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Analysis of food demand in Vietnam and short-term impacts of market shocks on quantity and calorie consumption

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Abstract

A complete demand system for Vietnam was estimated using household survey data. Results showed that demand for rice with respect to prices and expenditure is relatively inelastic compared to other foods. Demand for food in general tends to be less elastic at higher levels of income and for urban households. In the short term, a market shock such as a 10% decrease in income or a 30% increase in rice prices forces households to spend a larger portion of their expenditure on rice at the expense of other foods. Low-income households face a higher risk of undernourishment as their daily calorie intake is more negatively affected by the shocks than high-income households. The results suggest the importance of policies that provide necessary safety net programs for the poor.

JEL classifications: D12

Keywords: Household consumption; Vietnam; Demand analysis; QUAIDS; Food security; Calorie intake

1. Introduction

Vietnam is a fast-growing economy with remarkable achievements in poverty reduction and food production. Within a span of two decades, the poverty headcount decreased from 58% to less than 10% in 2010, according to the basic need poverty line standard (Badiani et al., 2013). Nominal GDP per capita grew from nearly $100 in 1990 to more than $2000 by the end of 2014 (World Bank, 2016). From a rice importing country in the 1980s, reforms in agricultural policies have transformed Vietnam into one of the world's top rice exporters.

The impacts of economic growth, however, are not felt equally across all households. The inequality gap has been widening between rural and urban areas and between high and low-income households, not only in income but also in food consumption (Thang and Popkin, 2004). Food demand patterns have also changed dramatically as rice consumption per capita keeps declining while the consumption of high-protein foods such as meat, seafood, and eggs has been on the rise (Fig. 1). Increasing demand for food, especially from newly rich and high-income households, has also put pressure on the country's food supply chain. In addition, there is a concern that the impact of market shocks on poor households has been underestimated. The 2007/2008 food price crisis showed that a rise in the price of food in Vietnam negatively affected poor households in various aspects of life, including breastfeeding, nutrition, child labor, childcare, school attendance and out-of-pocket health expenses, to name a few (UN Vietnam, 2008). Poor and low-income households still spend more than 60% of their total expenditure on food (General Statistics Office, 2013) in which rice and other cereals continue to provide the majority of daily calorie intake. This group of households is more susceptible to poverty and has a higher risk of undernutrition.

Analyses of food demand in Vietnam and impacts of market shocks on different groups of households are of broad interest to food policy makers as well as non-profit organizations, businesses and analysts whose activities are related to food security. Literature using household-level data to explore the impact of market shocks on Vietnamese consumers' food consumption is limited, and most studies employed data prior to 2010. Earlier studies mainly focused on estimating demand parameters (Benjamin and Brandt, 2002; Le, 2012; Minot and Goletti, 2000; Niimi, 2005; Vu, 2009). Their estimated elasticities of demand for rice, however, showed some inconsistent results when disaggregated by rural and urban samples. Other studies covered a wider range of food demand patterns. For example, demand for fruits and vegetables sourced from

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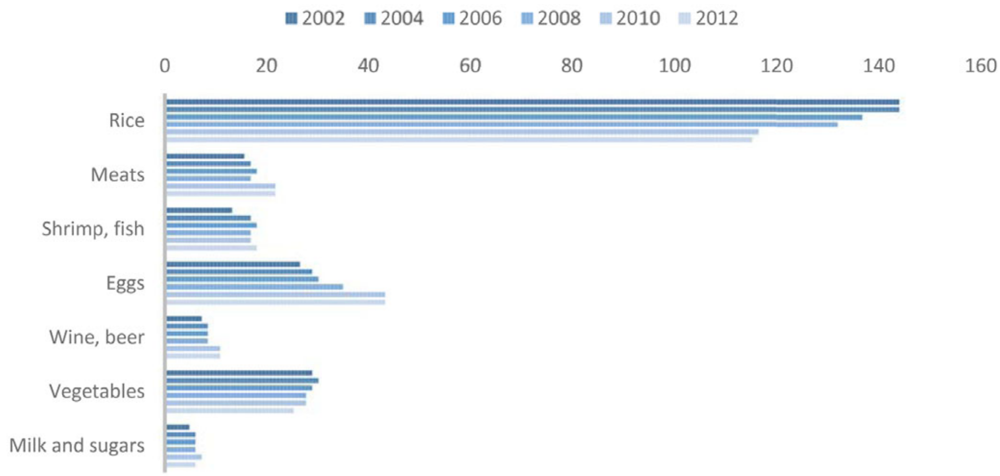

Source: General Statistics Office of Vietnam, 2013.
Note: * number for eggs, liter for wine and beer.

Fig. 1. Per capita annual food consumption in Vietnam (kg/person/year*), 2002–2012. [Color figure can be viewed at wileyonlinelibrary.com]

modern supply chains such as supermarkets was estimated to be more elastic with respect to changes in income than in prices (Mergenthaler et al., 2009). In addition, urban, female-headed households and households with children are more likely to increase milk consumption (Phuong et al., 2014). Food expenditures tend to increase with short-term migration, which helps improve food security (Nguyen and Winters, 2011). A relatively small increase in food prices tends to increase overall welfare, although households that are net consumers are worse off (Vu and Glewwe, 2011). Gibson and Kim's study (2013) is one among very few that focused on nutritional impacts of market shocks. Using the 2010 Vietnam Household Living Standard Survey and an independent price survey, they found that a 10% increase in rice prices decreases calorie consumption by less than 2%, considering quality adjustments. However, their study did not cover the consumption of all foods, and calorie elasticities were estimated as a fixed share of demand elasticities. Mergenthaler et al. (2009) applied a two-stage budgeting model with the Almost Ideal Demand System (AIDS) in the second stage. However, their data were limited to less than 500 observations since it was a self-conducted survey specifically focusing on food supply chains.

This study contributes to the literature on the impact of negative market shocks on food and calorie consumption in Vietnam in some important ways. First, it examines a complete food demand system of Vietnam using more recent household survey data and covers the consumption of more than 50 different food items. In addition to estimating the elasticity of demand with respect to food expenditure, which most previous studies did, income elasticity is estimated using a two-stage budgeting system where a consumer is assumed to make decisions in sequential stages. In the first stage, the consumer allocates expenditures to a broad group of commodities such as food, housing, transportation etc. In the second stage, group expenditures are allocated to individual commodities within that group. This approach assumes weak separability of the direct utility function, which simplifies the estimation and allows greater disaggregation of commodities. The two-stage budgeting system can also provide estimation of the total (unconditional) instead of partial (conditional) elasticities in which the former is believed to be more policy relevant (Decoster and Vermeulen, 1998). One of the disadvantages of estimating a two-stage budgeting system is the lack of data on broad groups of commodities. Prices of housing, transportation or education are often unavailable and researchers usually overcome this by constructing composite price indices.

Second, in this study the results are reported considering the combined effect of income and location, which are believed to be major factors influencing a household's consumption patterns. This is a unique contribution in that even though a few researchers have defined Vietnam's demand system using disaggregated data either by region or by income, none have conducted analyses on calorie consumption considering a combination of both factors. Since short-term impacts of market shocks are the focus of this study, I consider only the direct impacts of the shocks on household consumption while ignoring supply responses by producers. Clearly in the longer term with time for supply to respond, the impacts would be moderated by supply adjustments, but this is beyond the scope of this study. Results from this study, on the one hand, are consistent with previous studies in the literature that estimated household demand systems for Vietnam. On the other hand, findings are aligned with the expectation that demand patterns change over time. Finally, the study provides insights into the Vietnamese households' demand structure and the short-term impacts of negative market shocks on households' calorie consumption and food insecurity.

The rest of the article is organized as follows. The next section discusses model specifications and the two-stage budgeting process. Section 3 presents the household data and describes the technique to adjust unit prices for quality biases. Summary statistics on household food budget shares and purchasers' quantity and calorie consumption by type of food are also provided. Section 4 presents the two-stage model estimation results and the short-term impacts of negative market shocks on demand and calorie consumption. Conclusions and implications are drawn in the final section.

2. Model specification

Following Deaton and Muellbauer (1980), food and non-food expenditures are assumed to be weakly separable. The Quadratic Almost Ideal Demand System (QUAIDS), developed by Banks et al. (1997), which was further augmented with demographic variables by Poi (2013), is used to estimate price and food expenditure elasticities in the second stage. QUAIDS has been widely applied in the literature on food demand analysis. For developing countries in particular, examples include the application of QUAIDs to analyze food and nutrient demand in Malawi (Ecker and Qaim, 2011), food demand in urban China (Gould and Villarreal, 2006; Zheng and Henneberry, 2010), food demand in Nigeria (Elijah Obayelu et al., 2009), fish demand in Philippines (Garcia et al., 2005), rice demand in Malaysia (Tey et al., 2008), food demand in Indonesia (Pangaribowo and Tsegai, 2011), a series of food demand projections using QUAIDS for Ethiopia (Tafere et al., 2011), Bangladesh (Ganesh-Kumar et al., 2012), and India (Ganesh-Kumar et al., 2012).

Based on an indirect utility function, the QUAIDS has a form as follows:

$$w_i = \alpha_i + \sum_{j=1}^{n} \gamma_{ij} \ln p_j + \beta_j \ln\left[\frac{m}{a(\boldsymbol{p})}\right] + \frac{\lambda_i}{b(\boldsymbol{p})}\left\{\ln\left[\frac{m}{a(\boldsymbol{p})}\right]\right\}^2, \tag{1}$$

where w_i is a household's budget share of good 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 a household's per capita total food expenditure, $a(\boldsymbol{p})$ 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:

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

$$b(\boldsymbol{p}) = \prod_{i=1}^{n} p_i^{\beta_i}. \tag{3}$$

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: $\sum_{j=1}^{n} \gamma_{ij} = 0 \,\forall j$, and
Symmetry: $\gamma_{ij} = \gamma_{ji}$

Expenditure elasticities are obtained from

$$\eta_i = \mu_i / w_i + 1, \quad \text{where } \mu_i = \beta_i + \frac{2\lambda_i}{b(\boldsymbol{p})}\left\{ln\left[\frac{m}{a(\boldsymbol{p})}\right]\right\}. \tag{4}$$

Uncompensated price elasticities are given by

$$e_{ij}^{u} = \mu_{ij} / w_i - \delta_{ij}, \quad \text{where } \mu_{ij} = \gamma_{ij} - \mu_i\left(\alpha_j + \sum_k \gamma_{jk} \ln p_k\right) - \frac{\lambda_i \beta_i}{b(\boldsymbol{p})}\left\{\ln\left[\frac{m}{a(\boldsymbol{p})}\right]\right\}^2. \tag{5}$$

Compensated price elasticities are derived from the Slutsky equation:

$$e_{ij}^{c} = e_{ij}^{u} + \eta_i w_i. \tag{6}$$

Furthermore, to account for demographic characteristics of a household, Poi (2013) extended Eq. (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:

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

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

$$\ln \phi(p, z, u) = \frac{\prod_{j=1}^{k} p_j^{\beta_j}\left(\prod_{j=1}^{k} p_j^{\eta_j' z} - 1\right)}{\frac{1}{u} - \sum_{j=1}^{k} \lambda_j \ln p_j}. \tag{8}$$

QUAIDS with a vector of demographic variables $\boldsymbol{z}$ now has the form:

$$w_i = \alpha_i + \sum_{j=1}^{n} \gamma_{ij} \ln p_j + (\beta_j + \boldsymbol{\eta}_i{}'\boldsymbol{z}) \ln\left[\frac{m}{\overline{m}_0(\boldsymbol{z}) a(\boldsymbol{p})}\right] + \frac{\lambda_i}{b(\boldsymbol{p}) c(\boldsymbol{p}, z)}\left\{\ln\left[\frac{m}{\overline{m}_0(z) a(\boldsymbol{p})}\right]\right\}^2, \tag{9}$$

where $\overline{m}_0(z) = \mathbf{1} + \rho' \boldsymbol{z}$ and $c(\boldsymbol{p}, z) = \prod_{j=1}^{k} p_j^{\eta_j' \mathbf{z}}$ with $\sum_{j=1}^{k} \eta_{rj} = 0$ $(r = 1, \ldots, s)$ to satisfy the adding-up condition. Two additional vectors of demographic parameters, $\boldsymbol{\rho}$ and $\boldsymbol{\eta}$, are to be estimated.

It is noted that when $\lambda_i = 0$, Eq. (1) becomes the original AIDS. With a quadratic term in the expenditure m, QUAIDS allows a good to change from luxury (expenditure elasticity >1) to necessity (expenditure elasticity <1) at higher levels of expenditure.

In the first stage, a Working–Lesser model is used to estimate the income elasticity of food expenditure, following Chern et al. (2002). This model can be expressed as

$$\ln m = \alpha_0 + \alpha_1 \ln M + \alpha_3 \ln \boldsymbol{P} + \sum_k \beta_k z_k + \varepsilon, \tag{10}$$

where m is total food expenditure per capita as appears in Eq. (9). M is total income per capita, which is the income a household receives from all sources such as businesses, agriculture, forestry, and aquaculture. $\boldsymbol{P}$ is Laspeyres price index, defined as

$$\ln(\boldsymbol{P}) = \sum_i \overline{w_i} \ln(\boldsymbol{p}_i), \tag{11}$$

where $\overline{w_i}$ is the mean budget share and $\boldsymbol{p}_i$ is the price of the good i.

The elasticity of demand for food with respect to income, $E_{f,i}$, is estimated as the product of the food expenditure elasticity of demand for food, e_i, and the income elasticity of food expenditure, e_f. Thus,

$$E_{f,i} = e_i.e_f. \tag{12}$$

3. Data

This study uses the 2010 Vietnam Household Living Standard Survey (VHLSS) conducted by the General Statistics Office of Vietnam for analysis. The full survey contains 36,756 households with information on education, health and healthcare, employment and income, expenditures, housing, poverty reduction, and sociodemographic characteristics. Data for this study are mainly obtained from the Vietnamese Income and Expenditure Survey, a subset of the VHLSS containing information on income and expenditure on food and nonfood items of 9,399 households from 63 provinces and cities, 687 districts, and 3,129 communes. Interviews were conducted in three quarters from June to December of 2010.

Data on food consumption and expenditures are collected for foods that are purchased, home-produced, given as gifts or as in-kind contributions, covering 54 different food items. Consumption is divided into two groups based on its regularity: holiday (reported on an annual basis) and 30-day period consumption (here defined as regular consumption). Quantity consumption is converted into kilogram equivalence for certain food items using the conversion factors. Total food expenditures are the sum of regular and holiday consumption expenditures. Household income is calculated as total revenue minus total costs accrued from all activities including businesses, agriculture, husbandry, forestry and aquaculture. This approach is consistent with that of the General Statistics Office of Vietnam (2011).

Unit prices are derived from dividing the reported expenditure that a household spent by the corresponding quantity of the individual food item. This approach is also called "purchase unit value" in distinction with the "consumption unit value" which takes into account the consumption of not only purchased food but food received as gifts or from home-production (Gibson and Kim, 2013). In the absence of market prices, purchase unit value is preferred to consumption unit value (Gibson and Kim, 2013). As a side note, the Spatial Cost-of-Living Index survey, a market price survey conducted in conjunction with VHLSS 2010, provided market prices of food items purchased by households. However, the price information is incomplete and cannot be used for the purpose of this analysis since the survey only followed the second and third rounds of VHLSS 2010.

Tobacco and betel leaf expenditures are excluded from the calculation of food expenditures, leaving 52 individual items counted as food. Following Dharmasena and Capps Jr (2014) and Kyureghian et al. (2011), missing unit prices due to zero-consumption or omitted quantity are imputed using an auxiliary regression where the observed prices are regressed on income, household demographics, the region where the household resides and the time period (quarterly) when the interview was conducted. Income captures the quality variation of the food purchased. Regional and quarterly assessments cover the spatial and temporal variations, and other demographic variables consider differences in household demographic compositions.

The computed unit prices, however, 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, 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 and Wohlgenant (1986) and later modified by Vu (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 and Rozelle, 2011; Majumder et al., 2012; Niimi, 2005). The procedure for computing unit prices and adjusting for quality biases is provided in Appendix A.

Data cleaning resulted in 9,383 households for analysis. Household socioeconomic and demographic characteristics are presented in Table B1, Appendix B. All food items were aggregated into seven major food groups including (1) rice (white rice, sticky rice, rice noodles or *bún*); (2) pork; (3) other meats and seafood (beef, buffalo meat, poultry, fish, shrimps, other processed meats and seafood); (4) vegetables (beans, peanuts, tofu, fresh peas, morning glory vegetables, kohlrabi, cabbage, tomato, other vegetables, orange, banana, mango, other fruits); (5) sugar (sugar, molasses and confectionery); (6) drinks (alcohols, beer, fruit drinks, soft drinks); and (7) miscellaneous food (food away from home, other cereals, spices, coffee and tea, eggs, milk and dairy products, seasonings, and cooking oil etc.).

Table 1
Food expenditure share by income levels and regions (%)

Food group	Households with non-zero consumption	Entire sample	Low-income	Middle-income	High-income	Rural	Urban
RICE	99.7	21.5	30.2	20.5	13.7	24.2	14.5
PORK	99.1	11.4	11.9	11.9	10.3	11.9	10.0
OMSF	99.3	19.3	17.6	19.8	20.5	19.2	19.5
VEGF	99.7	11.2	11.1	11.3	11.3	11.1	11.6
SUGA	99.0	2.3	2.4	2.4	2.1	2.4	2.0
DRIN	97.8	4.5	3.9	4.5	5.1	4.6	4.4
MISC	100.0	29.8	22.8	29.6	37.0	26.7	37.9
Share of food expenditure in total income		47.8	62.4	48.6	34.3	49.5	43.5
Annual income per capita (1000 Vietnamese Dongs)		17,801	6,442	12,967	32,291	14,437	26,031
Number of HHs		9,383	3,128	3,128	3,127	2,642	6,741

Source: Vietnam's Household Living Standard Survey, 2010.
Note: Exchange rate US$1 = 18,613 Vietnamese Dongs. Food groups RICE = rice, PORK = pork, OMSF = other meats and seafood, VEGF = vegetables and fruits, SUGA = sugar, DRIN = drink, MISC = miscellaneous.

The sample is divided into three income terciles (low, middle, high) and also into rural and urban households. Table 1 presents average budget shares and annual per capita consumption of each food group for the entire sample and sub-samples. Rural households account for two thirds of the sample. The average expenditure of a Vietnamese household on food and non-food in 2010 was approximately $1000. High-income households tend to earn four times more than households on the other end of the income spectrum, and urban households' income is nearly twice as much as that of rural households, which fairly reflects the income gap that has been widening in Vietnam in the past decade (World Bank, 2015). For the entire sample, food expenditure accounts for nearly half of total income on a per capita basis. Low-income households, however, spent about 62% of their income on food, while it was only 34% for high-income households. Rural households spent nearly half of their income on food, slightly higher than urban households. Nearly 100% of households in the sample had nonzero consumption; thus, the dataset does not suffer from censoring issues.

Except for the miscellaneous food group, rice makes up the largest percentage of food expenditures (21.5%) for the entire sample, followed by other meats and seafood (19.3%), pork (11.4%), vegetables (11.2%), drinks (4.5%), and sugar (2.3%). High-income and urban households spent relatively smaller proportions of their food expenditure on rice compared to lower-income and rural households. Proportions of the miscellaneous food group increased significantly with income, in contrast to the relative decrease in rice. A major driver of this increase in miscellaneous food consumption is food away from home. It is noteworthy that high-income households spent a slightly lower proportion of their expenditure on pork in exchange for a higher proportion for other meats and seafood. Pork is the most popular meat in Vietnam and considered inferior to beef and some types of seafood. This trend is also prevalent in urban households.

Quantity consumption was converted into daily calorie intakes using the 2007 Vietnamese Food Composition Table (Ministry of Health, 2007). The median calories consumed per person per day is 2216 kcal (Table B2). The estimate is similar to that of Gibson and Kim (2013). Their estimated median calories per person per day vary from 2027 to 2194. However, calorie share for rice in this study is higher, due possibly to aggregation since other rice-based products such as noodles were also included in the calculation. As a major staple, rice still accounts for more than 60% of daily calorie intake on average despite accounting for just a fifth of food expenditure.

4. Results

4.1. Entire sample

Elasticity estimates are presented in Table 2. Own-price elasticities, which measure the percentage change in the quantity demanded caused by a percentage change in price, are all negative and statistically significant. Demand for all foods except the miscellaneous food group is inelastic in response to changes in prices. Cross-price elasticity estimates are quite consistent in both directions (demand good i with respect to price of good j vs. demand of good j with respect to price of good i). Rice appears to be complementary to all other food groups (except for the miscellaneous group which is a combination of many disparate food items). Pork and other meat and seafood are substitutable with each other and are complementary to vegetables and fruits. Sugar and confectionery are complementary to all other foods except vegetables and fruits. Drinks are complementary to rice, pork, and sugar but substitutable with other meats and seafood, vegetables and fruits. Demand for rice is less elastic (-0.5) to changes in rice prices compared to other foods, which have own-price elasticities ranging from -0.7 to -1.7.

Expenditure elasticity estimates are all positive and statistically significant. Rice, pork, vegetables, fruits, and sugar appear to be necessity goods while other meats and seafood, along with drinks (and the miscellaneous food group) are luxury goods.

Table 2
Income, expenditure, and uncompensated price elasticities

Quantity demanded	With respect to price change							Expenditure elasticity	Income elasticity
	RICE	PORK	OMSF	VEGF	SUGA	DRIN	MISC.		
RICE	-0.475^{**}	-0.067^{*}	-0.166^{***}	−0.024	−0.012	-0.049^{**}	0.449^{***}	0.346^{**}	0.155
	(0.167)	(0.029)	(0.025)	(0.028)	(0.015)	(0.018)	(0.095)	(0.114)	
PORK	-0.260^{**}	-0.848^{***}	0.016	-0.061^{*}	-0.063^{**}	−0.021	0.321^{***}	0.956^{***}	0.428
	(0.088)	(0.055)	(0.03)	(0.03)	(0.02)	(0.02)	(0.075)	(0.061)	
OMSF	-0.384^{***}	−0.02	-0.834^{***}	−0.011	−0.03	0.031^{*}	0.078	1.199^{***}	0.537
	(0.092)	(0.043)	(0.018)	(0.019)	(0.016)	(0.013)	(0.059)	(0.052)	
VEGF	−0.168	−0.058	0.039^{*}	-0.904^{***}	0.031	0.041	0.145	0.876^{***}	0.392
	(0.203)	(0.055)	(0.019)	(0.037)	(0.017)	(0.025)	(0.27)	(0.025)	
SUGA	−0.22	-0.297^{*}	-0.172^{***}	0.16	-0.717^{***}	0.016	0.44	0.814^{***}	0.365
	(0.577)	(0.123)	(0.035)	(0.097)	(0.031)	(0.057)	(0.717)	(0.082)	
DRIN	−0.462	−0.092	0.127^{*}	0.067	−0.002	-0.873^{***}	0.005	1.202^{***}	0.538
	(0.511)	(0.116)	(0.058)	(0.055)	(0.031)	(0.032)	(0.643)	(0.026)	
MISC	0.105	0.068	−0.006	−0.011	0.021	−0.01	-1.651^{***}	1.449^{***}	0.649
	(0.36)	(0.091)	(0.026)	(0.069)	(0.025)	(0.043)	(0.502)	(0.031)	

Source: Estimated.
Note: Food groups RICE = rice, PORK = pork, OMSF = other meats and seafood, VEGF = vegetables and fruits, SUGA = sugar, DRIN = drink, MISC = miscellaneous; $^{*}P < 0.05$, $^{**}P < 0.01$, $^{***}P < 0.001$. Standard errors are in parentheses.

The expenditure elasticity of demand for rice is 0.4 whereas the elasticities of other food groups are significantly larger, ranging from 0.8 to 1.5. The estimates are consistent with results in relevant studies such as Vu (2009) and Gibson and Kim (2013) as well as the expectation that demand patterns change over time. Using VHLSS 2006, Vu (2009) estimated an own-price elasticity of − 0.8 and expenditure elasticity of 0.3 for rice demand. The latter is similar to this study's estimate although the former is higher in absolute terms (this study's estimate is −0.5). This suggests that demand for rice might have become less elastic over time for an average Vietnamese household. Gibson and Kim (2013) estimated own-price elasticities of rice demand ranging from −0.3 to −0.8 with and without quality substitutions. The Standard Unit Price method used in their study, which is most similar to this study's approach, estimated the own-price elasticity of rice demand to be −0.6, which was quite close to our finding (−0.5). Their expenditure elasticity estimates, however, were not available for comparison.

Finally, income elasticity for each food group was derived by multiplying the expenditure elasticity with the sample mean income elasticity of food expenditure, which is 0.45 according to Eq. (10). Because elasticities were reduced by half, all food groups became necessity goods with respect to changes in income.

4.2. Disaggregation

The entire sample was divided into income terciles (low, medium, and high) and rural and urban subsamples. Elasticity estimates are presented in Table 3 at mean values (elasticities estimated for three income strata within each urban and rural subsample are also provided in Table B3). Own-price elasticities are all negative and expenditure elasticities all positive. Most of the estimates are statistically significant. In general, demand for foods, especially rice, tends to be less elastic with respect to expenditure for higher income and urban households. For example, the expenditure elasticity of demand for rice is 0.04 for urban households and 0.4 for rural households, which is consistent with results from existing studies that provided disaggregated estimates such as Canh (2008). Their expenditure elasticity for rice demand was 0.02 and 0.8 for urban and rural subsample, respectively. It should be noted that in our study pork is a luxury good with an expenditure elasticity of 1.03 for low-income households, while it is a normal good for middle- and high-income households. Vu (2009), using 2006 data, also found that pork is a luxury good for rural households and households that are not in the top 20% of expenditure.

Demand elasticities with respect to price seem to follow a similar pattern. For example, the own-price elasticity of rice demand is −0.3 and −0.5 for urban and rural households, respectively. Our results are consistent with Canh (2008) and Vu (2009). Both studies found that rice demand in urban areas is less elastic with respect to price than in rural areas. Our own-price elasticities are also smaller than their estimates in absolute terms, which supports the view that demand for rice becomes less elastic over time, both at the national and regional level.

4.3. Impacts of negative price and income shocks on calorie consumption

A substantial negative shock on food prices or income could adversely affect a household's food security at various degrees. Households' coping mechanisms might range from switching to cheaper and lower quality food, reducing diversity of food and nutrient intakes, reducing the size of the meal, or even forcing its members including children to work more hours. At its most severe stage, hunger, malnutrition, and engagements in illegal

Table 3
Expenditure and uncompensated own-price elasticities for income and regional subsamples

Food group	Expenditure					Uncompensated price				
	Low-income $n = 3128$	Middle-income $n = 3128$	High-income $n = 3127$	Rural $n = 6741$	Urban $n = 2642$	Low-income $n = 3128$	Middle-income $n = 3128$	High-income $n = 3127$	Rural $n = 6741$	Urban $n = 2642$
RICE	0.506^{***}	0.348^{**}	0.025	0.418^{***}	0.038	-0.593^{***}	-0.476^{**}	−0.243	-0.521^{***}	−0.28
	(0.069)	(0.115)	(0.232)	(0.096)	(0.212)	(0.113)	(0.168)	(0.296)	(0.145)	(0.274)
PORK	1.028^{***}	0.954^{***}	0.870^{***}	0.968^{***}	0.916^{***}	-0.874^{***}	-0.847^{***}	-0.816^{***}	-0.856^{***}	-0.823^{***}
	(0.06)	(0.061)	(0.067)	(0.06)	(0.062)	(0.052)	(0.055)	(0.061)	(0.053)	(0.061)
OMSF	1.271^{***}	1.196^{***}	1.139^{***}	1.208^{***}	1.175^{***}	-0.841^{***}	-0.835^{***}	-0.823^{***}	-0.836^{***}	-0.829^{***}
	(0.067)	(0.051)	(0.043)	(0.055)	(0.043)	(0.02)	(0.018)	(0.018)	(0.018)	(0.018)
VEGF	0.880^{***}	0.875^{***}	0.871^{***}	0.875^{***}	0.878^{***}	-0.906^{***}	-0.904^{***}	-0.903^{***}	-0.903^{***}	-0.906^{***}
	(0.023)	(0.026)	(0.03)	(0.025)	(0.026)	(0.036)	(0.037)	(0.038)	(0.037)	(0.036)
SUGA	0.863^{***}	0.816^{***}	0.750^{***}	0.828^{***}	0.769^{***}	-0.733^{***}	-0.722^{***}	-0.689^{***}	-0.729^{***}	-0.679^{***}
	(0.068)	(0.082)	(0.103)	(0.078)	(0.097)	(0.028)	(0.031)	(0.036)	(0.029)	(0.038)
DRIN	1.156^{***}	1.203^{***}	1.239^{***}	1.192^{***}	1.230^{***}	-0.861^{***}	-0.874^{***}	-0.886^{***}	-0.874^{***}	-0.871^{***}
	(0.033)	(0.026)	(0.037)	(0.025)	(0.033)	(0.036)	(0.032)	(0.029)	(0.031)	(0.033)
MISC	1.502^{***}	1.454^{***}	1.407^{***}	1.497^{***}	1.367^{***}	-1.793^{**}	-1.655^{**}	-1.558^{***}	-1.715^{**}	-1.540^{***}
	(0.035)	(0.029)	(0.03)	(0.03)	(0.03)	(0.67)	(0.508)	(0.389)	(0.578)	(0.371)

Source: Estimated.
Note: Food groups RICE = rice, PORK = pork, OMSF = other meats and seafood, VEGF = vegetables and fruits, SUGA = sugar, DRIN = drink, MISC = miscellaneous; $^{*}P < 0.05$, $^{**}P < 0.01$, $^{***}P < 0.001$. Standard errors are in parentheses.

activities may arise (Compton et al., 2010). An example of a negative price shock is what occurred during the food price crisis 2007/2008. Between January and April of 2008, the international price of rice (Thai f.o.b.) almost tripled, from around \$370 to over \$1000 a ton (Tiwari and Zaman, 2010). CPI-adjusted monthly data from Luckmann et al. (2014) showed that at its peak in May 2008, retail prices of rice in Ho Chi Minh city (representing urban areas) and Son La (representing mountainous and rural areas) increased by 24% and 40% compared to their 2007 averages, respectively. On the income side, a shock could be caused by a typhoon that affects crop production or by an economic crisis that squeezes the economy at a broad scale.

Nevertheless, most studies drew their attention to the causes of high food prices and impacts on poverty and welfare (Coxhead et al., 2012; Dewbre et al., 2008; Ivanic and Martin, 2008; Minot and Dewina, 2015). Empirical analyses of the impacts of market shocks on calorie consumption at the household level are limited. Some recent examples include the use of an equilibrium macroeconomic model to simulate such shocks on income and food prices. The changes in income and price are then used as inputs for household-level analyses of food security risks (OECD, 2015, 2017).

In this study, two hypothetical scenarios are developed to measure the short-term impacts of a substantial negative market shock on food and calorie consumption: (1) a 10% decline in household-level income and (2) a 30% increase in rice prices. Rice is the most important staple food of Vietnamese households. A 30% change in rice prices is based on what was observed during the food crisis 2007/08, as briefly mentioned above. It is harder to come to a consensus on a substantial income change but a 10% change seems reasonable based on the country's historical GDP growth rates as well as future projections, which might be as close as 5% annually (World Bank and Ministry of Planning and Investment of Vietnam, 2016). It should be noted that in QUAIDS the adding-up condition still holds after the shocks, meaning that a household will adjust its budget allocation so that the total food budget share still sums to 1. Both scenarios reflect the short-term impacts of shocks on consumption, assuming there is neither exogenous income shift nor adjustments in the elasticity of food expenditures with respect to income. The model, however, considers cross-price effects among different food groups in the demand system and allows the demand elasticities with respect to food expenditures to change as food expenditures change.

In particular, scenario 1 involves two stages of budgeting. Under the new income level, new food expenditures are predicted for the entire sample, according to Eq. (10) (stage 1). New food expenditure will enter Eq. (9) to give the predicted values on budget shares, which are multiplied with total food expenditure to get the predicted expenditure for each food group at the household level (stage 2). Quantity demand for each food group is calculated by dividing the predicted expenditure by its respective unit prices. Scenario 2 only involves stage 2 because it assumes no change in income, although the income effect of the price change is still reflected in the results. For scenario 2, the unit price of rice in Eq. (9) is multiplied by a factor of 1.3. New budget shares are derived under the new price levels. Quantity demanded for each food group is calculated by dividing the predicted food expenditure by the new unit price. Calorie intakes from each food group are calculated by multiplying predicted quantity with the respective calorie content factor, which is a weighted average of the calorie content factors of the individual foods in the composite food group. For unquantified food items such as other vegetables or food away from home, the calories per dollar approach is used in which the cost to acquire a calorie is calculated for each food item with

Table 4
Impacts of income and price shocks on budget share, per capita quantity, and calorie consumption

Food group	Budget share									Quantity								
	Baseline (%)			Difference from baseline (percentage point)						Baseline (kg+/person/year)			Difference from baseline (%)					
				Income decreases by 10%			Rice price increases by 30%						Income decreases by 10%			Rice price increases by 30%		
	Entire sample	Low	High	Entire sample	Low	High	Entire sample	Low	High	Entire sample	Low	High	Entire sample	Low	High	Entire sample	Low	High
URBAN																		
RICE	14.5	23.6	11.1	1.7	1.8	1.4	4.0	4.2	3.5	103.3	112.0	99.4	8.4	5.5	7.3	−3.4	−7.5	−3.6
PORK	10.0	12.0	9.0	0.2	−0.9	0.9	−0.8	−2.0	−0.1	14.7	10.8	16.4	−2.0	−17.5	3.7	−3.1	−16.0	2.5
OMSF	19.5	17.9	20.2	−0.2	−0.2	−0.3	−2.2	−2.2	−2.2	29.3	17.2	35.0	−9.3	−10.0	−9.6	−8.3	−10.0	−7.6
VEGF	11.6	11.7	11.5	0.2	0.4	0.2	−0.4	−0.1	−0.4	81.2	48.7	95.9	−5.8	−2.9	−6.3	−2.3	0.6	−2.0
SUGA	2.0	2.6	1.8	0.1	−0.2	0.2	−0.1	−0.3	0.0	5.0	4.1	5.4	0.0	−9.1	2.7	−2.4	−9.1	0.0
DRIN	4.4	3.4	4.8	−0.2	0.3	−0.3	−0.6	−0.1	−0.7	24.4	11.4	30.8	−13.4	2.2	−16.0	−11.6	1.3	−12.8
MISC	37.9	28.8	41.6	−1.8	−1.3	−2.1	0.1	0.5	0.0	–	–	–	–	–	–	–	–	–
Calories per person per day (median, kcal)										2154.1	1882.5	2285.2	−2.3	−4.9	−1.3	−5.4	−12.5	−2.8
RURAL																		
RICE	24.2	31.0	16.2	2.1	0.4	3.1	4.7	3.2	5.9	134.9	135.0	133.1	8.1	−0.6	18.6	−4.5	−13.2	4.9
PORK	11.9	11.9	11.5	0.2	0.7	−0.1	−0.8	−0.4	−1.1	12.9	9.5	17.6	−8.2	−5.8	−6.4	−7.1	−4.6	−7.8
OMSF	19.2	17.6	20.8	−0.4	0.0	−0.4	−2.4	−2.2	−2.5	25.0	17.3	36.0	−13.6	−15.0	−9.9	−12.2	−13.8	−10.4
VEGF	11.1	11.0	11.1	0.2	0.3	0.1	−0.4	−0.3	−0.4	60.2	45.2	83.2	−6.5	−6.4	−4.9	−2.9	−3.5	−2.1
SUGA	2.4	2.4	2.4	0.1	0.2	0.0	−0.1	0.00	−0.1	5.2	3.8	6.9	−5.3	−3.6	−2.6	−3.9	−1.3	−3.7
DRIN	4.6	4.0	5.5	−0.2	0.2	−0.7	−0.6	−0.3	−1.1	20.7	14.4	31.1	−14.3	−8.6	−18.5	−12.9	−9.7	−17.4
MISC	26.7	22.1	32.6	−2.1	−1.6	−2.0	−0.4	−0.03	−0.5	–	–	–	–	–	–	–	–	–
Calories per person per day (median, kcal)										2240.6	2059.6	2521.5	−2.0	−7.0	4.4	−8.7	−16.2	−1.7

Source: Estimated.
Note: +liter for drinks, no quantity calculated for miscellaneous group. Calorie consumption estimation from this group is based on its relative expenditure to other food groups. Low = Low-income households, High = High-Income households. Food groups RICE = rice, PORK = pork, OMSF = other meats and seafood, VEGF = vegetables and fruits, SUGA = sugar, DRIN = drink, MISC = miscellaneous.

reported expenditure and quantity. The implied calories for an unquantified food item are the respective expenditure divided by the average cost to acquire a calorie of the appropriate quantified food items. Because of space limitation, the impacts on budget share, quantity and calorie consumption are presented and discussed only for low- and high-income households within each urban and rural subsample (Table 4). Full results can be provided upon request.

Urban households

In the scenario where income decreases by 10%, the budget share for rice increases by 1.7 percentage points, which is largely compensated by a decrease of 1.8 percentage points of the miscellaneous group for the entire urban subsample. Compared to high-income households, low-income households tend to have a slightly higher increase in rice budget share but a smaller increase in terms of quantity (5.5% vs. 7.3%) due to the household's relatively lower income. Low-income households also reduce their demand for pork as well as other meats and seafood by 17.5% and 10%, respectively. In contrast, high-income households decrease their demand for other meats and seafood by 9.6%, and increase their demand for pork by 3.7%. This suggests that low-income households are more likely to suffer from a greater reduction in protein consumption. The shock decreases the median daily calorie intake by 2.3% for the urban subsample in which the level of reduction for low-income households is larger (4.9%) compared to that of high-income households (1.3%).

In response to a 30% increase in rice prices while income stays unchanged, households devote a greater share of expenditures on rice while reducing expenditures on most other foods. However, the increase in rice price seems large enough to outweigh the increase in expenditures, resulting in a reduction in quantity demand for rice as well as other foods. Low-income households decrease their demand for rice at a greater level (7.5%) compared to high-income households (3.6%). Demand for protein food including pork, other meats and seafood also declines substantially for low-income households. Overall, the median calorie intake declines by 5.4% for the urban subsample in which the level of reduction for low-income households is much larger (12.5%) compared to high-income households (2.8%).

Rural households

A 10% decrease in income increases the budget share for rice for both low- and high-income households. Low-income households also slightly increase budget shares for all other foods while reducing the share for the miscellaneous food group. The increases in budget shares for necessity foods, however, are outweighed by the reduction in income. Thus, low-income households' quantity demand decreases for all types of foods, resulting in a 7% decline in daily calorie intake. High-income households also reduce their demand for foods, but increase rice consumption by 18.6%. Thus, the median daily calorie intake of high-income households increases slightly by 4.4%, largely due to the fact that rice is high in calories.

In response to a 30% increase in rice prices, low- and high-income households devote a larger budget share for rice while reducing the shares for all other foods. Similar to their urban counterparts, low-income households in rural areas reduce their quantity demand for rice by 13.2%. In contrast, high-income households in rural areas increase their rice consumption by 4.9%. But this comes as a trade-off because they also reduce quantity demanded for all other foods, as opposed to an increase in pork consumption for high-income households in urban areas. Overall, the median calorie intake for low-income households in the rural sub-sample decreases by 16.2% compared to a mere 1.7% decrease for high-income households.

In summary, results show that either a 10% decrease in income or a 30% surge in rice prices leads to an increase in spending on rice at the expense of reduced spending on other foods. Low-income households consume 400-500 kcal less than high-income households do while experiencing larger reductions in calories under the shocks. The relative reduction in spending tends to weigh more on the miscellaneous food group under the 10% income shock, suggesting that households are likely to cut down on eating away-from-home food when their income is curtailed. The impact of a 30% increase in rice prices has the largest negative effect on the budget share devoted to other meats and seafood group. In terms of quantity, a 10% decrease in income increases the demand for rice in exchange for a lower demand for other foods with an exception that demand for rice even decreases for low-income households in rural areas. A 30% increase in rice prices reduces the household demand for rice as well as for some, if not all, other food groups. Low-income households in rural areas experience the largest reductions in both rice demand and daily calorie consumption, which raises the concern of being undernourished.

5. Conclusion and policy implications

This study examined a complete demand system for Vietnam using data from the 2010 Vietnam Household Living Standard Survey. The study provided a set of demand parameter estimates for seven major food groups, considering quality biases, spatial and temporal variations, and differences in household characteristics. Results showed that all own-price elasticities are negative and expenditure elasticities are positive for the entire sample as well as for income terciles (low, medium, and high) and for rural and urban subsample. With respect to income, all foods appear to be normal goods. With respect to food expenditure, rice, pork, vegetables and fruits, and sugar are normal goods while other meats and seafood, drinks, and the miscellaneous food group are luxury goods. Demand for rice with respect to prices and expenditure is relatively inelastic compared to other foods. Demand for food in general tends to be more inelastic at higher levels of income and for urban households.

Simulation results showed that either a 10% decrease in income or a 30% increase in rice prices increases a household's spending on rice at the expense of other foods. Low-income households' daily calorie intake is more negatively affected by the shocks than high-income households. Low-income households are also more vulnerable to undernourishment as they consume 400-500 kcal less than high-income households on a daily basis. The lack of diversity and balance in the diet, especially the lack of protein, is evident as some households might not only cut down on eating out but significantly on the consumption of meats and seafood. While the results do not consider supply response, the analytical framework using QUAIDS is able to provide full direct and cross-price effects as well as income effects of a price and income change.

Results from the analysis provide some insights into Vietnamese household food demand and food security. The diet has been shifting from staple food, typically rice, to more protein-rich food such as meats and seafood. As Vietnamese household income grows, demand for food will continue to increase. With relatively elastic demand for meats, seafood and drinks, it is expected that more pressures will weigh on the production and import of these foods. Nevertheless, rice remains the major source of calories, especially during times of market shocks. This poses a threat to the diversity of the diet for households that substitute rice for nutritionally rich foods when their purchasing power declines. A more elastic demand with respect to food prices and income implies that low-income households suffer from a larger reduction in food consumption and have a higher risk of undernourishment.

To mitigate such adverse impacts on a household's food security, Vietnam's agricultural and food policies need to be geared toward directions that increase food supply through improving agricultural productivity while maintaining a healthy food trade balance to ensure that food is available at all times and at reasonable prices. Investments in food marketing and distribution systems are important to bridge the supply-demand gap, making sure people in remote areas have access to food and prices are affordable for low-income households. As negative market shocks pose a larger threat on low-income household calorie intake in the short term, social safety nets such as cash transfers and food vouchers are necessary for the poor, who are most vulnerable to undernutrition. Further research on the impacts of market shocks on different demographic groups and on nutrition is needed to provide an understanding about these risks at a more disaggregated level. Another area of future research is the comparison of the demand elasticities through time using longitudinal or panel analysis, which would provide better insights into Vietnam's food demand patterns over time and projections for household food demand in the future.

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Appendix A

Calculating unit prices and adjusting for quality biases

First, prices are adjusted for quality differences and are calculated as

$$p_i = \alpha p_i^c + \gamma w_{nf} + \sum_n \eta_{in} Z_{in} + \varepsilon_i, \quad (1)$$

where i denotes food item i, p_i is the unit price of food item i indirectly paid by a household (p_i is derived by dividing expenditure by the respective quantity); p_i^c is the mean of unit prices at communal level; w_{nf} is a household budget share for food away from home; and ε_i is the error term. Household characteristics Z_n include household size, urban and regional dummy variables as well as the sex, education, and age of the household head.

The residual ε_i from Eq. 13 is added to the communal mean unit price p_i^c to obtain the quality-adjusted prices p_i^a at the household level. Thus,

$$p_i^a = p_i^c + \widehat{\varepsilon_i}. \quad (2)$$

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 prices. Taking this insight into consideration, this study assumes that households in the same commune (the smallest administrative 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, which leads to an overall communal price calculation expressed as

$$p_i^{c*} = \overline{p_i^a}. \quad (3)$$

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 communal mean budget shares are used as weights. Thus, the mean budget communal shares are calculated as

$$p_g^c = \sum_{i=1}^{k} p_i^{c*} u_i^c \Bigg/ \sum_{i=1}^{k} u_i^c\ , \quad (4)$$

where u_i^c is the mean budget share at the communal level of individual food item i; k is the number of food items i in the group, and 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 et al. (2012) and Vu (2009), the prices of this group were replaced by the 2010 provincial CPIs.

Appendix B

Additional Tables

Table B1
Household characteristics

Demographic variables	Entire sample	Rural	Urban
No. of households	9399	6750	2649
	Mean*		
Household size	3.9	4.0	3.8
	(1.6)	(1.6)	(1.5)
Age of the household head	48.3	47.8	49.7
	(14.2)	(14.3)	(14.1)

(Continued)

Table B1
Continued

Demographic variables	Entire sample	Rural	Urban
Proportion of infants (age < 5) in the household	0.08	0.09	0.08
	(0.1)	(0.1)	(0.1)
Proportion of elders (age > 60) in the household	0.13	0.13	0.13
	(0.3)	(0.3)	(0.3)
	Percent		
If head of the household is male	75.2	79.2	65.3
If the household lives in urban areas	28.2		
If the household is an ethnic minority	17.7	21.8	7.6
If the head of the household works in agriculture, aquaculture or forestry	55.6	69.5	20.0
If the head of the household finished primary school or had no degree	44.2	49.1	31.6
If the head of the household finished elementary, high school or equivalent vocational school	49.4	48.3	52.1
If the head of the household has a undergraduate or graduate degree	6.5	2.6	16.4
If the household lives in Region 1 - Red River Delta	18.5	19.2	16.4
If the household lives in Region 2 - North East	9.1	8.9	9.3
If the household lives in Region 3 - North West	11.1	12.7	8.3
If the household lives in Region 4 - North Central Coast	10.3	11.6	7.3
If the household lives in Region 5 - South Central Coast	11.8	10.4	14.6
If the household lives in Region 6 - Central Highlands	6.7	6.7	7.5
If the household lives in Region 7 - South East	12.2	8.9	19.7
If the household lives in Region 8 - Mekong River Delta	20.4	21.6	17.0
If the interview was conducted in June, July	32.8	33.3	32.8
If the interview was conducted in August, September, October	33.9	33.9	33.8
If the interview was conducted in November, December	33.4	32.7	33.4

Source: Author's calculation from the 2010 Vietnam's Household Living Standard Survey.
Note: *standard deviations are in parentheses.

Table B2
Share of daily calorie intake per person (%)

Food group	Entire sample	Low-income	Middle-income	High-income	Rural	Urban
RICE	62.7	72.7	62.8	51.2	66.2	52.0
PORK	4.0	3.1	4.2	4.7	3.8	4.6
OMSF	4.6	3.2	4.7	6.1	4.3	5.6
VEGF	6.1	4.7	6.2	7.2	5.6	7.0
SUGA	2.7	2.2	2.9	3.1	2.6	3.0
DRIN	1.0	1.0	1.0	1.0	1.1	0.7
MISC	13.5	8.9	13.4	21.4	11.3	22.2
	Median calories per person per day (kcal)					
	2215.7	2038.1	2243.5	2393.9	2240.6	2154.1

Source: Vietnam's Household Living Standard Survey, 2010.
Note: Food groups RICE = rice, PORK = pork, OMSF = other meats and seafood, VEGF = vegetables and fruits, SUGA = sugar, DRIN = drink, MISC = miscellaneous.

Table B3
Expenditure and price elasticities by income strata within urban and rural subsample

Food group	Urban						Rural					
	Expenditure			Uncompensated price			Expenditure			Uncompensated price		
	Low	Middle	High	Low	Middle	High	Low	Middle	High	Low	Middle	High
RICE	0.398***	0.217	−0.289	−0.536***	−0.411*	−0.044	0.518***	0.379***	0.206	−0.598***	−0.491**	−0.357
	(0.092)	(0.147)	(0.362)	(0.141)	(0.203)	(0.425)	(0.067)	(0.109)	(0.17)	(0.11)	(0.16)	(0.23)
PORK	1.033***	0.971***	0.855***	−0.858***	−0.837***	−0.803***	1.027***	0.949***	0.881***	−0.875***	−0.850***	−0.827***
	(0.06)	(0.06)	(0.067)	(0.057)	(0.06)	(0.065)	(0.06)	(0.062)	(0.067)	(0.051)	(0.054)	(0.058)
OMSF	1.270***	1.214***	1.138***	−0.844***	−0.837***	−0.821***	1.271***	1.191***	1.140***	−0.841***	−0.835***	−0.826***
	(0.059)	(0.048)	(0.04)	(0.02)	(0.018)	(0.018)	(0.068)	(0.052)	(0.046)	(0.02)	(0.018)	(0.018)
VEGF	0.887***	0.881***	0.873***	−0.911***	−0.907***	−0.904***	0.879***	0.873***	0.869***	−0.905***	−0.903***	−0.901***
	(0.022)	(0.023)	(0.029)	(0.034)	(0.035)	(0.037)	(0.024)	(0.027)	(0.031)	(0.036)	(0.038)	(0.039)
SUGA	0.857***	0.808***	0.720***	−0.719***	−0.693***	−0.656***	0.864***	0.818***	0.772***	−0.735***	−0.729***	−0.714***
	(0.07)	(0.085)	(0.113)	(0.034)	(0.037)	(0.04)	(0.068)	(0.081)	(0.097)	(0.028)	(0.03)	(0.033)
DRIN	1.169***	1.206***	1.251***	−0.848***	−0.860***	−0.882***	1.155***	1.202***	1.229***	−0.863***	−0.877***	−0.891***
	(0.036)	(0.029)	(0.041)	(0.042)	(0.037)	(0.03)	(0.033)	(0.025)	(0.033)	(0.035)	(0.031)	(0.027)
MISC	1.387***	1.365***	1.361***	−1.636**	−1.565***	−1.513***	1.523***	1.489***	1.464***	−1.821**	−1.689**	−1.614***
	(0.032)	(0.029)	(0.03)	(0.499)	(0.408)	(0.334)	(0.035)	(0.028)	(0.028)	(0.701)	(0.549)	(0.461)

Source: Estimated.
Note: Low = Low-income households, Middle = Middle-income households, High = High-income households. Food groups RICE = rice, PORK = pork, OMSF = other meats and seafood, VEGF = vegetables and fruits, SUGA = sugar, DRIN = drink, MISC = miscellaneous; $^{*}P < 0.05$, $^{**}P < 0.01$, $^{***}P < 0.001$. Standard errors are in parentheses.

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