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Estimation and Analysis of Food Demand Patterns in Vietnam

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Abstract: The paper analyzes food consumption patterns of Vietnamese households, using a complete demand system and socio-demographic information. Demand elasticities are estimated applying a modified Almost Ideal Demand System (AIDS) model on the Vietnamese household survey data in 2006. The results indicate that food consumption patterns in Vietnam are affected by income, price, as well as socio-economic and geographic factors. All food has positive expenditure elasticities and negative own-price elasticities. Rice has mean expenditure elasticity of 0.36 and mean own-price elasticity of −0.80. Using the estimated elasticities, the study finds that when rice prices increase by 20 percent, average household welfare rises by 1.3 percent, yet it is important to note that the benefits and costs are not spread evenly across the population. Overall, middle-income households gain the most, while the poorest households gain the least from higher rice prices. This indicates that support programs should target the poorest quintile, especially the poor in the regions hit hardest by higher prices. More generally, our study points out that targeted food policies should be formulated based on specific food demand patterns in the groups.

Keywords: food demand; food consumption; elasticity; Vietnam

JEL Classification: D12; Q11; Q18

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1. Introduction

Household food consumption has long been an important area of research for economists. Studies on food consumption help to provide a better understanding of how the demand for food responds to changes in food prices as well as changes in household income. This information is essential for evaluating the welfare effects of many types of economic shocks as well as the welfare impacts from trade liberalization or a change in tax policy. Demand analysis can be based on either aggregated time-series data or household surveys. However, in many developing countries the availability of reliable time-series data on aggregate demand, prices, and income is limited. In contrast, many household surveys implemented in these countries provide rich and reliable micro data on household consumption patterns. Food demand analysis based on household surveys has been increasingly used in recent years. In developing countries, where a large percentage of household expenditure is allocated to food, consumer expenditure surveys are particularly useful because they can provide information on specific subpopulation of households that are more likely to be affected by changes in commodity prices or household incomes. Therefore, policies that aim at increasing household income (income policies) may be ineffective compared with policies that control prices (price policies) in the case of rice. In contrast, income policies may be more effective in enhancing meat and fish consumption than price policies, as the expenditure elasticities of these foods are higher than their own-price elasticities. However, both price and income policies are important, as the expenditure and price elasticities are highly significant.

There is extensive literature on the price and income elasticity of food categories in the world. Andreyeva et al. (2010) reviewed 160 studies on the price elasticity of demand for major food categories to assess mean elasticities by food category and variations in estimates. They found that the price elasticities for foods and nonalcoholic beverages ranged from 0.27 to 0.81, with food away from home, soft drinks, juice, and meats being most responsive to price changes (0.7–0.8). Green et al. (2013) reviewed 135 studies from 162 countries and found that the elasticities differ between low and high income countries. For example, a 1 percent increase in the price of cereals results in reductions in consumption of 0.61 percent in a high-income and 0.43 percent in a low-income country. Within all countries, poorer households will be the most adversely affected by increases in food prices. There have also been many studies on countries with food demand elasticities, such as India (Kumar et al. 2011; Abdulai et al. 1999), China (Chen et al. 2016; Yu and Abler 2009; Huang and Gale 2009), and in other developing countries.

Several papers have been written on household food demand in Vietnam, particularly rice demand. Benjamin and Brandt (2004) used panel data from the 1993 and 1998 Vietnam Living Standard Survey to estimate Engel curves for Vietnam. The expenditure elasticity of rice is estimated to be 0.49 and 0.41 for the urban North and the urban South, respectively, and 0.64 and 0.63 for the rural North and rural South. As part of a comprehensive study on rice market liberalization in Vietnam, Minot and Goletti (2000) used the Almost Ideal Demand System (AIDS) functional form to estimate household food demand in Vietnam in 1998. Their expenditure elasticities of rice were 0.48 for the North and 0.11 for the South, while the estimated own-price elasticities were −0.2 in the North and −0.38 in the South. Niimi (2005) examined the robustness of Deaton's method to correct the bias from using unit values as proxies for missing market prices (Deaton 1990), using the 1993 and 1998 Vietnam Living Standards Survey (VLSS) data. Canh (2008) used a linear approximation of the Almost Ideal Demand System (AIDS) in 2004 to calculate income and price elasticities for three different components of food categories and found that rice food and meat/fish are normal goods, while non-rice food is luxury.

This paper contributes to the analysis of food demand by applying a method based on Cox and Wohlgenant (1986) to correct for the bias from using unit values as proxies for prices. Using household expenditure data and a linear approximation of the Almost Ideal Demand System (AIDS) developed by Deaton and Muellbauer (1980), this study estimates food demand parameters in Vietnam. The AIDS model is the most popular method in demand analysis, which allows for comparisons with other studies.

The structure of the rest of this paper is organized as follows. Section 2 presents the model and estimation. Section 3 describes the data and summarizes food consumption patterns in Vietnam. Section 4 presents the estimation results. The last section provides concluding remarks.

2. Materials and Methods

The Almost Ideal Demand System (AIDS) is the most common functional form used to estimate systems of demand. The popularity of the AIDS model is due to it satisfying many desirable qualities of demand systems. In particular, the model satisfies the axioms of choice, can be aggregated over consumers, is consistent with budget constraints, is flexible in the functional form, and is relatively simple to estimate and interpret. In practice, a linear approximation of the Almost Ideal Demand System (LA/AIDS) is often employed. This paper uses the LA/AIDS model, assuming weak separability of demand, thus ignoring non-food commodities in the estimation. The model takes the following form:

$$w_i = \alpha_i + \beta_i \ln\left(\frac{\mathrm{X}}{\mathrm{P_c}}\right) + \sum_{j=1} \theta_{ij} \ln\left(p_j\right) + \sum_{m=1} \gamma_{im} Z_{im} + u_i \tag{1}$$

where w_i is the budget share of food item i, p_j is the jth food item, Z_{im} is a set of household characteristics, x is the value of food consumption expenditure per person, and P_c is a unit value index defined by

$$\ln P_c = \delta_0 + \sum_j \delta_j \ln p_j + \frac{1}{2} \sum_j \sum_k \theta_{jk} \ln p_j \ln p_k \tag{2}$$

The presence of Z vector implies that the differences in tastes for foods are mainly determined by those household characteristics.

In practice, to avoid nonlinearity, $\ln P_c$ can be approximated by the logarithm of Stone's price index.

$$nP_c = \sum_j \overline{w}_j \ln p_j \tag{3}$$

In this equation, $\overline{w}_j$ represents the mean budget share of food item j.

The following set of restrictions are derived from economic theory and imposed upon the parameters in the LA/AIDS model to make the model consistent with the theory of demand.

Adding-up restrictions:

$$\sum\nolimits_i \alpha_i = 1; \sum\nolimits_i \beta_i = 0; \sum\nolimits_i \theta_{ij} = 0; \sum\nolimits_i \gamma_{im} = 0; \tag{4}$$

Homogeneity restriction:

$$\sum\nolimits_j \theta_{ij} = 0 \tag{5}$$

Symmetry restriction:

$$\theta_{ij} = \theta_{ji} \tag{6}$$

By differentiating Equations (1) and (2) with respect to prices and expenditure, one obtains the following elasticity measures[1]:

Marshallian owned-price elasticity of food item i:

$$\epsilon_{ii} = (\theta_{ii} - \beta_i w_i)/w_i - 1 \tag{7}$$

Marshallian cross-price elasticity of food item i with respect to the price of food item j:

$$\epsilon_{ij} = \left(\theta_{ij} - \beta_i w_j\right)/w_i \ \forall\ i \neq j \tag{8}$$

Expenditure elasticity of food item i:

$$\eta_i = \beta_i / w_i + 1 \tag{9}$$

The Hicksian price elasticity is estimated from the Slutsky equation:

$$\epsilon^h_{ij} = \epsilon_{ij} + \eta_i w_j \ \forall\ i,\ j \tag{10}$$

One problem with using household expenditure surveys for estimating household demand is that many household surveys do not collect price data. A common practice has been to calculate unit values dividing expenditures by corresponding quantities and use them as a direct substitute for market prices (Deaton 1988). However, it has been argued (Deaton 1990; Cox and Wohlgenant 1986; Huang and Lin 2000) that there are some problems with treating unit values as market prices. First, such

[1] Readers unfamiliar with the elasticity terms may visit USDA (United States Department of Agriculture) for a glossary of terms.

a calculated unit value may reflect not only differences in prices but also differences in the qualities of the goods that households purchase. The quality effects implicit in unit values may be influenced by prices and income as consumers respond to changes in price and income by altering both the quantity and the quality of the goods they purchase. Second, because unit values are calculated by dividing expenditures by quantities, the approach suffers from measurement errors in both the quantity and the expenditure data.

Several methods have been applied to overcome the quality and measurement errors problems. Deaton (1990) developed a procedure to correct the price elasticities. He assumed that households within the same geographical cluster face the same market prices; thus, within-cluster variation in unit values and expenditures is used to estimate the effects of household income and characteristics on quantities and qualities of purchased goods, as well as to separate measurement errors from price data. Based on corrected quantities and unit value, it is then possible to estimate the "corrected" demand system, removing the impacts of both quality effects and measurement errors. The method is widely applied in literature, for example in Nicita (2004), Niimi (2005), and Friedman and Levinsohn (2002). The disadvantage of Deaton's method is that the covariance of residuals, which is used to estimate corrected price elasticities, can be influenced by many unexplained factors, not just price variation. Deaton's approach is also hard to implement, using complicated matrix multiplication.

Cox and Wohlgenant (1986) proposed another approach. They assumed that the deviations of unit values from regional or seasonal means reflect quality effects. They regressed the mean-deviated unit values on household characteristics to exclude the quality effects from unit values and obtain quality-adjusted prices. These quality-adjusted prices are then used in their household demand system estimation. Cox and Wohlgenant's approach is used in several papers such as Park et al. (1996) and Lazaridis (2003). An important advantage of Cox and Wohlgenant's approach is its ease of use. A major disadvantage is that the adjusted price would vary from household to household, in contrast with the theory that the households in the same market face similar market prices at a given time. Moreover, Cox and Wohlgenant's approach does not deal with measurement error problems. This paper develops a modified version of Cox and Wohlgenant (1986) approach that is more suitable with the assumption of common market prices. This modified Cox and Wohlgenant approach is described in detail as follows.

The Cox and Wohlgenant (CW) approach assumes that prices are functions of food item characteristics. The quality effects can be identified as the difference between the unit value paid by the household and the communal average unit value and therefore can be attributed to household characteristics. In this paper, the price/quality function is characterized by the following equation:

$$v_i = \overline{v}_i + \varphi_i x + \omega_i f_i + \sum\nolimits_m b_i Z_{im} + e_i \qquad (11)$$

Here, v_i is the unit value paid by the household for food item i, $\overline{v}_i$ is the communal mean unit value, f_i is the share of food budget spent on food away from home, x is the household food expenditure per capita, e_i is the residual, and Z_{im} are the household characteristics in Equation (1). This model assumes that quality is influenced by taste and convenience, and taste and convenience is influenced by the share of food away from home in the food budget and household expenditure per capita, in addition to various household demographic characteristics.

The quality-adjusted prices for each food item, denoted by p_i is generated by adding the communal mean unit value to the residual derived from (11).

$$p_i = \overline{v}_i + \hat{e}_i \qquad (12)$$

These quality-adjusted prices proposed by Cox and Wohlgenant are inconsistent with the hypothesis that households in the same market face the same prices. Since $\hat{e}_i$ is random, p_i would vary among households in the same market. Moreover, empirical work by Niimi (2005) using a Vietnam household survey indicated that the communal unit values are better proxies for market price than household-specific values because the former help mitigate measurement errors. Therefore, this paper uses the communal mean quality-adjusted prices, $\overline{p}_i$, as the corrected prices in the LA/AIDS model, which are defined as follows:

$$\overline{p}_i = \overline{\overline{v}_i + \hat{e}_i} \tag{13}$$

Thus, each household in the commune is assumed to face the same market price, represented by $\overline{p}_i$, for the "standard" food item, i.e., without quality effects. By substituting $\overline{p}_i$ from Equation (14) into Equations (1) and (2) with the imposed restrictions of Equations (4)–(6), one can estimate the demand system and then use the results to construct the price and expenditure elasticities of food demand as given in Equations (7)–(9).

3. Data on Food Consumption in Vietnam

The data analyzed in this paper are from the 2006 Vietnamese Household Living Standards Survey (2006 VHLSS), a nationwide survey conducted in 2006. The 2006 VHLSS was conducted by Vietnam's General Statistics Office. The main objective of the survey is to collect data on household living standards, as measured by households' income and expenditure, as well as household members' occupation, health, and education status. The survey was conducted in all of Vietnam's 64 provinces, and expenditure data were collected from 9189 households. Food consumption expenditure was obtained for both regular and holiday periods. The data were collected for both purchased foods and self-supplied foods (home production). The 9189 households were sampled from 3060 communes in Vietnam.

Data on food expenditures were collected for 56 food items. The analysis of this paper aggregates these food items into 10 food groups for food eaten at home, plus food away from home (FAFH). Expenditure shares are calculated as a fraction of total food consumption, including both purchased food and home food production. Table 1 describes the percentage shares of total food consumption for each of the 11 food groups: rice (26 percent[2]), other staple foods (3 percent), pork (13 percent), poultry (6 percent), other meats[3] (3 percent), fish and seafood (10 percent), vegetables (7 percent), fruit (3 percent), drinks (5 percent), other foods (15 percent), and food consumed away from home (FAFH, 10 percent). The analysis assumes that food consumption is assumed to be weakly separable from the demand of non-food goods and services in order to estimate the demand for food categories separately from the demand for non-food commodities.

For Vietnam as a whole, 53 percent of household expenditure is devoted to food, 55 percent in rural areas and 48 percent in urban areas. Rice is the most important single food. On average, expenditure on rice per month is about 50,000 VND per capita (3.3 USD) in urban areas and 44,000 VND per capita (2.9 USD) in rural areas. Rice accounts for nearly 30 percent of food expenditure in rural areas and 17 percent in urban areas. The "other foods" category is the second most important food group in terms of expenditure, accounting for nearly 15 percent of total food expenditure. This category comprises diverse foods such as fat and oil, cakes, fish sauce, spice, sugar, salt, condensed milk, ice creams. Pork is the most important meat, amounting to 13 percent of food expenditure in both rural and urban areas. Food away from home (FAFH) makes up nearly 10 percent of food expenditure, yet its share is much larger in urban areas than in rural areas. In urban areas, over 16 percent of food expenditure is allocated to FAFH, while in rural areas the corresponding figure is 7 percent. Thus, while FAFH is the second most important food group in urban areas (after rice), it only ranks fifth among 11 food categories in rural areas.

2 The percentages in parentheses represent average percentages of all households.

3 This category includes beef, buffalo meat, other meat, and processed meat, in which beef and buffalo meat constitute about 63 percent in terms of value.

Table 1. Shares of food expenditures (%).

	Rice	Other Staples	Pork	Other Meats	Poultry	Fish	Vegetables	Fruits	Other Foods	Drink	FAFH	Food Share
All	26.4	2.9	13.1	5.6	2.9	9.9	6.7	3.4	14.5	4.9	9.6	53.3
Rural	29.6	3.0	13.1	6.0	2.4	9.6	6.8	3.2	14.4	4.6	7.3	55.0
Urban	16.9	2.6	13.1	4.5	4.5	10.8	6.4	4.1	15.0	5.7	16.4	48.2
Red River Delta	26.6	2.8	15.4	6.3	3.7	6.3	7.0	3.5	13.0	4.9	10.3	49.1
North East	30.8	3.0	15.4	8.9	2.5	5.5	7.7	3.2	12.3	4.4	6.4	57.2
North West	38.4	2.9	12.9	8.8	3.4	5.9	7.5	2.8	10.0	4.6	2.7	67.6
North Central Coast	31.6	3.3	12.4	5.2	2.9	10.2	6.0	2.8	13.9	4.6	7.0	51.1
South Central Coast	22.3	2.9	10.2	3.4	3.8	12.3	5.9	3.5	16.5	5.0	14.2	51.4
Central Highlands	30.2	3.4	11.4	5.2	3.7	9.4	6.8	3.1	14.8	5.8	6.1	53.2
South East	18.3	3.0	12.1	3.8	3.3	11.8	6.9	4.0	16.7	5.5	14.5	52.9
Mekong River Delta	23.4	2.5	11.8	4.2	1.5	15.4	6.1	3.6	16.7	4.6	10.0	53.9
Quintile 1	41.4	3.3	10.5	5.7	1.5	8.4	7.3	2.5	13.3	3.5	2.7	67.6
Quintile 2	31.6	2.8	12.9	5.9	2.0	10.3	7.2	3.0	14.7	4.0	5.4	58.0
Quintile 3	25.7	2.9	14.2	5.8	2.6	10.4	6.8	3.4	14.8	4.8	8.7	53.1
Quintile 4	20.2	2.9	14.1	5.4	3.4	10.6	6.5	3.6	15.0	5.4	12.9	47.5
Quintile 5	13.7	2.7	13.6	5.1	5.1	9.8	5.9	4.6	14.9	6.8	18.0	40.8
Ethnic majority	24.5	2.8	13.2	5.2	3.1	10.4	6.6	3.6	15.0	5.0	10.7	51.0
Ethnic minorities	37.5	3.6	12.1	7.8	2.2	7.1	7.3	2.6	12.0	4.4	3.4	66.3
Non-farmer	17.6	2.7	13.0	4.1	4.2	11.4	6.2	3.9	15.6	5.6	15.7	49.7
Farmer	29.8	3.0	13.1	6.2	2.5	9.3	6.9	3.2	14.1	4.6	7.2	54.7

Notes: Other staples include all starchy food such as corn, cassava, bread, potato, noodle, and vermicelli; other meats include beef, buffalo meat, and other types of meat; other foods include the remaining food items in the questionnaire such as fish sauce, spices, food seasoning, etc.; FAFH is the food consumed away from home, e.g., in restaurants, at school, and at work. The food share is measured as the expenditure percentage of food item.

The differences in food consumption patterns across different regions are remarkable. In the regions with large percentages of urban population, such as the South East and the South Central Coast, rice expenditure percentages are lower while FAFH percentages are higher than the other regions. The largest discrepancy is observed when comparing the most urban region, the South East, with the least urban region, the North West. In the North West, rice consumption is 38 percent of food expenditure, while FAFH is less than 3 percent. In the South East, rice is just 18 percent and FAFH is 15 percent of food expenditure.

Differences in consumption patterns are also observed across different income groups. The population can be divided into five quintiles, based on the household real expenditure. Among the poorest quintile, rice occupies 41 percent, meat and fish 26 percent, and FAFH 3 percent of food expenditure. In contrast, among the richest quintile, rice consumption is 14 percent, meat and fish 34 percent, and FAFH 18 percent of food expenditure. Higher income households rely more on meat, fish, and FAFH and less on rice than the poorer households. There are also differences in food consumption patterns between ethnic minorities and the ethnic majority. As a group, ethnic minorities consume less meat, fish, and FAFH and more rice than the ethnic majority group. Regarding occupation, farmers eat more rice and less meat, fish, and FAFH than non-farmers.

Unit values were calculated for each category by dividing purchased food value by purchased food quantity. To construct aggregate unit values for food groups, unit values for individual food items were calculated by dividing expenditure by quantity for each individual food item. For some foods, such as other meat and other seafood, data were collected for values but not quantities. These items were dropped from estimating the unit value of the food group to which these food items belong. Food group unit values were calculated as weighted averages of the individual unit values, with the weights being the (household-level) expenditure shares of the individual goods within the food group. For households that reported zero consumption, the unit values were assumed to be the same as the average unit values of the other households in the same geographical groups, in this case the communes.

Following Cox and Wohlgenant (1986) and Niimi (2005), this study dropped as outliers all unit values that were more than five standard deviations from their means and replaced those unit values with the mean of the unit values of households in the communes. From the individual unit values, one can calculate the communal unit values as the mean of individual unit values of the households in the commune. Since no quantity for food away from home (FAFH) is reported, provincial price deflators are used as a proxy for the price of FAFH. The unit value data are summarized in Table 2.

Table 2. Unit values * of food categories and percentage of consuming households.

	Individual Unit Vales		**Communal Mean Unit Values**		**Percentage of Consuming Households**
	Mean	**S.D.**	**Mean**	**S.D.**	
Rice	5.18	1.37	5.23	1.17	99.9
Other staples	8.30	4.67	8.33	3.64	94.3
Pork	28.81	7.28	28.84	5.81	99.6
Poultry	31.05	11.74	30.87	10.37	93.3
Other meats	42.31	19.66	41.58	16.63	79.2
Fish	18.41	11.50	18.43	9.84	98.5
Vegetables	4.74	2.44	4.75	1.86	99.7
Fruits	3.36	2.63	3.26	2.17	98.5
Other foods	9.82	15.89	9.82	10.36	100.0
Drinks	19.38	24.03	19.36	14.90	98.5
FAFH	0.98	0.10	0.98	0.10	78.3

The unit values are in thousand VND per kg, except per liter for drink and except FAFH in which provincial deflators are used.

Table 2 also indicates the degree of non-consumption in our study. It shows that most of the food groups are consumed by nearly all households. Rice, other food, pork, vegetables, fish, and fruits are all consumed by more than 98 percent of the sample. The two least consumed groups are other meats and FAFH, which are still consumed by nearly 80 percent of the households in the sample. Overall, the data show that zero consumption is not a serious problem.

Table 3 summarizes the variables used in the analysis in this paper. The regressors include the prices (with proxies being individual unit values, communal unit values, or quality-corrected unit values) of 11 food categories; log of food expenditure per capita; household demographic variables; and variables that control for community, geographic, and seasonal differences. The demographic vector includes household head's age; household size; household head's years of schooling; the proportion of infant (<3 years), child (3–15 years), and elderly household members (>59 years); and dummy variables indicating whether the household head is an ethnic minority or whether the head is female. The average household has 4.3 members. The average head's age is 49 years old, and the average head's schooling is 7 years. The proportions of infants, children, and elderly are 0.04, 0.20, and 0.13, respectively. About 25 percent of households' heads are female heads, and 15 percent are ethnic minorities.

The community variables include binary variables for mountainous and seaside communes. The geographical variables consist of dummy variables for urban areas and Vietnam's seven regions (with the Red River Delta being the default region). The seasonality variables are dummy variables for different quarters during the year.

Table 3. Definition and description of variables.

	Mean	S.D.		Mean	S.D.
Log of prices of					
Rice	1.63	0.21	Proportion of infants	0.04	0.09
Staple	2.03	0.43	Proportion of children	0.20	0.20
Pork	3.34	0.20	Proportion of elderly	0.13	0.26
Poultry	3.37	0.35	**Community variables**		
Other meat	3.63	0.48	Near sea	0.05	0.23
Fish	2.80	0.46	Mountainous	0.30	0.46
Vegetables	1.47	0.44	**Geographical variables**		
Fruits	0.97	0.70	Urban	0.25	0.43
Other foods	1.95	0.83	North East	0.14	0.35
Drink	2.74	0.78	North West	0.05	0.21
FAFH	−0.02	0.1	North Central Coast	0.11	0.31
Log of food expenditure	7.79	0.5	South Central Coast	0.09	0.29
Demographic Characteristics			Central Highlands	0.06	0.24
Head's age	49.4	13.6	South East	0.13	0.34
Household size	4.25	1.69	Mekong River Delta	0.20	0.40
Female-headed	0.25	0.43	**Seasonality**		
Head's schooling	6.97	3.70	Quarter 2	0.45	0.50
Ethnic minority	0.15	0.36	Quarter 3	0.35	0.50
			Quarter 4	0.51	0.48

4. Empirical Results

The system of demand equations is estimated using seemingly unrelated regressions (SUR) with homogeneity and symmetry restrictions imposed. To preserve the adding-up restriction, one equation (the FAFH in this case) is omitted. The coefficient of this equation is obtained by imposing the adding-up restriction in Equation (4). The elasticities are all evaluated at mean values.

Table 4 shows expenditure elasticities and the Marshallian (uncompensated) and own-price elasticities, obtained by four methods: SUR with individual unit values, SUR with communal unit values, modified Cox and Wohlgenant (CW) quality-adjusted approach, and Deaton's approach to correct unit value bias. Expenditure elasticities are all positive, implying all 11 food categories are normal goods. Results from the model with individual unit values are very different from the three other models. This implies that using individual unit values as prices might lead to remarkably different results from using some kinds of correction models.

Table 4. Expenditure and price elasticities.

	Individual	Communal	Cox and Wohlgenant	Deaton
Expenditure Elasticities				
Rice	0.96	0.37	0.31	0.53
Staples	1.00	0.96	0.99	0.99
Pork	1.01	1.13	1.13	1.12
Poultry	1.01	1.10	1.10	1.20
Other meats	1.02	1.63	1.75	1.73
Fish	1.03	1.05	1.07	0.99
Vegetables	0.99	0.85	0.84	0.69
Fruit	1.00	1.20	1.23	1.13
Other foods	0.98	0.98	0.95	0.98
Drink	1.02	1.44	1.46	1.52
FAFH	1.07	2.10	2.24	2.08
Marshallian Own-Price Elasticities				
	Individual	**Communal**	**Cox and Wohlgenant**	**Deaton**
Rice	−0.89	−0.73	−0.80	−0.69
Staples	−0.75	−0.74	−0.75	−0.73
Pork	−0.79	−0.79	−0.83	−0.55
Poultry	−1.09	−1.08	−1.07	−0.90
Other meats	−0.94	−0.83	−0.95	−1.04
Fish	−0.94	−0.99	−0.99	−1.24
Vegetables	−0.97	−0.99	−1.00	−0.88
Fruit	−0.93	−0.93	−0.94	−0.88
Other foods	−1.07	−1.01	−1.01	−0.89
Drink	−1.01	−1.03	−1.00	−1.01
FAFH	1.11	−2.65	−2.03	N/A

Note: This table presents the expenditure and price elasticities using four different methods: SUR with individual unit values, SUR with communal unit values, modified Cox and Wohlgenant's quality-adjusted approach, and Deaton's approach to correct unit value bias.

The CW quality-adjusted model yields slightly different estimates from the model with communal unit values and with Deaton's model. This study uses the results from the CW quality-adjusted model as the basis for the analysis in this paper. Very few studies have been conducted to compare these correction methods, so it is impossible to derive the conclusion about which method performs best. However, Deaton's approach has received criticism from some authors, for example Huang and Lin (2000) and Niimi (2005), for being unsatisfactory, which motivated me to choose the modified CW approach, with communal quality-corrected unit values being proxies for prices, as the main model for analysis.

For most of the food groups, the unadjusted communal value method and the CW-adjusted elasticities are similar. The food groups for which there are important differences between the two models are rice, other meat, and FAFH. Therefore, a simple model that ignores the differences in quality may lead to significant bias in the estimates of the elasticities of rice, other meat, and FAFH. This is an improvement of our analysis compared to previous studies that did not consider the quality variability.

The expenditure elasticities reflect how the quantity was purchased in response to a change in the consumer's expenditure, which is a proxy for income. If the percent change in the quantity demanded is greater than the percent change in consumer expenditure, the demand is said to be expenditure-elastic. FAFH and other meat (mostly beef) are the two most expenditure-elastic food groups (i.e., their expenditure elasticities are greater than one). In contrast, rice is the least expenditure-elastic food item. Rice, other staples, vegetables, and other foods are necessities (i.e., they have expenditure elasticities less than 1), while pork, poultry, beef, fish, fruit, drinks, and FAFH are luxury goods (expenditure elasticities greater than 1). Thus, when household income increases, the expenditure shares of meats, fish, fruit, drinks, and FAFH will increase while the shares of rice, staples, vegetables, and other foods decrease.

The estimated expenditure elasticity for rice is 0.31 after quality adjustment by CW method. Estimates from past studies vary widely, from 0.09 to 0.83 (Benjamin and Brandt 2004; Canh 2008;

Niimi 2005; Minot and Goletti 2000). These estimates may differ for several reasons. First, they use different specifications (double-log model, Engel curve estimation, or AIDS model). Second, some studies estimate only the demand for rice (Haughton et al. 2004), while others cover both food and non-food (Canh 2008). Third, except for Canh 2008, all previous studies examine food demand in Vietnam in the 1990s, while the estimates presented here are based on 2006 data. Food demand patterns may change considerably as income and nutritional status improve.

Because the expenditure elasticity of rice is lower than the elasticities for all other food groups, the importance of rice in the Vietnamese diet will decrease as economic growth continues. This trend has been observed in recent years. In 1993, rice expenditure was 30 percent of total consumption expenditures and contributed 75 percent of calorie intake (Minot and Goletti 2000). In 2006, rice accounts for only 14 percent of total consumption expenditure, 26 percent of food expenditure, and 59 percent of calorie intake. However, rice will certainly remain the most important single food item in the Vietnamese diet for many years to come.

Future expenditures on meat, fish, and fruit will increase significantly because their expenditure elasticities are larger than one. It means that when people's income increases, they will spend a relatively higher proportion of their income on those goods. Particularly, the role of beef (in the "other meat" category) and fruit will rapidly increase if Vietnam maintains its rapid economic growth.

The expenditure elasticity of FAFH is very high, at 2.2. Therefore, income growth will lead to a significant increase in FAFH share among Vietnam's food consumption, shifting away from at-home diet to outside meals. In 1993, FAFH accounts for 1 percent and 2 percent of food expenditure in rural North and rural South and 6 percent and 10 percent of food expenditure in urban North and urban South (Benjamin and Brandt 2004). In 2006, FAFH represents 7 percent and 16 percent of food expenditure in rural and urban areas, respectively. This growing trend of FAFH share will continue in the future as Vietnam's economy develops and its population becomes more urbanized.

Table 4 also shows estimates of own-price elasticities in Vietnam. It reports both the Marshallian (uncompensated) and Hicksian (compensated) price elasticities. As expected, all the own-price elasticities are negative. Based on the quality-adjusted Marshallian price elasticities, FAFH, poultry, and other foods are relatively price-elastic foods, with Marshallian price elasticities above unity. Meanwhile, rice, other staples, pork, other meats, fish, and fruit have Marshallian price elasticities of less than unity.

The most price-elastic food is FAFH (−2.0); an increase in its price will reduce its consumption substantially. Poultry also has a rather large own-price elasticity (−1.07). Thus, a uniform increase in the price of all foods will make households cut their consumption of FAFH and poultry considerably, while they are more reluctant to reduce their consumption of rice, staples, and pork. However, the own-price elasticities of all foods are rather large, with their absolute values greater than 0.7, implying that household food consumption is sensitive to food price changes.

Table 5 provides detail information on the own-price and cross-price elasticities of food demands. Most of the Marshallian and Hicksian cross-price elasticities are very small, at less than 0.1. Some cross-price effects are important for rice and FAFH. As rice is the most important food, the consumption of all other food groups is significantly affected by the price of rice. Except for vegetables and FAFH, all other foods are considered complements to rice. The Marshallian cross-price elasticities between rice and other food groups are the highest in terms of absolute values for FAFH (+0.30), drink (−0.29), other meats (−0.20), poultry (−0.18), and fruit (−0.18). Many food consumption items are also sensitive to the price of FAFH (represented by the general province-level price). Households tend to move to the traditional diet, based on rice and other staples, as FAFH price increases. Among the other food groups besides rice and FAFH, only the price of pork has important impacts on other food consumption. An increase in the price of pork leads to a reduction in the other meat products (poultry and other meats), and a cut in the expenditure on staples other than rice, vegetables, fruits, and FAFH, but leads to an increase in the consumption of rice, fish, and other foods. Therefore, rice, fish, and other foods are substitutes for pork, while all the other food groups are complements.

Table 5. Marshallian and Hicksian owned-price and cross-price elasticities of food demand.

	With Respect to the Price of										
	Rice	**Staples**	**Pork**	**Poultry**	**Other Meats**	**Fish**	**Vegetables**	**Fruit**	**Other Foods**	**Drink**	**FAFH**
					Marshallian elasticities						
Rice	−0.80	0.00	0.07	0.01	0.02	0.02	0.05	0.01	0.01	0.00	0.29
Staples	−0.14	−0.75	−0.14	−0.03	−0.06	−0.11	0.06	0.01	−0.03	−0.04	0.23
Pork	−0.08	−0.03	−0.83	−0.04	0.00	0.03	−0.11	−0.03	0.03	0.00	−0.07
Poultry	−0.18	−0.02	−0.09	−1.07	0.06	−0.03	0.08	0.00	0.02	0.00	0.14
Other meats	−0.20	−0.08	−0.09	0.08	−0.95	0.10	0.03	0.04	0.00	0.01	−0.69
Fish	−0.14	−0.03	0.05	−0.02	0.05	−0.99	−0.06	0.00	−0.03	−0.01	0.11
Vegetables	0.07	0.03	−0.17	0.08	0.04	−0.06	−1.00	0.00	0.00	0.02	0.15
Fruits	−0.18	0.00	−0.11	−0.01	0.05	−0.01	−0.03	−0.94	0.02	0.02	−0.04
Other foods	−0.14	−0.01	0.05	0.01	0.02	−0.01	−0.01	0.01	−1.01	0.02	0.11
Drink	−0.29	−0.04	−0.04	−0.02	0.01	−0.06	−0.02	0.01	−0.01	−1.01	0.00
FAFH	0.30	0.03	−0.24	0.02	−0.23	0.00	0.01	−0.05	−0.02	−0.04	−2.03
					Hicksian elasticities						
Rice	−0.72	0.01	0.11	0.02	0.03	0.05	0.07	0.02	0.06	0.02	0.32
Staples	0.12	−0.72	−0.01	0.02	−0.03	−0.01	0.13	0.05	0.11	0.01	0.32
Pork	0.22	0.00	−0.68	0.02	0.03	0.14	−0.03	0.01	0.19	0.06	0.04
Poultry	0.11	0.01	0.05	−1.01	0.09	0.07	0.16	0.04	0.18	0.05	0.25
Other meats	0.26	−0.03	0.14	0.17	−0.90	0.28	0.15	0.10	0.26	0.10	−0.52
Fish	0.14	0.00	0.19	0.04	0.08	−0.88	0.01	0.04	0.12	0.04	0.21
Vegetables	0.29	0.06	−0.06	0.13	0.07	0.02	−0.94	0.03	0.12	0.06	0.23
Fruits	0.14	0.04	0.05	0.06	0.09	0.11	0.05	−0.90	0.20	0.08	0.08
Other foods	0.11	0.02	0.17	0.07	0.05	0.08	0.06	0.05	−0.87	0.07	0.20
Drink	0.10	0.01	0.15	0.06	0.06	0.08	0.08	0.06	0.20	−0.93	0.14
FAFH	0.89	0.10	0.05	0.15	−0.16	0.22	0.16	0.03	0.30	0.07	−1.81

4.1. Disaggregated Elasticities

In order to have a better understanding of food demand in Vietnam, this subsection examines the expenditure and price elasticities for different groups by running separate regressions for these groups. This information is important for policymakers in formulating as well as in evaluating the possible effects of food policies and programs on different groups. Table 6 summarizes expenditure elasticities for different household groups.

Households in urban areas have higher expenditure elasticities than those in rural areas for rice, FAFH, drinks, and other meats but lower elasticities for other food groups. Thus, as income rises, urban households are more likely to spend on rice, other meats, drinks, and FAFH and less likely to spend on other foodstuffs than are rural households.

The food patterns are also somewhat different across regions. The income elasticity of rice is lowest in the North and highest in the South. In contrast, the income elasticity of FAFH is higher in the Center and the North than in the South. Nevertheless, the general pattern is similar for all three regions. Some exceptions concern fish and other staples. Fish demands are relatively income-elastic in the North and in the Center but income inelastic in the South. In contrast, other staples demand is rather inelastic in the Center while elastic in the South. Thus, households in the Center tend to prefer to buy more fish rather than other staples as their incomes rise, whereas Southern households are more likely to spend more on staples and less on fish as their income rises.

Regarding the expenditure groups, the poorest 20 percent of households have relatively high expenditure elasticities for poultry, fish, vegetables, and fruit than other groups. Interestingly, the mean expenditure elasticity for rice of the poorest group is lower than that of the richest group, although it is higher than the other quintiles. The relatively high expenditure elasticity for rice (0.46) in this group implies that these households in the poorest group may be constrained in their access to food as they increase significantly their consumption of rice, the most basic component in the Vietnamese diet, as their income rises. Poorer households tend to increase their food consumption when their incomes rise more than do rich households. In fact, except for rice and staples, the expenditure elasticities of the poorest 20 percent of Vietnamese households for all the other nine food groups are equal or greater than one. Meanwhile, for the richest 20 percent, only five among 11 food groups have expenditure elasticities that are greater than unity.

Turning to the Marshallian own-price elasticities, rural demand is more price-elastic for rice, poultry, other meats, vegetables and fruit but less price-elastic for the other food. Geographically, Vietnam has three regions: The North (including North East, North West, and Red River Delta), the Center (including North Central Coast and South Central Coast) and the South (including Central Highland, Mekong River Delta, and South East). Households in the Center have the highest price elasticity for rice but the lowest price elasticity for FAFH. In general, households in the South are more price-elastic than those in the North and the Center.

When the prices of rice, other staples, and pork increase, the poorest quintile is most likely to cut their corresponding food consumption, since their demand for such foods is more price-elastic than the demands of other groups. Because rice, other staples, and pork supply the basic diet for most Vietnamese, poor households' food security and nutrition are vulnerable to food price increases. On the other hand, the richest households tend to reduce their share of FAFH and drink more than the poor do as the prices of these food groups increase.

Table 6. Disaggregated expenditure and Marshallian price elasticity.

	Rice	Staples	Pork	Poultry	Other Meats	Fish	Vegetables	Fruits	Other Foods	Drinks	FAFH
Expenditure elasticity											
Rural	0.25	1.00	1.27	1.15	1.68	1.09	0.88	1.23	0.97	1.45	2.12
Urban	0.46	0.96	0.88	0.99	1.75	0.97	0.75	1.14	0.91	1.46	2.49
North	0.22	1.00	1.07	1.17	1.89	1.18	0.78	1.31	0.99	1.35	2.37
Center	0.31	0.91	1.13	1.02	1.79	1.03	0.85	1.16	0.92	1.50	2.39
South	0.39	1.02	1.20	1.05	1.56	0.97	0.87	1.15	0.92	1.52	2.11
Quintile 1	0.46	0.67	1.15	1.29	1.35	1.39	1.16	1.14	1.02	1.06	1.48
Quintile 2	0.41	0.98	1.18	1.08	1.16	1.30	1.11	1.00	0.99	1.13	1.87
Quintile 3	0.37	1.08	1.23	1.00	1.22	1.34	0.87	0.81	0.91	0.96	2.29
Quintile 4	0.42	0.89	1.14	0.89	1.23	1.12	0.93	0.96	0.86	1.25	2.44
Quintile 5	0.55	0.91	0.84	1.01	1.53	0.93	0.74	1.11	0.91	1.39	2.46
Marshallian own-price elasticity											
Rural	−0.82	−0.74	−0.81	−1.07	−1.07	−0.99	−1.02	−0.97	−1.00	−1.00	−1.80
Urban	−0.72	−0.76	−0.94	−1.05	−0.46	−0.99	−0.91	−0.81	−1.03	−1.02	−2.24
North	−0.80	−0.85	−0.60	−1.01	−0.98	−0.89	−0.96	−0.92	−0.99	−0.97	−1.97
Center	−0.90	−0.69	−0.80	−1.12	−0.66	−0.96	−0.97	−0.89	−1.04	−1.07	−1.23
South	−0.81	−0.70	−1.04	−1.12	−1.01	−1.11	−1.02	−0.98	−1.02	−0.99	−2.66
Quintile 1	−0.89	−0.91	−0.98	−1.01	−1.09	−1.05	−1.03	−0.97	−0.99	−0.99	−1.26
Quintile 2	−0.87	−0.64	−0.89	−1.02	−1.14	−0.99	−1.04	−0.99	−1.02	−1.01	−1.51
Quintile 3	−0.84	−0.77	−0.76	−1.08	−1.07	−1.01	−0.97	−0.97	−1.02	−0.98	−1.79
Quintile 4	−0.83	−0.66	−0.73	−1.11	−0.93	−0.96	−1.00	−0.92	−1.02	−1.04	−1.96
Quintile 5	−0.82	−0.70	−0.84	−1.04	−0.54	−0.95	−0.94	−0.88	−0.99	−1.05	−2.29

4.2. Impacts of Rice Prices on Household Welfare and Poverty in Vietnam

This subsection uses the estimated elasticities from the 2006 VHLSS to examine the impacts of changing rice prices on household welfare and poverty, using the method firstly proposed by Deaton (1989) and modified in Vu and Glewwe (2011). It focuses on the impact of a hypothetical 20 percent increase in rice prices on consumer welfare. Following the seminal study of Deaton (1989), the change in income (ΔB) can be expressed as a fraction of household expenditure (X):

$$\frac{\Delta B}{X} = \sum\nolimits_{i=1}^{n} (w_i \Delta \ln(p_{ci}) - \left(\frac{p_{pi} y_i}{X}\right) \Delta \ln\left(p_{pi}\right)) \tag{14}$$

where w_i is the budget share of food item i, and $(\frac{p_{pi} y_i}{X})$ is the sales of i as a fraction of household consumption expenditure. For estimation, w_i is the household's budget share of food item i. Equation (14) is like the result in Deaton (1989), but this case is more flexible since it allows the changes in the consumer and producer prices to differ (see Vu and Glewwe 2011 for more detailed derivation of this equation).

Equation (14) measures the immediate effect of price changes. However, consumers can substitute away from goods whose prices have risen relatively higher. This can be called the short-run effect of price changes[4]. A second-order Taylor's expansion of the expenditure function is derived allowing for substitution behavior, leading to the following expression for the change in expenditure needed to maintain utility after a change in prices:

$$\Delta C = \sum_{i=1}^{n} q_i \Delta p_{ci} + \left(\frac{1}{2}\right) \sum_{i=1}^{n} \sum_{j=1}^{n} s_{ij} \Delta p_{ci} \Delta p_{cj} \tag{15}$$

where s_{ij} is the Slutsky derivative[5]. Equation (15) can be expressed in terms of budget shares and proportional price changes:

$$\Delta \ln(C) = \sum_{i=1}^{n} w_i \Delta \ln(p_{ci}) + \left(\frac{1}{2}\right) \sum_{i=1}^{n} \sum_{j=1}^{n} w_i \varepsilon_{ij} \Delta \ln(p_{ci}) \Delta \ln(p_{cj}) \tag{16}$$

where ε_{ij} is the compensated price elasticity of food item i with respect to the price of food item j.

Thus, from (14) and (16) the short-run effect of an increase in prices, after allowing for consumer switching between different food items, becomes:

$$\Delta \ln(B^{sr}) = \sum_{i=1}^{n} [w_i \Delta \ln(p_{ci}) - \left(\frac{p_{pi} y_i}{X}\right) \Delta \ln(p_{pj})] + \left(\frac{1}{2}\right) \sum_{i=1}^{n} \sum_{j=1}^{n} w_i \varepsilon_{ij} \Delta \ln(p_{ci}) \Delta \ln(p_{cj}) \tag{17}$$

Equation (17) is the short-run impact. Finally, to assess the impact of a change in the price of a single food item i, such as rice, Equation (17) simplifies to:

$$\Delta \ln\left(B_i^{sr}\right) = w_i \Delta \ln(p_{ci}) - \left(\frac{p_{pi} y_i}{X}\right) \Delta \ln(p_{pj}) + \left(\frac{1}{2}\right) \sum_{j=1}^{n} w_i \varepsilon_{ij} \Delta \ln(p_{ci}) \Delta \ln(p_{cj}) \tag{18}$$

Similar procedures have been used by Friedman and Levinsohn (2002) and Minot and Goletti (2000).

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[4] It is called short-run because during this period, supply and producer behavior is fixed.

[5] The Slutsky derivative, $s_{ij} = \partial x(\mathbf{p}_c, b)/\partial p_{ci} + x(\mathbf{p}_c, b) \times \partial x(\mathbf{p}_c, x)/\partial b$ $(x(\mathbf{p}_c, x)$, is the Walrasian demand function.

In this subsection, rice price is assumed to increase by 20% while other food prices remain the same. Equation (18) is estimated with the calculated Hicksian own- and cross-price elasticities as from Table 5. The results are given in Table 7.

Table 7. Percentage of household welfare change due to rice price increases.

	Welfare Change	% of Worse Off
All	1.3	63.8
Rural	2.0	54.4
Urban	−0.7	91.8
Red River Delta	1.2	51.9
North East	−0.2	57.2
North West	0.1	49.0
North Central Coast	0.4	60.8
South Central Coast	0.3	65.4
Central Highlands	−0.8	80.8
South East	−0.5	87.9
Mekong River Delta	5.6	64.7
Rural		
Quintile 1	0.7	51.0
Quintile 2	2.2	49.0
Quintile 3	3.0	51.6
Quintile 4	2.4	59.9
Quintile 5	1.7	70.8
Urban		
Quintile 1	−1.5	78.1
Quintile 2	−0.7	79.4
Quintile 3	−0.4	86.9
Quintile 4	−0.9	93.4
Quintile 5	−0.5	95.7

Overall, average household welfare in Vietnam increases by 1.3 percent due to the 20 percent increase in rice price change. This is not surprising, since Vietnam is one of the world's top rice exporters. In rural areas, household welfare increases by 2.0 percent, while it falls by 0.7 percent in urban areas. Geographically, the biggest rice-growing region in Vietnam, Mekong River Delta, is the biggest winner, with welfare increasing by 5.6 percent, while the mountainous Central Highlands is the biggest loser, suffering a welfare loss of 0.8 percent. More detailed analysis using income quintiles in urban and rural areas yields interesting results. The middle-income rural households (quintile 3) have the largest welfare increase of 3 percent, while the poorest rural quintile has the lowest welfare increase of 0.7 percent. In urban areas, all quintiles get lower welfare from higher rice prices, but the loss is the highest for the poorest urban quintile. Therefore, rural middle-income groups receive the highest benefits, while the poorest urban groups suffer the most. The last column of Table 7 shows the percentages of households whose welfare falls. In total, about 64 percent of all Vietnamese households, 54 percent of rural households, and 92 percent of urban households have lower welfare due to higher rice prices. Interestingly, about half of rural households in quintiles 1, 2, and 3 and even higher percentage among quintiles 4 and 5 are made worse off. In urban areas, about 80 percent of households in quintiles 1 and 2 are worse off, while nearly all households in quintiles 4 and 5 are worse off. Thus, while Vietnam's average welfare increases when rice prices increase, most households in Vietnam are made worse off due to the price changes.

5. Conclusions

This paper analyzed the food consumption patterns of Vietnamese households by estimating a complete demand system. Demand elasticities are estimated using a modified AIDS model and the latest Vietnamese household survey data. The results indicate that food consumption patterns in Vietnam are affected by income and prices, as expected, and by socio-economic and geographic factors. All food items have positive expenditure elasticities and negative own-price elasticities.

This study indicates that demand functions in urban and rural areas and across regions and income groups are different. It points out that targeted food policies should be formulated based on specific food demand patterns in the groups. Socio-economic factors such as household size and composition, as well as household's head age and education, affect food consumption significantly in most cases. Using the estimated own- and cross-price elasticities, I estimated the welfare impacts of rice price change. If consumer and producer prices increase at the same rate, higher rice prices increase average household welfare. When rice prices increase by 20 percent, average household welfare rises by 1.3 percent, yet it is important to note that the benefits and costs are not spread evenly across the population. Overall, middle-income households gain the most while the poorest households gain the least from higher rice prices. In urban areas, the poorest households lose the most (in percentage terms) from an increase in rice prices. This indicates that support programs should target the poorest quintile, especially the poor in the regions hit hardest by higher prices, such as the South East and the Central Highlands.

Economic shocks such as a drastic increase in food prices can lead to substantial changes in consumer behavior. Estimates of consumer demand reveal the effects of prices and total expenditures on the demand for food, which in turn inform policymakers about how consumers make food purchasing decisions and help them design effective food and nutrition policies. This study highlights the importance of estimating food demand elasticities for both researchers and policymakers, especially during a food price hike.

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