surveys (Silva & Dharmasena, 2013). In addition, AIDS and LA/AIDS were employed in a limited number of recent demand studies such as analyses of rice demand in Philippines (Lantican, Sombilla, & Quilloy, 2013), demand for food (Canh, 2008; Linh, 2009) and demand for fruits and vegetables (Mergenthaler, Weinberger, & Qaim, 2009) in Vietnam or food demand in Romania (Cupák, Pokrivčák, Rizov, Alexandri, & Luca, 2014).

It is interesting that most recent studies examining rice demand patterns in Southeast Asia found rice to be a normal good with respect to food expenditure at the national level. For example, the expenditure elasticity of rice demand was found to be positive but highly elastic in Malaysia (0.98) in a study using a 2008/09 household survey (Tey et al., 2008), less elastic in Philippines (0.5) according to results from Lantican et al. (2013)'s study using a 2008/09 survey, highly inelastic in Thailand (0.08) according to Isvilanonda & Kongrith (2008)'s analysis using 2002 household data and also very inelastic in Indonesia (0.06) according to Anton, Kimura, & Ogawa (2014). These studies also found that rice was a necessity good for almost all consumers of different income brackets and different geographic areas in the corresponding country. However, there were exceptions that consumers in the highest income quintile in Thailand and Indonesia had negative expenditure elasticities, implying that rice was an inferior good for the richest consumers in these countries.

In the context of Vietnam, a number of studies have examined rice consumption and food demand patterns (Table 1). Price and income elasticities of demand for rice were estimated using household data and different demand models such as AIDS (Benjamin & Brandt, 2004; Le, 2008; Minot & Goletti, 2000; Niimi, 2005), LA/AIDS (Linh, 2009) or double-log functional form (Haughton, Fetzer, Lo, & Nguyen, 2004). Two Vietnam Living Standards Surveys (VLSS)[3] 1993 and 1998, and two VHLSSs conducted in 2004 and 2006 were used across these studies. In general, the estimated elasticities of demand for rice at the country-level were estimated to be positive and less than one, implying that rice was a normal and necessity good in Vietnam. Given the fact that the country has undergone massive economic growth in the past 10 years, data and results from the existing literature have failed to reflect recent changes in the country's

[3] These are the very first kind of nation-wide and in-depth household surveys in Vietnam and are considered as the pilot projects for the onset of the new and improved VHLSS rounds starting in 2002.

food consumption patterns. The most recently used VHLSS dates back to 2006 in Linh (2009)'s study while at least two new VHLSS rounds have been available since then. In addition, there is a lack of studies that apply more advanced demand systems such as QUAIDS to capture the possible non-linear Engel relationship.

Table 1: Comparisons of expenditure elasticities in the Vietnamese food demand literature

Author	Method	Survey year	Expenditure			Own-price		
			All	North	South	All	North	South
Minot and Goletti, 2000	AIDS	1993		0.48	0.11		-0.2	-0.38
			All	Urban	Rural	All	Urban	Rural
Benjamin and Brandt, 2002	Working-Leser	pooled 1993/98		0.49 - 0.41*	0.64- 0.63*			
Haughton et. al, 2004	Log-log quadratic, national mean	1998	0.12	0.11	0.10			
	Log-log quadratic, rural-urban mean	1998		0.04	0.16			
	Log-log quadratic, national mean	1993	0.16	-0.40	0.27			
	Log-log quadratic, subgroup mean	1993		-0.43	0.19			
Niimi, 2004	Commune-specific unit values	1993	0.62			-0.85		
		1998	0.52			-0.72		
Canh, 2008	AIDS	2004	0.76	0.02	0.80	-0.33	-0.47	-0.54
Linh, 2009	LA/AIDS with communal adjusted price	2006	0.31	0.46	0.25	-0.8	-0.72	-0.82

Source: Compiled. *: numbers are reported for northern and southern region, respectively.

One of the first internationally-recognized studies related to rice consumption in Vietnam is the IFPRI's study on rice market liberalization conducted by Minot & Goletti

(2000). The authors used VLSS 1993 and employed AIDS to estimate food demand parameters for rice and 13 other food groups, divided by northern and southern regions. Results showed that the expenditure elasticity of rice demand in the northern region was higher, 0.48, compared to that in the south, 0.11. This is sensible as consumers in the south generally have higher incomes than those in the north. Rice demand was inelastic with respect to price; own-price elasticities were estimated to be -0.2 in the north and -0.38 in the south.

Using a panel data set pooled from VLSSs 1993 and 1998, Benjamin & Brandt (2004) estimated expenditure elasticities of rice demand of the 1993-1998 period using Working-Leser model, which is mainly based on the assumption that budget share is a linear function of per capita expenditure and prices. In addition to rice, their model includes cereals, meat, oils, fish, other protein products, vegetables, fruits and food away from home (FAFH). Unadjusted unit values, which were calculated from dividing expenditure by the corresponding quantity purchased, were used as proxies for market prices. Consistent with previous studies, expenditure elasticities in urban areas were found to be smaller than in rural areas. In particular, the elasticities ranged between 0.41 for urban consumers in the south and 0.49 for those in the north while own-price elasticities varied slightly between 0.63 and 0.64 in northern and southern-rural areas. Between 1993 and 1998, the study showed that expenditure share for rice decreased from 32% to 25% for urban north and from 25% to 23% for urban south. In rural areas, rice budget share declined from 51% to 44% for rural north and 43% to 40% for rural south. Budget shares of other food groups increased but minimally, which seemed to indicate a slow transition from cereals to high-protein products such as meat and fish in the diets of the Vietnamese during this period.

Haughton et al. (2004) employed a double–logarithmic quadratic functional form to estimate the demand curve for rice using VLSSs 1993 and 1998. Interestingly, the study found that rice expenditure elasticity declined at higher income levels and reached zero value at $290 (3.56 million VND), suggesting that rice became an inferior good for richer consumers. However, the results did not show a consistent trend between 1993 and 1998. For example, expenditure elasticities estimated at the national level were negative (-0.4) in urban areas and positive in rural areas (0.3). If this finding were true, rice should continue to be an inferior good for urban consumers in 1998 as the country had shown sustained economic growth. However, the results showed that rice was a normal good for both rural and urban consumers with elasticities of 0.11 and 0.1 in 1998. Inconsistent results persisted even when the authors estimated elasticities separately for urban and rural samples.

Using a panel data set from VLSSs 1993 and 1998, Niimi (2005) applied AIDS to validate different methods of using market prices and unit prices in the demand system. Besides rice, the study also covered other major commodities including other staples, meat, fish, vegetables, fruits, sugar, spice and dairy. Estimated income and price elasticities for rice were 0.62 and -0.85 in 1993 and 0.52 and -0.72 in 1998, respectively. Noting that both price and expenditure elasticities decreased slightly between these two years. Similar to Haughton, Fetzer, Lo, & Nguyen (2004), the results appeared to be inconsistent as other staples, meat, fish and dairy shifted from being a normal good to a luxury good between 1993 and 1998. This seems to be a reversal in consumption patterns given the fact that income had increased, even modestly, between the two survey years.

Among existing studies on food demand in Vietnam, Canh (2008) and Linh (2009) are those that used more recent household surveys. Using AIDS and data from VHLSS 2004, Canh (2008) developed a food demand system of three food groups including (1) rice, (2) non-rice food including vegetables, fruits, drinks and miscellaneous, and (3) meat and fish.   The author used price indices averaged from individual prices of selected food items in the survey. At the national level, rice and meat were found to be normal and necessity goods while non-rice food group was a luxury. The expenditure elasticity of rice demand was estimated to be 0.76, the highest compared to results from previous studies. In addition, the expenditure elasticity appeared to be more elastic (0.8) in rural areas while it was very inelastic in urban areas (0.02).At the national average, demand for rice was found to be inelastic with respect to its own price (-0.33). For non-rice food group, however, the compensated own-price elasticity appeared to be positive at the national level. The author asserted that this problem was not uncommon in the demand analysis literature as Deaton & Muellbauer (1980) and Gibson (1995)'s studies also found positive own-price elasticities of demand for non-cereal food groups. In addition to this, another explanation could be aggregation biases as foods were categorized in only three groups in this study. Normally, products are aggregated if they are close substitutes for each other, e.g. rice and wheat, or pork and beef. In this study's non-rice food group, foods of close substitutes such as vegetables and fruits were combined with drinks, which seem to be rather a complement than a substitute for vegetables or foods of the same kind.

To account for unit price biases, which had not been well-treated in the literature on Vietnam's food demand analysis, Linh (2009) applied different methods to adjust prices for spatial and quality differences. LA/AIDS and data from VHLSS 2006 were used to estimated price and expenditure elasticities for rice and other 10 food groups including staples, pork, poultry, other meats, fish, vegetables, fruits, other foods, drinks and food away from home (FAFH). First, the study found that the Cox & Wohlgenant (1986)'s quality-adjusted approach outperformed other methods such as individual unit value, communal unit values or Deaton's technique. Second, the study found that rice and all other food groups were normal goods with elasticities being positive at the national level as well as at different levels of disaggregation. The national expenditure elasticity of rice demand was estimated to be 0.31, smaller than results from Canh (2008) and Niimi (2005), but rice demand was very price elastic with an own price elasticity being -0.8. The expenditure elasticities of other food groups were also very elastic, slightly below or above unity. However, findings of this study exposed some conflicting trends. For example, the mean expenditure elasticity for rural consumers was estimated to be higher than that for urban consumers (0.46 vs. 0.25). In addition, consumers of the 5th quintile, the richest group in the sample, were found to have the highest mean expenditure elasticity (0.55) compared to other income groups. Similarly, the expenditure elasticity in the south was higher than in the north (0.39 vs. 0.22) while the former region, in fact, was generally richer than the later.

While rice remained the focus of the literature on food demand in Vietnam, none of the previous studies have applied rank-three demand systems such as QUAIDS for their analysis. According to (Cirera & Masset, 2010), the rank of a demand system is "the maximum dimension of the function space contained by the Engel curve" and demand systems of this kind have been shown to outperform their counterparts in fitting data and providing projections. This study employs both AIDS and QUAIDS to estimate a food demand system for Vietnam using VHLSS 2010. Empirical tests will be conducted to compare the performance of both models in fitting the data. Conclusions will be drawn accordingly.

In the next section detailed specifications of AIDS and QUAIDS models are presented along with likelihood and Wald test procedures. Section 4 provides an overview of the household survey data used for the analysis. The categorization of composite food groups and demographic variables are defined and descriptive statistics are provided. Section 5 discusses analytical procedures to enumerate unit prices in order to account for quality and spatial biases in the estimation. Section 6 presents the results of the analysis including the assessment of the models' performance in fitting data based on test statistics. The elasticity estimates from the selected model are presented at various disaggregate levels. The last section of this essay summarizes results from the analysis and implications for food policy in Vietnam.

3. Model specification

The AIDS model developed by Deaton & Muellbauer (1980) and one of its various extended versions, the QUAIDS model, developed by Banks, Blundell, & Lewbel (1997) are used as the theoretical basis for this study. Based on an indirect utility function, the QUAIDS model has a form as follows:

$$w_i = a_i + \sum_{j=1}^{n} \gamma_{ij} \, lnp_j + \beta_j ln\left[\frac{m}{\alpha(\boldsymbol{p})}\right] + \frac{\lambda_i}{b(\boldsymbol{p})}\left\{ln\left[\frac{m}{\alpha(\boldsymbol{p})}\right]\right\}^2 \quad (1)$$

where w_i is the budget share of household i derived from price, quantity and total expenditure, $w_i = p_i q_i / m$, and satisfies the constraint $\sum_{i=1}^{n} w_i = 1$, n is the number of goods in the system, p_j is the price of good j, m is per capita total food expenditure, $\alpha(\boldsymbol{p})$ and $b(\boldsymbol{p})$ are the price indices, $\boldsymbol{p}$ is the vector of prices and α, β, γ, and λ are parameters to be estimated. Price indices are defined below:

$$ln a(\boldsymbol{p}) = a_0 + \sum_{n=1}^{n} \alpha_i ln p_i + \frac{1}{2} \sum_{i=1}^{n} \sum_{j=1}^{n} \gamma_{ij} ln p_i ln p_j$$

(2)

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

(3)

All parameters need to satisfy the adding-up condition, homogeneity condition, and Slutsky symmetry restriction:

Adding-up: $\sum_{i=1}^{n} \alpha_i = 1, \sum_{i=1}^{n} \beta_i = \sum_{i=1}^{n} \gamma_{ij} = 0,$

Homogeneity: $\sum_{i=1}^{n} \gamma_{ij} = 0 \; \forall \; j$

Symmetry: $\gamma_{ij} = \gamma_{ji}$

Expenditure elasticities are obtained from

$$\eta_i = {}^{\mu_i}/_{w_i} + 1 \text{ where } \mu_i = \beta_i + \frac{2\lambda_i}{b(\boldsymbol{p})} \left\{ ln \left[\frac{m}{\alpha(\boldsymbol{p})} \right] \right\}$$

(4)

Uncompensated price elasticities are given by

$$e_{ij}^{u} = {}^{\mu_{ij}}/_{w_i} - \delta_{ij} \text{ where } \mu_{ij} = \gamma_{ij} - \mu_i \left(\alpha_j + \sum_k \gamma_{jk} ln p_k \right) - \frac{\lambda_i \beta_i}{b(\boldsymbol{p})} \left\{ ln \left[\frac{m}{\alpha(\boldsymbol{p})} \right] \right\}^2$$

(5)

Compensated price elasticities are derived from the Slutsky equation:

$$e_{ij}^{c} = e_{ij}^{u} + \eta_i w_i \qquad (6)$$

In addition, to account for demographic characteristics of a household, Poi (2013) extended equation 1 using the scaling technique proposed by Ray (1983). Assuming a utility maximizing household with s demographic characteristics, represented by vector **z**, the scaled expenditure function has the form:

$$m_0\,(\boldsymbol{p}, \boldsymbol{z}, u) = \overline{m_0}\,(\boldsymbol{z}).\,\phi(\boldsymbol{p}, \boldsymbol{z}, u) \tag{7}$$

in which $\overline{m_0}\,(\boldsymbol{z})$ measures the change in a household's expenditure with respect to demographic characteristics holding consumption patterns constant. The second term, $\phi(\boldsymbol{p}, \boldsymbol{z}, u)$, on the other hand, accounts for actual prices and quantities consumed by a household. It is defined by:

$$ln\phi(\boldsymbol{p}, \boldsymbol{z}, u) = \frac{\prod_{j=1}^{k} p_j^{\beta_j} (\prod_{j=1}^{k} p_j^{\eta'_j \mathrm{z}} - 1)}{\frac{1}{u} - \sum_{j=1}^{k} \lambda_j ln p_j} \tag{8}$$

QUAIDS with a vector of demographic variables **z** now has the form:

$$w_i = a_i + \sum_{j=1}^{n} \gamma_{ij}\, lnp_j + (\beta_j + \eta_i \boldsymbol{z})\, ln\left[\frac{m}{m_0\,(\boldsymbol{z})\alpha(\boldsymbol{p})}\right] + \frac{\lambda_i}{b(\boldsymbol{p})c(\boldsymbol{p},\boldsymbol{z})}\left\{ln\left[\frac{m}{m_0\,(\boldsymbol{z})\alpha(\boldsymbol{p})}\right]\right\}^2$$

(9)

where $m_0\,(\boldsymbol{z})$ = 1 + ρ′ $\boldsymbol{z}$ and $c(\boldsymbol{p}, \boldsymbol{z}) = \prod_{j=1}^{k} p_j^{\eta'_j \mathbf{z}}$ with $\sum_{j=1}^{k} \eta_{rj} = 0$ (r=1…s) to satisfy adding-up condition. Two additional vectors of demographic parameters ρ and η are to be estimated.

It is noted that when λ_i = 0 equation 1 becomes the original AIDS model. With a quadratic term λ_i in the expenditure *m*, QUAIDS allows a good to change from luxury (expenditure elasticity>1) to necessity (expenditure elasticity<1) as expenditure increases.

Furthermore, likelihood ratio and Wald tests are conducted in the study to examine the suitability of QUAIDS over AIDS. First, Wald tests are used to test whether the quadratic terms λ_i in QUAIDS are significantly different from zero in every single equation and for all 7 equations simultaneously. If the test statistics are significant, the expenditure variable *m* should have a quadratic term in the demand system. Second, a likelihood ratio test is employed to check whether QUAIDS performs better than AIDS. The test statistic is simply derived from k=2*(L1-L0) where L1 is the likelihood value of QUAIDS (the unrestricted model) and L0 is the likelihood value of AIDS (the restricted model which has less parameters). The test statistic *k* has an asymptotic χ^2_{u-r}distribution with *u-r* degrees of freedom, where *u* is the number of parameters in the unrestricted model and *r* is the number of parameters in the restricted model. A significant *t* statistic indicates that QUAIDS fits data better than AIDS.

4. Data description

This study uses the household survey conducted by the General Statistics Office of Vietnam in 2010 for analysis. The full survey contains 36,756 households with information on education, health and healthcare, employment and income, expenditure, housing, poverty reduction and socio-demographic characteristics. However, data for this study are mainly obtained from the Income and Expenditure Survey (IES), a subset of VHLSS. IES is a nationally representative sample containing information on income and expenditure on foods and non-foods of 9,399 households from 63 provinces and cities, 687 districts and 3,129 communes. About two thirds of households in the sample lived in rural areas while the remainder lived in urban areas, a reflection of the agriculture-based economy of Vietnam. Interviews were conducted in three quarters from June to December of 2010.

Data on food consumption were collected for purchased, home-produced foods and foods given as gifts covering 54 different food items. The regularity of consumption was divided into holiday (reported on an annual basis) and 30-day period consumption[4] (here defined as regular consumption). Total food expenditure is calculated as the sum of regular and holiday consumption.

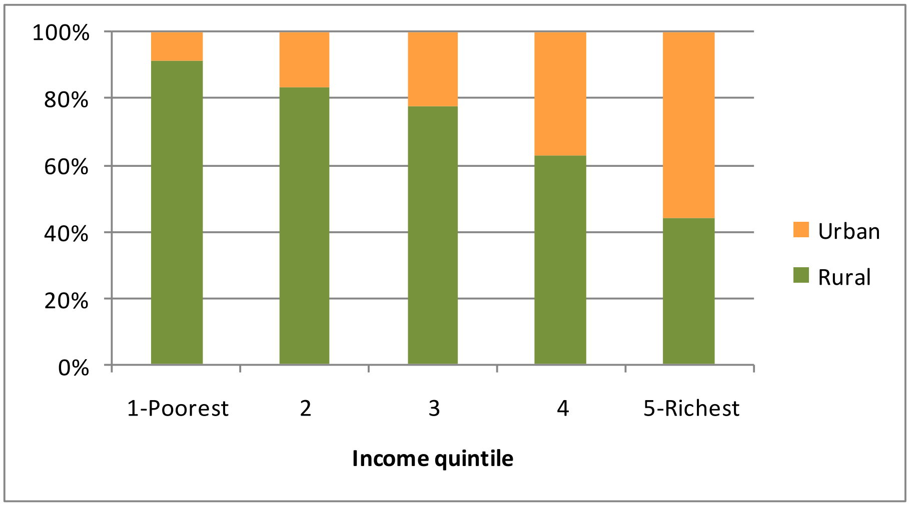
Out of 9,399 households in the sample, 9,319 households are used for analysis. Households that have missing values and negative prices are first removed from the dataset. In addition, households are dropped if they either spend 100% of expenditure on only one food group, have the budget share for rice less than 1%, have income per capita exceeding 2 billion VND (about 100 times higher than the average) or have annual rice consumption per capita exceeding 400 kg (about 3 times higher than the average). These could have been caused by measurement errors during the survey interviewing process.

A disaggregation of the sample by income quintile and by urban and rural households is shown in Figure 1. At higher income levels, the proportion of urban-dwellers increases significantly, from 9% at the lowest quintile to 56% at the highest quintile, indicating that people in urban areas are generally much richer than those in rural areas. This population decomposition also suggests that the share of urban households in each income class is expected to increase, especially at higher income brackets, as the economy continues to grow.

---

[4] First, the respondent is asked "Which of the following items has your household consumed on festive occasions over the past 12 months?" to report on food consumption on holidays. Then regular consumption is investigated by the following question "Over the past 30 days, which of the following items has your household consumed?"

Figure 1: Shares of rural and urban households by income quintile



Source: VHLSS 2010

All food items in the sample are aggregated into 7 major food groups including (1) rice, (2) pork, (3) meat and fish, (4) vegetables and fruits, (5) sugar, (6) drinks and (7) miscellaneous food which aggregates all the remaining food items. Table 2 presents in detail the categorization of each group along with corresponding budget shares and annual per cap consumption. Budget share is calculated as the percentage of expenditure on a particular food group in total food expenditure. On average, a household spends half of their total income on food. The average food expenditure per capita was $392 (7.3 million VND) or $33 (611,000 VND) per month, which is similar to GSO's calculations (GSO, 2011b). Among 7 food groups, meat including pork and other kinds of meat accounts for the largest part of a household's food expenditure, 29.8% total, followed by rice (20.3%) and vegetables (11.0%). The proportions of drinks and sugar in total expenditure are small, 4.4% and 2.2%, respectively. However, it should be noted that a portion of a household's total food consumption goes into foods that are consumed out of home. On average, FAFH alone accounts for 14.4% of the household's total food expenditure, or about half of the expenditure on miscellaneous foods.

Table 2: Food item aggregation

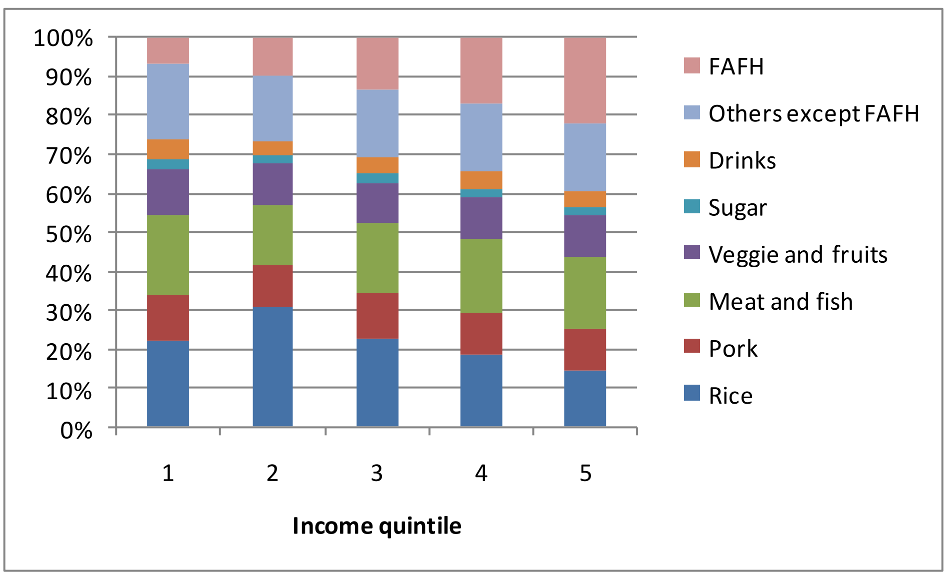
No	Food group	Constituent food items	Unit	Budget share	Annual per cap consumption
1	Rice	Plain rice, sticky rice	Kg	20.3%	124.0
2	Pork	Pork	Kg	11.0%	13.9
3	Meat and fish	Beef, buffalo meat, poultry, fish, shrimps, other processed meats and seafood	Kg	18.8%	26.8
4	Vegetables and fruits	Beans, peanuts, tofu, vegetables and fruits	Kg	11.0%	72.7
5	Sugar	Sugar and confectionery	Kg	2.2%	5.5
6	Drinks	Alcohols, beer, fruit drinks, soft drinks	Liter	4.4%	12.0
7	Miscellaneous*	Food away from home and other cereals, spices, coffee and tea, eggs, milk and dairy products, seasonings and cooking oil	Index	32.2%	24.9

Source: VHLSS 2010.

Note: *This group is a combination of disparate food items which have no consistent quantity units. The price of this food group is replaced by 2010 CPI, which is 109.9. More details on the calculation of unit prices are provided in the estimation strategy section.

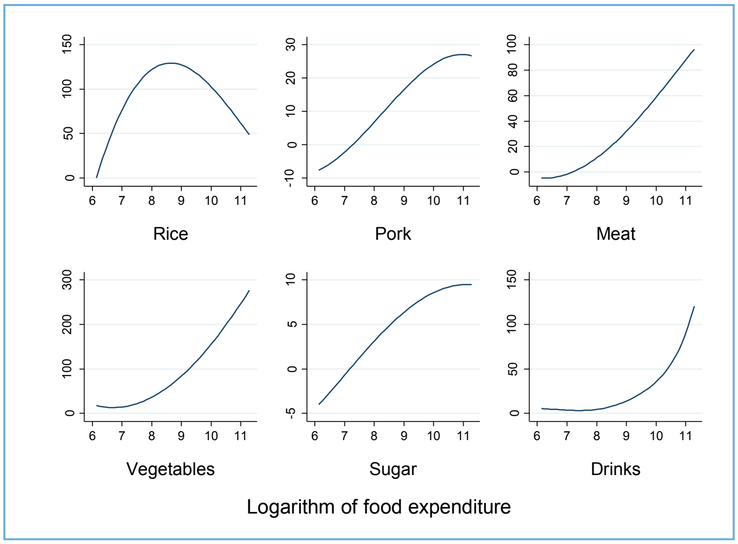
Figure 2 shows that food budget shares are substantially similar across different income levels for most food groups except rice and FAFH. The budget share of rice is highest in the second quintile group and has a declining trend at higher income quintiles. In contrast, the proportion of FAFH in total food expenditure increases considerably as income rises, from about 6% for consumers at the lowest income quintile to 23% for those at the highest income quintile. A clearer picture of how per capita consumption of each food group changes as food expenditures rise is shown in Figure 3. Consistent with Bennett's Law, the per capita consumption of all food groups except rice increases with expenditure. Interestingly, the relationship between per capita rice consumption and logarithm of per capita expenditure has an inverted U-shaped curve, which indicates that per capita rice consumption increases at lower income levels and starts to decline after reaching its maximum point, around the mean expenditure value of $401 (7.3 million VND).

Figure 2: Food budget shares by income quintile



Source: VHLSS 2010

Figure 3: The relationship between quantity consumed and logarithm of food expenditure on a per capita basis for 6 food groups

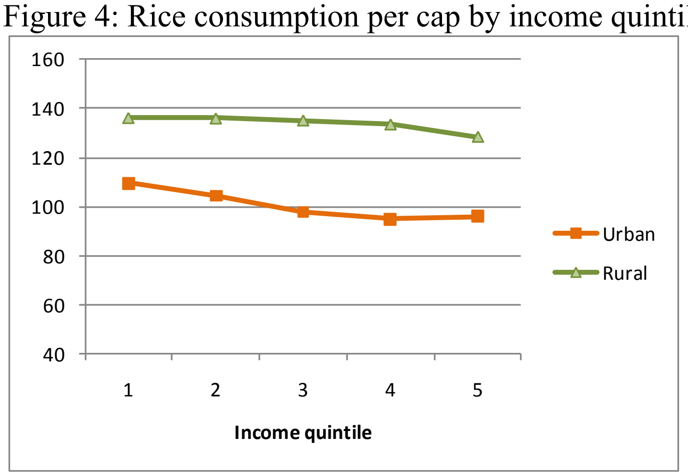


Source: VHLSS 2010.

Note: Non-parametric estimations using Gaussian kernel functions. Quantity and food expenditure are used on a per capita basis. Units of quantity consumed are kg for rice, pork, meat, vegetables, sugar and liter for drinks.

Particularly, annual per capita rice consumption averages 124 kg at the national level in which rural people consume about 134 kg of rice per person on average, 33.5 kg higher than urban consumers. Rice consumption also shows a declining trend at higher income brackets for both rural and urban consumers (Figure 4).

Figure 4: Rice consumption per cap by income quintile within rural and urban areas



Source: VHLSS 2010

In addition, a summary of socio-economic and demographic variables used for analysis is presented in Table 3. The average household size is 4 and average age of the head of a household is 48. The average proportion of kids under 5 years old is 8.5% while the proportion of the people above 60 years old in the household is 12.8%. Dummy variables are reported by the share of households that have the corresponding characteristics. 75% of households are headed by males. About 28% of households live in urban areas and 72% live in rural areas. The share of households that are ethnic minorities is 17%. The educational level of the household head is divided into groups that include those with less than or equivalent to primary school degrees or no degree (44.2%), elementary, high school or vocational school degrees (49.4%), and college or graduate school degrees (6.5%). Provinces are grouped into 8 different regions to reflect geographical differences among households. Mekong River Delta and Red River Delta are the two regions that have the highest proportion of households in the survey, 20.4% and 18.5% respectively. Three dummy variables are created based on the month the survey took place to take into account seasonal differences among households.

Table 3: Summary statistics of household demographic characteristics

Demographic variables	**Mean**
Household size	4.0
Age of the household head	48.3
Proportion of infants (age<5)	8.5%
Proportion of elders (age >60)	13.1%
Share of households with the following demographic characteristics	**%**
Head of the household is male	75.2
If the household lives in urban areas	28.2
Ethnic minority	17.7
Educational attainment - Primary school, no degree	44.2
Educational attainment - Elementary, high school or equivalent vocational school	49.4

Educational attainment - College and university degree and graduate degree	6.5
Region 1 - Red River Delta	18.5
Region 2 - North East	9.1
Region 3 - North West	11.1
Region 4 - North Central Coast	10.3
Region 5 - South Central Coast	11.8
Region 6 - Central Highlands	6.7
Region 7 - South East	12.2
Region 8 - Mekong River Delta	20.4
Season 1 - June, July	32.8
Season 2 - August, September, October	33.9
Season 3 - November, December	33.4

Source: VHLSS 2010.

5. Estimation strategy

One major problem with VHLSS 2010 is that the survey did not collect price data. Thus, in this study unit prices are derived from dividing expenditure by the corresponding quantity. For households that have missing unit prices due to zero-consumption or omitted quantity[5], missing prices are replaced by mean prices at the commune, district and province level, whichever comes first. Following Linh (2009), all unit prices that are more than five standard deviations from their means are replaced by the mean of unit values of households in the same commune.

In addition, the enumerated unit prices might suffer from quality effects and measurement errors, which are common in household data analysis (Deaton, 1988). Consumers choose quality which is reflected by the price (unit value). When prices change, however, consumers react by changing both quality and quantity. Measurement errors in reported quantities and expenditures also cause inaccuracy in enumerated unit prices. To account for these potential biases, this study employs the communal mean price method originally developed by Cox & Wohlgenant (1986) and later modified by Linh (2009) in his food demand study using VHLSS 2006. Several studies have affirmed the usefulness of this method in eliminating spatial and quality variations in price data (Gibson & Rozelle, 2011; Majumder, Ray, & Sinha, 2012; Niimi, 2005).

First, prices are adjusted for quality differences. The equation has the form as follows:

$$p_i = \alpha\, p_i^c + \beta f_i + \gamma\, x_i + \sum_n \eta_{in} z_{in} + e_i \qquad (10)$$

[5] For food group combining disparate types of foods the survey only asked for total expenditure and subjectively ignored quantity.

where i denotes the household i in the dataset, p_i is the unit price of an individual food faced by household i, p_i^c is the mean of unit prices at communal level, $f_i$is the share of food away from home, $x_i$is the household food expenditure per cap and e_i is the error terms. Household characteristics z_{in} include household size, urban and region dummy variables, the sex, education and age of the household head.

The residual for every household i in equation 10 is added to the communal mean unit price p_i^c to obtain the quality-adjusted prices p_i^a at the household level.

$$p_i^a = p_i^c + \hat{e_i} \tag{11}$$

According to Deaton (1988), household surveys normally collect data from households in the same village at the same time. Thus, it is plausible that these households should face the same price. Taking this insight into consideration, this study assumes that households in the same commune (the smallest geographic unit in the dataset) face the same prices. This communal mean quality-adjusted price of the individual food item is the mean of p_i^a calculated at the communal level.

$$p_i^{c*} = \overline{p_i^a} \tag{12}$$

Except for the group of miscellaneous foods, the composite price of the food group is also computed at the communal level, i.e. households in the same commune face the same unit prices for these composite food groups. Following Niimi (2005), the commune mean budget shares are used as weights.

$$p_g^c = {\sum_{i=1}^k p_i^{c*} u_i^c} \Big/ {\sum_{i=1}^k u_i^c} \tag{13}$$

where $u_i^c$is the mean budget share at the communal level of individual food item i, k is the number of food item i in the group, p_g^c is the price of the composite food group g at the communal level. As the miscellaneous food group is a combination of disparate food items with different quantity units, there is no standard unit price for this group. Following Ganesh-Kumar, Prasad, et al. (2012) and Linh (2009), I replaced the price of this group by the 2010 CPI, which is 109.19. The mean prices of each food group along with standard deviations are presented in Table 4. Zero-consumption is not a problem in this study as the number of non-consuming households is very minimal.

Table 4: Unit prices and shares of consuming households

Food group	Unit	Mean price (1000 VND)	Standard deviation	Percentage of consuming households (%)
Rice	Kg	9.5	1.8	99.7
Pork	Kg	54.2	8.2	99.1
Meat and fish	Kg	54.7	16.5	99.3
Vegetables and fruits	Kg	11.2	3.7	99.7
Sugar	Kg	30.6	13.8	99.0
Drinks	Liter	42.0	36.8	97.8
Miscellaneous	Index	109.2	0.0	100.0

Source: VHLSS 2010

6. Empirical results

1.1. Country-level

Both QUAIDS and AIDS yield consistent and similar results on mean expenditure and price elasticities across 7 food groups as shown in Table 5. Except for rice, all food groups were estimated to have positive expenditure elasticities by both models. Pork appeared to be a necessity with an expenditure elasticity below unity (0.78), while meat and fish group is a luxury good (1.26). This suggests a shift in demand for higher-valued meats away from pork as consumers' incomes increase, which seems sensible as pork is the most popular meat consumed in Vietnam. A shift away from pork consumption highlights consumers' dietary diversification. In addition, drinks and miscallenous foods are found to be luxury goods while vegetables and fruits and sugar are necessities. Studies conducted for other Asian countries such as China also found that drinks were a luxury good (Fan, Wailes, & Cramer, 1995; Huang & Bouis, 1996). Interestingly, the expenditure elasticity for rice is estimated to be positive in QUAIDS (0.05) but negative in AIDS (-0.04) although in terms of absolute values, both results show an inelastic demand curve for rice.

Table 5: QUAIDS and AIDS price and expenditure elasticity estimates

Food group	QUAIDS			AIDS		
	Expenditure	Own price		Expenditure	Own price	
		Marshallian	Hicksian		Marshallian	Hicksian
Rice	0.05	-0.12	-0.06	-0.04	-0.15	-0.09
Pork	0.78	0.05	0.15	0.86	-0.02	0.08
M&F	1.26	-0.73	-0.51	1.24	-0.74	-0.52
V&F	0.84	-0.77	-0.67	0.85	-0.77	-0.67
Sugar	0.65	-0.57	-0.55	0.65	-0.56	-0.55
Drinks	1.83	-1.10	-1.04	1.82	-1.10	-1.04
Misc.	1.53	-1.36	-0.91	1.54	-1.41	-0.96

Source: Calculated.

At the national level, the estimated Marshallian and Hicksian own-price elasticities are negative for all food groups except pork, which appeared to be a Giffen good with positive own-price elasticities. In the literature, Giffen goods have been shown to be a popular case rather than a paradox in consumer theory (Doi, Iwasa, & Shimomura, 2009; Spiegel, 1994). An example of Giffenity could be that a household chooses between pork and beef as alternative sources of protein. The former is considered cheaper and less preferred while the later is more expensive and tasty. However, if prices of pork soar but food budget remains unchanged, which also means real income declines, the household may have to reduce their consumption of beef and increase their quantity demanded for pork to meet daily nutritional requirements. This should be the case for an average Vietnamese household as the country faced stiff inflation in late 2010 (Bhattacharya, 2013).

In addition, Wald test results show that 5 out of 7 food equations have their quadratic terms λ significantly different from zero (Table 6). The null hypothesis that λ_i is jointly equal to zero in all 7 equations is rejected at 1% level of significance, which indicates the importance of the quadratic term in the expenditure variable. Moreover, *k* value from the likelihood ratio test is statistically significant at 1% as shown in Table 7. Thus, we reject the null hypothesis that two models are the same. Combining results from both tests, it is plausible to conclude that the expenditure *m* in equation 7 should have a quadratic term and QUAIDS fits data better than AIDS. Estimated parameters from QUAIDS regression are also presented in Table 8 with z-statistics. Out of 193 parameters to be estimated, 123 parameters are statistically significant at 10% level. Among 49 key parameters associated with α_i, β_i, γ_{ij}, and λ_i, 39 are estimated to be statistically significant at 1% level.

Table 6: Wald test results

	Chi-squared	Prob > chi2
Rice	858.04	0.00
Pork	73.24	0.00
Meat and fish	234.12	0.00
Vegetables and fruits	2.36	0.12
Sugar	34.69	0.00
Drinks	0.50	0.48
Others	9.72	0.00
H0: All quadratic terms = 0	1240.92	0.00

Source: Calculated.

Table 7: Likelihood ratio test results

	Log-likelihood	Number of variables
QUAIDS	92108.73	193
AIDS	91819.17	186
Test statistic, k	579.13	
Degree of freedom	7	
Chi-squared at 1% significance level, df=7	18.47	

Source: Calculated

Table 8: QUAIDS parameter estimates

Parameters	Food groups (i)							
	Rice	**Pork**	**M&F**	**V&F**	**Sugar**	**Drink**	**Misc.**	
α_i	0.30011	-0.29060	-0.29104	0.08409	-0.05545	0.09610	1.15679	
	(9.76)	(-9.16)	(-8.58)	(3.82)	(-7.07)	(6.77)	(21.72)	
β_i	0.10123	-0.11732	-0.16820	-0.00531	-0.02221	0.01793	0.19387	
	(11.04)	(-10.59)	(-13.76)	(-0.69)	(-8.14)	(3.56)	(10.36)	
λ_i	0.02212	-0.00900	-0.01856	0.00109	-0.00151	0.00033	0.00553	
	(29.29)	(-8.56)	(-15.30)	(1.54)	(-5.89)	(0.71)	(3.12)	
γ_{ij}	0.16931							
	(23.55)							
γ_{ij}	-0.06417	0.08345						
	(-11.09)	(9.88)						
γ_{ij}	-0.09967	0.04671	0.12705					
	(-15.60)	(6.34)	(9.99)					
γ_{ij}	-0.01291	-0.00647	0.00213	0.01815				
	(-4.21)	(-2.11)	(0.51)	(9.78)				
γ_{ij}	-0.01160	0.00043	0.00565	0.00276	0.00641			
	(-8.18)	(0.28)	(3.26)	(3.97)	(11.34)			
γ_{ij}	-0.00916	-0.00712	-0.00169	0.00237	-0.00028	0.00022		
	(-4.98)	(-3.71)	(-0.62)	(2.95)	(-0.67)	(0.29)		
γ_{ij}	0.02820	-0.05283	-0.08017	-0.00603	-0.00337	0.01566	0.09854	
	(3.11)	(-4.38)	(-5.15)	(-1.12)	(-1.31)	(4.78)	(3.99)	
Demographic parameters								**ρ**
η-age	-0.00007	0.00001	0.00002	-0.00002	0.00001	-0.00002	0.00007	-0.0007
	(-1.44)	(0.59)	(0.77)	(-1.90)	(3.31)	(-2.25)	(1.99)	(-0.86)
η-male_d2	0.00046	-0.00049	-0.00101	0.00152	0.00040	-0.00294	0.00205	0.0385
	(0.40)	(-1.56)	(-1.87)	(5.70)	(5.31)	(-15.27)	(2.31)	(1.81)
η-share of kids	0.01205	-0.00076	-0.00266	0.00022	-0.00194	0.00190	-0.00881	-0.1842
	(3.38)	(-0.76)	(-1.49)	(0.26)	(-8.11)	(3.27)	(-3.38)	(-2.87)
η-share of elders	0.00336	-0.00112	-0.00292	-0.00250	-0.00091	-0.00001	0.00410	0.0654
	(1.27)	(-1.66)	(-2.31)	(-4.32)	(-5.70)	(-0.03)	(2.13)	(1.22)
η-size	-0.00029	0.00074	-0.00023	0.00093	0.00020	0.00004	-0.00140	-0.0150
	(-0.86)	(7.71)	(-1.36)	(11.57)	(8.76)	(0.81)	(-5.73)	(-2.51)
η-urban_d2	-0.00638	-0.00024	0.00440	-0.00254	-0.00002	0.00169	0.00310	-0.2781
	(-3.70)	(-0.61)	(5.94)	(-7.32)	(-0.22)	(6.89)	(2.32)	(-8.40)
η-ethnic_d2	-0.00597	0.00094	0.00070	0.00096	0.00081	-0.00019	0.00274	0.0626
	(-3.32)	(2.21)	(0.80)	(2.84)	(8.40)	(-0.80)	(2.41)	(1.69)
η-edu_d2	0.00193	-0.00025	-0.00009	0.00005	-0.00001	-0.00060	-0.00104	-0.0010
	(1.90)	(-0.92)	(-0.17)	(0.20)	(-0.10)	(-3.80)	(-1.42)	(-0.05)
η-edu_d3	0.00459	0.00134	-0.00313	-0.00007	-0.00006	-0.00142	-0.00126	0.0277
	(2.24)	(2.10)	(-3.19)	(-0.13)	(-0.36)	(-3.74)	(-0.67)	(0.75)
η-region_d2	0.00323	0.00405	-0.00453	-0.00028	0.00032	-0.00002	-0.00277	0.0370
	(1.17)	(7.57)	(-3.54)	(-0.61)	(2.65)	(-0.05)	(-1.62)	(0.58)
η-region_d3	0.0034	-0.0019	-0.0028	0.0001	-0.0001	-0.0007	0.0021	0.1635
	(1.17)	(-3.23)	(-1.95)	(0.13)	(-0.79)	(-2.28)	(1.27)	(2.31)
η-region_d4	-0.0050	0.0057	-0.0022	0.0033	0.0000	0.0003	-0.0021	-0.1218
	(-1.98)	(10.85)	(-1.87)	(8.07)	(-0.39)	(1.13)	(-1.38)	(-2.54)
η-region_d5	-0.0002	0.0111	-0.0044	0.0013	-0.0006	0.0009	-0.0081	-0.1640
	(-0.09)	(19.06)	(-4.15)	(2.86)	(-4.42)	(3.01)	(-5.40)	(-3.94)
η-region_d6	-0.0073	0.0082	-0.0020	0.0002	-0.0001	-0.0005	0.0014	-0.1371
	(-2.59)	(12.82)	(-1.57)	(0.34)	(-0.36)	(-1.35)	(0.79)	(-2.74)
η-region_d7	-0.0038	0.0082	-0.0001	-0.0016	-0.0008	0.0013	-0.0033	-0.2800
	(-1.64)	(14.49)	(-0.13)	(-3.31)	(-5.69)	(3.84)	(-1.92)	(-7.41)
η-region_d8	-0.0048	0.0112	-0.0072	0.0002	-0.0019	0.0005	0.0021	-0.1657
	(-2.27)	(20.65)	(-7.73)	(0.55)	(-15.39)	(1.61)	(1.38)	(-4.09)
η-season_d2	0.00179	0.00145	-0.00183	0.00059	0.00012	0.00019	-0.00231	0.0375
	(1.55)	(4.65)	(-3.27)	(2.29)	(1.61)	(1.07)	(-2.76)	(1.68)
η-season_d3	-0.00130	-0.00014	0.00081	0.00061	0.00034	0.00088	-0.00119	0.0195
	(-1.13)	(-0.42)	(1.45)	(2.27)	(4.31)	(4.75)	(-1.37)	(0.90)

Note: Sample size: 9,319. Parameters are estimated using nonlinear seemingly unrelated regression (NLSUR) procedures satisfying adding-up, homogeneity and symmetry conditions. Numbers in parentheses are z-values. d denotes dummy variables.

1.2. Urban-rural disaggregation

In this section, results from QUAIDS are used to analyze the differences in expenditure and own-price elasticities by income class and between rural and urban households within each class. The disaggregated expenditure and own-price elasticities are presented in Table 9 and Table 10. For brevity, only 3 out of 5 income quintiles (the poorest, middle and richest) are reported. Complete results are presented in Table A1 and A2 in Appendix. Cross-price elasticities are also provided in Table A3 in Appendix.

Table 9: QUAIDS expenditure elasticities by income quintile

Food group	**Country-level**				**Rural**				**Urban**			
	All	Quintile			All	Quintile			All	Quintile		
		Q1	Q3	Q5		Q1	Q3	Q5		Q1	Q3	Q5
Rice	0.05	0.32	0.11	-0.34	0.14	0.36	0.18	-0.14	-0.18	0.12	-0.16	-0.55
Pork	0.78	1.00	0.80	0.47	0.89	1.04	0.89	0.71	0.51	0.72	0.57	0.18
M&F	1.26	1.61	1.22	1.03	1.34	1.69	1.28	1.13	1.07	1.25	1.04	0.93
V&F	0.84	0.83	0.85	0.85	0.84	0.83	0.85	0.85	0.84	0.84	0.84	0.84
Sugar	0.65	0.86	0.68	0.40	0.74	0.89	0.74	0.59	0.41	0.63	0.44	0.17
Drinks	1.83	2.03	1.76	1.62	1.76	1.97	1.81	1.56	2.00	2.44	2.01	1.60
Misc.	1.53	1.68	1.51	1.42	1.57	1.71	1.55	1.48	1.43	1.52	1.41	1.38

Source: Calculated.

Table 10: QUAIDS uncompensated own-price elasticities by income quintile

Food group	**Country-level**				**Rural**				**Urban**			
	All	Quintile			All	Quintile			All	Quintile		
		Q1	Q3	Q5		Q1	Q3	Q5		Q1	Q3	Q5
Rice	-0.12	-0.60	-0.26	0.67	-0.34	-0.64	-0.39	0.09	0.43	-0.23	0.34	1.36
Pork	0.05	-0.11	0.07	0.34	-0.03	-0.18	-0.03	0.21	0.24	0.03	0.12	0.58
M&F	-0.73	-0.88	-0.74	-0.60	-0.79	-0.91	-0.77	-0.70	-0.56	-0.62	-0.51	-0.53
V&F	-0.77	-0.74	-0.78	-0.78	-0.76	-0.74	-0.77	-0.77	-0.78	-0.78	-0.78	-0.78
Sugar	-0.57	-0.50	-0.63	-0.55	-0.59	-0.45	-0.64	-0.61	-0.54	-0.61	-0.56	-0.47
Drinks	-1.10	-1.12	-1.09	-1.07	-1.09	-1.12	-1.09	-1.06	-1.11	-1.17	-1.11	-1.07
Misc.	-1.36	-1.49	-1.35	-1.27	-1.40	-1.51	-1.38	-1.32	-1.28	-1.35	-1.26	-1.23

Source: Calculated.

The results show consistent patterns across income classes. Except for rice, all food groups remain normal goods at all five income brackets. Consistent with our expectations, the magnitudes of expenditure elasticities decrease at higher levels of expenditures. Between urban and rural areas, demand for all foods except rice and drinks is more expenditure-elastic in rural areas than in urban areas. For example, the expenditure elasticity of pork demand is 0.51 in urban areas but it is 0.89 in rural areas. Similarly, the expenditure elasticity of meat demand is 1.07 in urban areas but it is 1.34 in rural areas. Across 7 food groups, rice demand appears to be the most inelastic with respect to expenditure while drinks and miscellaneous food groups are the most elastic. These findings are consistent with our expectations that consumers in rural areas are more sensitive to an income change than urban consumers and in general, consumers' demand of non-basic foods such as drinks, FAFH is more sensitive than that of basic foods such as rice and pork. It is noted that meat and fish group switches from a luxury to a necessity good for high-income urban consumers, although just slightly in terms of magnitude, while it remains a luxury good for rural consumers at all income classes.

At all levels of disaggregation and for all foods except rice, own price elasticities are generally less inelastic than the corresponding expenditure elasticities. The demand for rice and pork is most inelastic with respect to their own-prices compared to other foods; nevertheless, they appear to have positive own-price elasticities at high expenditure levels. The case of Giffenity could have been possible for pork due to substitution effects between pork and other higher-priced meats, as explained earlier. Positive own-price elasticities for rice, however, warrant additional examination, which will be left for future work.

Unlike other foods, rice appears to have diverse consumption trends across different income brackets and between urban and rural areas. At the national level, rice is a normal good for consumers at low income quintiles but becomes an inferior good for those at the two highest income quintiles. The national mean expenditure elasticity of rice demand is 0.32 for the poorest quintile while it is -0.34 for the richest. A similar pattern is found when results are disaggregated by urban and rural areas. Rice appears to be an inferior good for urban consumers with an expenditure elasticity of -0.18 while it remains a normal good for rural consumers with an expenditure elasticity of 0.14. Rice is also found to be an inferior good for high-income consumers in both rural and urban areas. In particular, the expenditure elasticity of rice demand is negative (-0.14) for the rural fifth quintile, a group of the richest rural consumers, and for the three highest income quintiles in urban areas (elasticities range from -0.16 to -0.55). In general, the demand for rice is inelastic and tends to be more inelastic with respect to expenditure than to price, which is a reflection of the importance of rice in a household's food basket and the relatively small budget share of rice in total food expenditure.

2. Conclusion

This study examines food consumption patterns in Vietnam using 2010 household data. Several conclusions are made from the results of this study. First, Wald test and likelihood ratio test show that the overall performance of QUAIDS is better than AIDS, which suggests that budget shares and food expenditure have a quadratic relationship in the food demand system of Vietnam. Studies that assume a linear Engel curvature may have failed to capture the dynamics of the country's food demand patterns.

Second, the responsiveness of demand for foods varies across income classes and between urban and rural areas, most notably in the case of rice. In general, urban consumers are less expenditure elastic than rural consumers. Similarly, high income consumers, whether living in rural or urban areas, tend to be less expenditure-elastic than those who are low-income. With respect to food expenditure, meat and fish, drinks and miscellaneous food groups were found to be luxury goods while pork, vegetables and fruits, and sugar were necessities at the national level.

In addition, rice consumption patterns differ greatly by income class as well as between rural and urban areas. At the national level, the expenditure elasticity of rice was estimated to be positive but very small in magnitude, 0.05. However, rice appeared to be an inferior good for urban consumers while it is a normal good for rural consumers with expenditure elasticities being -0.18 and 0.14, respectively. Rice was also found to be an inferior good for consumers at higher income quintiles in both rural and urban areas. The expenditure elasticity of rice demand is negative for the richest rural consumers and for the three highest income groups in urban areas. Most previous studies found that rice was a normal good at the national level as well as in rural and urban areas. Findings of this study, however, suggests that rice is in a transition from a normal good to an inferior good for Vietnamese consumers, especially those who live in urban areas. The result is similar to recent findings in Thailand (Isvilanonda & Kongrith, 2008) and Indonesia (Anton et al., 2014), which found that rice was an inferior good for high-income consumers in these countries.

Findings from this study provide strong implications for food, nutrition and poverty policies. Effective policies need to take into consideration the heterogeneity in the patterns of food consumption across income classes and between rural and urban consumers. In the case of rice, per capita consumption will be greatly affected by the trend and speed of urbanization, the structural change of the population as well as the levels of growth in urban and rural consumers' incomes. In addition, it is expected that as the economy continues to grow, people in urban areas will consume less rice and more meat, fish, vegetables, drinks as well as out-of-home foods. Meeting the growing demand of these foods, especially meats, is important for the country to ensure food security.

APPENDIX

Table A1: QUAIDS estimated expenditure elasticities

	Rice	Pork	Meat and fish	Vegetables and fruits	Sugar	Drinks	Misc.
National	*0.05*	*0.78*	*1.26*	*0.84*	*0.65*	*1.83*	*1.53*
Quintile 1	0.32	1.00	1.61	0.83	0.86	2.03	1.68
Quintile 2	0.20	0.90	1.32	0.85	0.73	1.92	1.58
Quintile 3	0.11	0.80	1.22	0.85	0.68	1.76	1.51
Quintile 4	-0.06	0.72	1.13	0.84	0.57	1.82	1.46
Quintile 5	-0.34	0.47	1.03	0.85	0.40	1.62	1.42
Rural	*0.14*	*0.89*	*1.34*	*0.84*	*0.74*	*1.76*	*1.57*
Quintile 1	0.36	1.04	1.69	0.83	0.89	1.97	1.71
Quintile 2	0.25	0.96	1.38	0.85	0.79	1.82	1.60
Quintile 3	0.18	0.89	1.28	0.85	0.74	1.81	1.55
Quintile 4	0.03	0.83	1.20	0.85	0.70	1.67	1.50
Quintile 5	-0.14	0.71	1.13	0.85	0.59	1.56	1.48
Urban	*-0.18*	*0.51*	*1.07*	*0.84*	*0.41*	*2.00*	*1.43*
Quintile 1	0.12	0.72	1.25	0.84	0.63	2.44	1.52
Quintile 2	0.03	0.62	1.12	0.83	0.48	2.16	1.45
Quintile 3	-0.16	0.57	1.04	0.84	0.44	2.01	1.41
Quintile 4	-0.35	0.43	0.99	0.84	0.34	1.82	1.38
Quintile 5	-0.55	0.18	0.93	0.84	0.17	1.60	1.38

Table A2: QUAIDS estimated own-price elasticities

	Rice	Pork	Meat and fish	Vegetables and fruits	Sugar	Drinks	Misc.
National	*-0.12*	*0.05*	*-0.73*	*-0.77*	*-0.57*	*-1.10*	*-1.36*
Quintile 1	-0.60	-0.11	-0.88	-0.74	-0.50	-1.12	-1.49
Quintile 2	-0.41	-0.12	-0.76	-0.77	-0.60	-1.11	-1.40
Quintile 3	-0.26	0.07	-0.74	-0.78	-0.63	-1.09	-1.35
Quintile 4	0.02	0.06	-0.67	-0.77	-0.59	-1.09	-1.31
Quintile 5	0.67	0.34	-0.60	-0.78	-0.55	-1.07	-1.27
Rural	*-0.34*	*-0.03*	*-0.79*	*-0.76*	*-0.59*	*-1.09*	*-1.40*
Quintile 1	-0.64	-0.18	-0.91	-0.74	-0.45	-1.12	-1.51
Quintile 2	-0.51	-0.09	-0.81	-0.76	-0.59	-1.10	-1.42
Quintile 3	-0.39	-0.03	-0.77	-0.77	-0.64	-1.09	-1.38
Quintile 4	-0.23	-0.05	-0.76	-0.77	-0.63	-1.08	-1.34
Quintile 5	0.09	0.21	-0.70	-0.77	-0.61	-1.06	-1.32
Urban	*0.43*	*0.24*	*-0.56*	*-0.78*	*-0.54*	*-1.11*	*-1.28*
Quintile 1	-0.23	0.03	-0.62	-0.78	-0.61	-1.17	-1.35
Quintile 2	0.00	0.19	-0.62	-0.78	-0.53	-1.13	-1.29
Quintile 3	0.34	0.12	-0.51	-0.78	-0.56	-1.11	-1.26
Quintile 4	0.71	0.27	-0.54	-0.78	-0.53	-1.09	-1.24
Quintile 5	1.36	0.58	-0.53	-0.78	-0.47	-1.07	-1.23

Table A3: QUAIDS estimated cross-price elasticities

	Rice	Pork	M&F	V&F	Sugar	Drinks	Misc
Rice	-0.12	-0.20	-0.17	-0.02	-0.04	-0.02	0.53
Pork	-0.76	0.05	0.01	-0.12	-0.11	-0.03	0.17
Meat and fish	-0.36	-0.07	-0.73	-0.01	-0.04	0.03	-0.09
Vegetables and fruits	-0.18	-0.07	0.06	-0.77	0.03	0.04	0.04
Sugar	-0.56	-0.44	-0.24	0.25	-0.57	0.08	0.85
Drinks	-0.71	-0.22	0.16	0.10	0.04	-1.10	-0.10
Misc	0.01	-0.03	-0.11	-0.06	0.03	-0.01	-1.36

REFERENCES

Abdulai, A. (2002). Household Demand for Food in Switzerland. A Quadratic Almost Ideal Demand System. *Swiss Journal of Economics and Statistics (SJES)*, *138*(I), 1–18.

Anton, J., Kimura, S., & Ogawa, H. (2014, May). *Risk of Transitory Food Insecurity in Indonesia: Food Demand Estimation and Assessment of Selected Scenarios*. Retrieved from http://www.apeaweb.org/confer/bangkok14/papers/Ogawa_Hiroaki.pdf

Banks, J., Blundell, R., & Lewbel, A. (1997). Quadratic Engel Curves and Consumer Demand. *The Review of Economics and Statistics*, *79*, 527–539.

Benjamin, D., & Brandt, L. (2004). *Agriculture and Income Distribution in Rural Vietnam under Economic Reforms: A Tale of Two Regions*. The World Bank. Retrieved from http://www.economics.utoronto.ca/public/workingPapers/UT-ECIPA-BENJAMIN-02-01.pdf

Bhattacharya, R. (2013). *Inflation Dynamics and Monetary Policy Transmission in Vietnam and Emerging Asia* (No. WP/13/155). International Monetary Fund. Retrieved from http://www.imf.org/external/pubs/ft/wp/2013/wp13155.pdf

Canh, L. (2008). An Empirical Study of Food Demand in Vietnam. *Asean Economic Bulletin*, *25*(3), 283–292. doi:10.1355/AE25-3C

Cirera, X., & Masset, E. (2010). Income distribution trends and future food demand. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *365*(1554), 2821–2834. doi:10.1098/rstb.2010.0164

Cox, T. L., & Wohlgenant, M. K. (1986). Prices and quality effects in cross-sectional demand analysis. *American Journal of Agricultural Economics*, *68*(4), 908–919.

Cupák, A., Pokrivčák, J., Rizov, M., Alexandri, C., & Luca, L. (2014). *Economic Development and Food Demand in Central and Eastern European Countries: The Case of Romania*. Budapest, Hungary. Retrieved from http://ageconsearch.umn.edu/bitstream/168929/2/paper_Cupak_Pokrivcak_Rizov_Alexandri_Luca.pdf

Deaton, A. (1988). Quality, quantity, and spatial variation of price. *The American Economic Review*, 418–430.

Deaton, A., & Muellbauer, J. (1980). An Almost Ideal Demand System. *The American Economic Review*, *70*(3), 312–326.

Doi, J., Iwasa, K., & Shimomura, K. (2009). Giffen Behavior Independent of the Wealth Level. *Economic Theory*, *41*(2), 247–267.

Ecker, O., & Qaim, M. (2011). Analyzing Nutritional Impacts of Policies: An Empirical Study for Malawi. *World Development*, *39*(3), 412–428. doi:10.1016/j.worlddev.2010.08.002

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

Fan, S., Wailes, E. J., & Cramer, G. L. (1995). Household Demand in Rural China: A Two-Stage LES-AIDS Model. *American Journal of Agricultural Economics*, *77*(1), 54–62. doi:10.2307/1243888

Ganesh-Kumar, A., Mehta, R., Pullabhotla, H., Prasad, S. K., Ganguly, K., & Gulati, A. (2012). *Demand and Supply of Cereals in India* (Discussion Paper No. 01158). International Food Policy Research Institute. Retrieved from http://re.indiaenvironmentportal.org.in/files/file/Demand%20and%20Supply%20of%20Cereals%20in%20India.pdf

Ganesh-Kumar, A., Prasad, S. K., & Pullabhotla, H. (2012). *Supply and Demand for Cereals in Bangladesh* (Discussion Paper No. 01186). International Food Policy Research Institute. Retrieved from http://www.ifpri.org/sites/default/files/publications/ifpridp01186.pdf

Garcia, Y. T., Mohan Dey, M., & Navarez, S. M. M. (2005). Demand for Fish in the Philippines: A Disaggregated Analysis. *Aquaculture Economics & Management*, *9*(1-2), 141–168. doi:10.1080/13657300591001810

Gibson, J. (1995). *Food Consumption and Food Policy in Papua New Guinea*. Institute of National Affairs.

Gibson, J., & Rozelle, S. (2011). The effects of price on household demand for food and calories in poor countries: are our databases giving reliable estimates? *Applied Economics*, *43*(27), 4021–4031. doi:10.1080/00036841003781478

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

GSO. (2011). *Results of the Vietnam Household Living Standard Survey 2010* (p. 276). Hanoi: General Statistics Office of Vietnam. Retrieved from http://www.gso.gov.vn/default.aspx?tabid=512&idmid=5&ItemID=12425

Haughton, J., Fetzer, J., Lo, D., & Nguyen, B. (2004). The Effects of Rice Policy on Food Self-Sufficiency and on Income Distribution in Vietnam. *Draft Version Available on Http://mail. Beaconhill. Org/∼j_haughton/RiceArt3. Pdf*. Retrieved from http://www.iatp-web.us/iatp/files/258_2_70033.pdf

Huang, J., & Bouis, H. E. (1996). *Structural changes in the demand for food in Asia.:* (2020 vision discussion paper No. 11). International Food Policy Research Institute. Retrieved from http://ideas.repec.org/p/fpr/2020dp/11.html

Isvilanonda, S., & Kongrith, W. (2008). Thai Household´ s Rice Consumption and Its Demand Elasticity. *Asean Economic Bulletin*, *25*(3), 271–282. doi:10.1355/AE25-3B

Lantican, F., Sombilla, M., & Quilloy, K. (2013). *Estimating the demand elasticities of rice in the Philippines*. Los Baños, laguna: Southeast Asian Regional Center for Graduate Study and Research in Agriculture (SEARCA).

Linh, V. (2009). Estimation of Food Demand from Household Survey Data in Vietnam (Vol. No.2009/12). DEPOCEN. Retrieved from http://www.depocenwp.org/upload/pubs/VuHoangLinh/Estimation%20of%20Food%20Demand%20from%20Household%20Survey%20Data%20in%20Vietnam_DEPOCENWP.pdf

Majumder, A., Ray, R., & Sinha, K. (2012). Calculating Rural-Urban Food Price Differentials from Unit Values in Household Expenditure Surveys: A Comparison with Existing Methods and A New Procedure. *American Journal of Agricultural Economics*, *94*(5), 1218–1235. doi:10.1093/ajae/aas064

Mergenthaler, M., Weinberger, K., & Qaim, M. (2009). The food system transformation in developing countries: A disaggregate demand analysis for fruits and vegetables in Vietnam. *Food Policy*, *34*(5), 426–436. doi:10.1016/j.foodpol.2009.03.009

Minot, N., & Goletti, F. (2000). *Rice market liberalization and poverty in Viet Nam* (Vol. 114). International Food Policy Research Inst. Retrieved from http://books.google.com/books?hl=en&lr=&id=Dhnxf2bLzSsC&oi=fnd&pg=PA44&dq=Minot+and+Goletti+(1999)+vietnam&ots=g1xUtAwyE7&sig=u5Q9wAvB1FEgF5d_uTOWtW-Q73Y

Nguyen, M. C., & Winters, P. (2011). The impact of migration on food consumption patterns: The case of Vietnam. *Food Policy*, *36*(1), 71–87. doi:10.1016/j.foodpol.2010.11.001

Niimi, Y. (2005). An Analysis of Household Responses to Price Shocks in Vietnam: Can Unit Values Substitute for Market Prices? *Poverty Research Unit at Sussex, University of Sussex, Sussex*. Retrieved from http://www.sussex.ac.uk/Units/PRU/wps/wp30.pdf

Ohno, K. (2009). Avoiding the Middle-Income Trap: Renovating Industrial Policy Formulation in Vietnam. *ASEAN Economic Bulletin*, *26*(1), 25–43.

Pangaribowo, E. H., & Tsegai, D. (2011). Food demand analysis of Indonesian households with particular attention to the poorest. *ZEF-Discussion Papers on Development Policy*, (151). Retrieved from http://www.zef.de/fileadmin/webfiles/downloads/zef_dp/zef_dp_151.pdf

Poi, B. (2013). Easy demand system with quaids. *The Stata Journal*, *12*(3), 433–446.

Ray, R. (1983). Measuring the costs of children : An alternative approach. *Journal of Public Economics*, *22*(1), 89–102.

Silva, A., & Dharmasena, S. (2013). Modeling Seasonal Unit Roots as a Simple Empirical Method to Handle Autocorrelation in Demand Systems: Evidence from UK Expenditure Data. In *2013 Annual Meeting, August 4-6, 2013, Washington, DC*. Agricultural and Applied Economics Association. Retrieved from http://ageconsearch.umn.edu/bitstream/149928/2/Seasonal%20QUAIDS%20AAEA%202013.pdf

Spiegel, U. (1994). The Case of a "Giffen Good." *The Journal of Economic Education*, *25*(2), 137–147. doi:10.2307/1183280

Tafere, K., Taffesse, A., Tamiru, S., Tefera, N., & Paulos, Z. (2011). *Food Demand Elasticities in Ethiopia: Estimates Using Household Income Consumption Expenditure (HICE) Survey Data* (ESSP2 Discussion Paper No. 011). International Food Policy Research Institute. Retrieved from http://dspace.cigilibrary.org/jspui/handle/123456789/31914

Tey, Y.-S., Shamsudin, M. N., Mohamed, Z., Abdullah, A. M., & Radam, A. (2008). Demand analyses of rice in Malaysia. *University Library of Munich, Germany, MPRA Paper*, (15062).

Timmer, P., Falcon, W. P., Pearson, S. R., Agriculture, W. B., Economics, R. D. D., & Division, P. (1983). *Food policy analysis* (Vol. 1983). Johns Hopkins University Press Baltimore. Retrieved from http://iis-db.stanford.edu/pubs/10361/Food_Policy_Analysis.pdf

Vu, L. (2009). *Estimation of Food Demand from Household Survey Data in Vietnam* (Working Paper No. 12). Development and Policies Research Center (DEPOCEN), Vietnam. Retrieved from http://ideas.repec.org/p/dpc/wpaper/1209.html

Zheng, Z., & Henneberry, S. R. (2010). The Impact of Changes in Income Distribution on Current and Future Food Demand in Urban China. *Journal of Agricultural and Resource Economics*, *35*(1). Retrieved from http://ideas.repec.org/a/ags/jlaare/61058.html