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Changing food consumption patterns in rural and urban Vietnam: Implications for a future food supply system*

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Rapid income growth and urbanisation could significantly change the composition of the food basket in many emerging economies. This study estimates a demand system, including 15 major food items in Vietnam, with multiyear household survey data. We find a large variation in the estimated price elasticities (–0.05 to –0.88) and expenditure elasticities (–0.16 to 2.56). Food types, urban status and income groups can explain this variation. We also find that the staple food, rice, is already an inferior good for rich urban households in Vietnam. Moreover, food preferences are evolving away from rice but towards animal proteins (fish, pork, chicken, eggs and milk), fruits and vegetables, irrespective of urban status and income groups. As the Vietnam economy continues to grow with a doubling of gross domestic product (GDP) in the next decade, per capita rice consumption in both urban and rural areas and across different income groups will continue to decline, whereas demand for other high-value products will rise. Thus, government policy should focus on encouraging demand-oriented food production. In addition, crop diversification at the farm level needs to improve substantially to meet the rising demand for these food products due to income growth and urbanisation.

Key words: change in preferences, demographic change, food demand, household expenditure, income growth, urbanisation, Vietnam.

1. Introduction

Changing food preferences (e.g. increasing consumption of luxury foods and eating away from home) could be an important demand shifter in the twenty-first century. Various factors could influence food preferences, such as income growth, the progress of urbanisation, structural changes in population demographics, health and environmental concerns, more women in the

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workforce, and retail market transformation (Mergenthaler *et al*. 2009; McCluskey 2015; Cobiac *et al*. 2018). Food preferences between rural and urban households could also evolve differently, as these two groups are highly heterogeneous (Huang and David 1993; Regmi 2001). Therefore, the major driving factors of food preferences should be considered in a demand analysis.

Urbanisation, defined as the increasing share of the total population living in urban areas, has profound implications for a country's food demand structure (Satterthwaite *et al*. 2010; FAO 2017). Urbanisation takes agricultural labour away, causing rural wage rates to rise. This leads to a rise in production cost and food price increases (Stage *et al*. 2010). Higher food prices tremendously affect a country's demand structure, affecting different people differently. For instance, the rural poor may benefit from higher food prices if they are net producers, whereas the urban poor are only consumers and thus higher prices may exacerbate their food security status (Vu and Glewwe 2011; Gibson and Kim 2013a). In contrast, urbanisation is highly and positively associated with income growth (Spence *et al*. 2009; Chen *et al*. 2014). As income grows, people are likely to diversify their food consumption. It is evident in many developing countries that, with an increase in income and urbanisation, people are moving away from cereals to more high-value food consumption (Huang and David 1993; Huang and Bouis 1996; Pingali 2006; Cockx *et al*. 2018; Mottaleb *et al*. 2018).[1]

In Vietnam, this similar transformation in the food basket is also taking place, particularly increasing preference towards luxury foods (e.g. meat and milk) and decreasing consumption of the main staple, rice. For instance, using 1997–1998 household expenditure data, Dien *et al*. (2004) found that urban residents in Vietnam consume greater amounts of animal products than their rural counterparts. World Bank (2016) also observed pronounced differences in food consumption between rural and urban residents during 2002–2012: urban residents spent less on rice and more on livestock products. In contrast, using data from 1993 to 2004, Stage *et al*. (2010) found that not urban living, but income growth was the driving force for the increasing consumption of luxury foods in Vietnam. Recently, Hoang (2018) noted that newly growing rich and high-income households in Vietnam are putting pressure on the country's food supply chain due to changing consumption patterns away from the main staple, rice, to high-protein foods (e.g. meat, seafood and eggs). Interestingly, Nguyen *et al*. (2019) found a new food demand trend in Vietnam upon analysing income effects on household rice consumption at home and away from home. Nguyen *et al*. (2019) found that rice consumption away from home increases with household income: urban and richer residents spend more consuming rice away from home. In the light

[1] Since income and urbanisation are highly intercorrelated, disentangling their effects on food consumption is challenging. A review on urbanisation and food consumption can be found in Cockx *et al*. (2018).

of this finding, it can be argued that overall rice consumption might not decrease due to urbanisation and income growth as was expected. It could be a reorientation of rice demand: decreasing home consumption but offsetting it from restaurant consumption.[2] Finally, while Gibson and Kim (2013b, 2019) contributed significantly to the food demand literature in Vietnam, revisiting elasticities with an appropriate demand model and data, their studies do not provide new information about income and urbanisation effects. Therefore, the main gaps in the demand literature in Vietnam are twofold: (i) most of the previous studies relied on cross-sectional data and used data no later than 2012; and (ii) none of these studies tested the hypothesis of whether income alone or income and urbanisation together or urbanisation alone influence food demand structure. We fill these gaps by estimating food demand systems with the most recent and longest time-series household survey data (2012–2016) and taking into consideration income and urbanisation effects.

Vietnam used to be one of the poorest countries in the world three decades ago, but it is now considered one of the most dynamic emerging economies in the world (Davis 2016; Vanham 2018). The main contributors to this economic development have been international integration through trade liberalisation, domestic reforms through deregulation, and enormous investment in human and physical capital through public investment (McCaig and Pavcnik 2013). In Vietnam, the gross domestic product (GDP) is projected to reach approximately USD 500 billion in 2030 as compared to USD 200 billion in 2018, more than double in the next ten years (Henry and Pomeroy 2018). Similarly, the proportion of the population living in an urban setting is also expected to increase from 37 per cent in 2020 to 45 per cent in 2030 and, by 2050, more than half of the country's population is expected to live in urban areas (Jiang and O'Neill 2017). Moreover, changes in population demographics such as more educated people, more working-age people in the labour market (Minh 2009) and women in the labour force (Banerji *et al.* 2018) are expected. These factors are likely to accelerate the changes in food consumption patterns in Vietnam. In contrast, the country's food security and poverty status are still unsatisfactory. For example, the current poverty rate in Vietnam is approximately 21 per cent (World Bank 2012); stunting, underweight and wasting are very common in lower-income groups; approximately 12 per cent of preschoolers suffer from vitamin A deficiency; approximately one-fifth of the country's women are underweight; and anaemia is a public health concern for pregnant women (32 per cent) (FAO 2014). Therefore, it is very important to investigate the changing consumption patterns across income and urban status, and how they are likely to evolve in the future (Gouel and Guimbard 2019). The findings from our study will be useful for policymakers and researchers in identifying opportunities

[2] Fast-food restaurants are serving rice in many South-East Asian countries (e.g. the Philippines and Vietnam).

for reforming the food supply system to meet the upcoming challenges that involve changing consumer preferences and maintaining food and nutrition security status.

1.1 Previous literature

Demand studies have tremendous policy implications, particularly in poor and developing economies. The knowledge of how price and income changes affect demand for various foods, respectively, measured by price and income elasticities can help policymakers design careful policies to improve food and nutrition security and alleviate poverty. This significant importance of demand studies has thus resulted in a plethora of empirical literature on the topic during the last three decades (Ogundari and Abdulai 2013; Zhou and Yu 2015). Importantly, four intensive meta-analysis studies on the topic exist (Ogundari and Abdulai 2013; Cornelsen *et al.* 2015; Colen *et al.* 2018; Femenia *et al.* 2019). Therefore, here we refer to only the major studies and discuss the main knowledge from the literature.

First, price elasticity of demand (PE) measures how consumers' demand changes due to price changes. PE values are measured as the ratio of percentage change in demand associated with percentage change in the price of that good (own-PE) or another good (cross-PE). The sign of own-PE is almost always negative, but the sign of cross-PE could be positive or negative depending on the substitutability or complementarity nature of the good (Deaton 2018). Demand is inelastic (PE < 1) if it does not respond much to price changes (necessity good), and is elastic (PE > 1) if demand changes a lot when the price changes (luxury good). The size of price elasticities varies widely across various foods and income groups (whether a country is poor or developed) (Cornelsen *et al.* 2015; Femenia *et al.* 2019). For instance, based on 78 global studies, Cornelsen *et al.* (2015) and Green *et al.* (2013) found that own-PE for cereals in low-income, middle-income and high-income countries was –0.61, –0.55 and –0.43, respectively; for meat, own-PE was –0.78, –0.72 and 0.60, respectively. Price elasticities also vary within a food item. For instance, for rice, one of the main staple foods in Asia, own-PE was found between –0.04 and –2.17 (Gibson and Kim 2013b, 2019; Chen *et al.* 2016; Hoang 2018; Mottaleb *et al.* 2018). This large variation is mainly attributed to the time and the country considered in the analysis, quality data used and robust method applied.

Second, expenditure (income) elasticity measures how consumers' food demand changes (either quantity or caloric basis) as their income changes. The relationship between food consumption and income is generally considered to be positive and linear, which is called the Engel curve in economics. However, until recently, the relationship was considered to be nonlinear because people might behave differently when increasing their income (Ogundari and Abdulai 2013; Zhou and Yu 2015). For instance, more rice and wheat are consumed with little increased income, whereas consumption of meat and dairy products

increases with consumers' affluent stage (Chen *et al.* 2016). In the literature, like price elasticities, a large heterogeneity in income elasticities is also found. Figure 1 illustrates the income elasticities for more than 33 previous studies in Asia, which shows that income elasticities of food vary widely, from –0.50 to 3.54. Food items, publication bias and methodological attributes (e.g. model type, sample size, types of data) are the major drivers of this large variation (Ogundari and Abdulai 2013; Colen *et al.* 2018). However, it is well agreed that income growth will increase food consumption and lead to more nutritionally diverse diets.

Third, demand models for estimating price and income elasticities can be traced back to the 1950s (Stone 1954; Prais and Houthakker 1955). Demand models can broadly be categories such as no demand system (e.g. double log or log–log inverse model) and demand system models, such as the linear expenditure system (LES), the Rotterdam model (Barten 1964; Theil 1965), the Translog model (Christensen *et al.* 1975), the Almost Ideal Demand System (AIDS) (Deaton and Muellbauer 1980; Deaton 1990) and variants of the AIDS (Banks *et al.* 1997; Lewbel and Pendakur 2009). To operate a demand system with consistent estimates, the utility function is required to be separable and additive. Additionally, aggregation (Gorman 1959) and

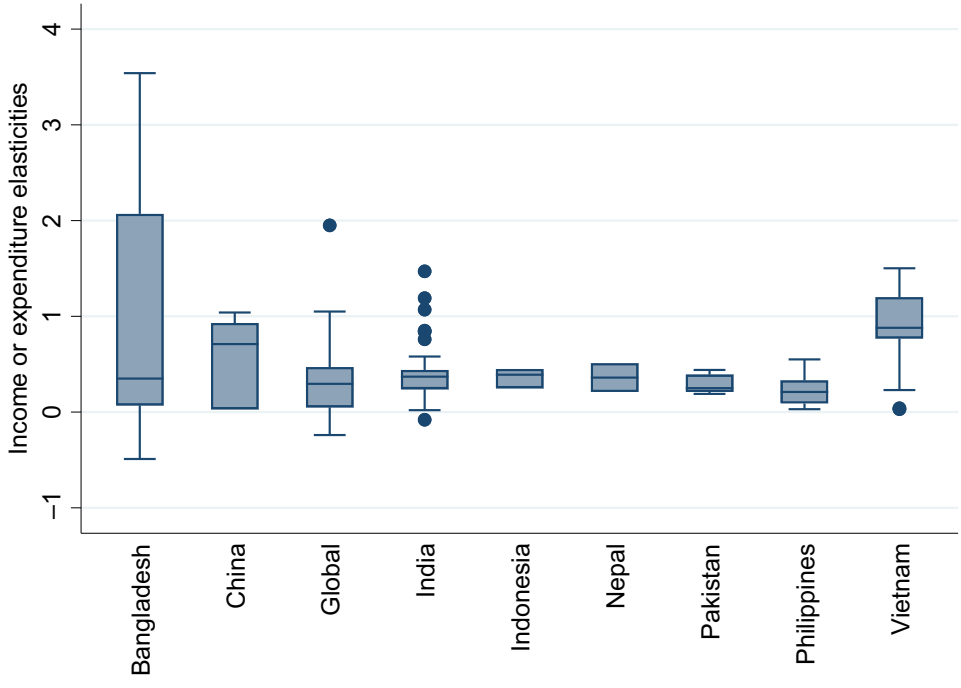

Figure 1 Income or expenditure elasticities, collected from 34 previous studies in South and South-East Asia: 1977–2019. Notes: Most of the references can be found in Ogundari and Abdulai (2013) and Zhou and Yu (2015). Other studies are Gouel and Guimbard (2019), Hoang (2018), Khanal *et al.* (2016) and Zheng *et al.* (2018). [Colour figure can be viewed at wileyonlinelibrary.com]

symmetry (Spence 1976; Dixit and Stiglitz 1977) restrictions need to be imposed to mitigate any dimensionality problem that might arise due to the large number of parameters to be estimated in the demand system (Nevo 2010). Today, a complete demand system imposing these restrictions can easily be estimated because of the tremendous development of programming software and gradual improvement in computing capacity during the previous decades.

However, the unavailability of actual market prices at the household level remains one of the main problems in estimating demand in the literature. Some developing countries (e.g. Bangladesh, India, Indonesia and Vietnam) collect only expenditure data, whereas others (e.g. the Philippines) collect only physical quantity information. Therefore, previous demand studies used two approaches to derive prices. The first one is the unit price method. If physical quantity and total expenditure are available, unit prices are derived dividing expenditure by physical quantity. However, these are unit values, not the market prices, so estimated elasticities would be biased, first, because people pay not only for quantity but also for quality of the product, and, second, because of spatial variations in prices. To solve these problems, Deaton (1990) proposed a method estimating quality-adjusted prices along with controlling for cluster-level fixed effects. However, several studies found significant differences in own-PE estimated with Deaton's data on quality-adjusted prices vs actual market prices (McKelvey 2011; Gibson and Kim 2013b, 2019). Quality substitution bias might also arise from the aggregation problem, such as pork, beef and chicken commonly being grouped as meat, so quality substitution within group might be high. The second approach is to use aggregate national price indices as a proxy of market prices, when only the physical quantity is available. Nonetheless, estimates from such approach might suffer from an endogeneity problem. To avoid this problems several studies constructed household-level price indices using aggregate price data along with subgroup-level expenditure shares, such as the Exact Affine Stone Index (EASI), to estimate a food demand system (Lewbel and Pendakur 2009).

In sum, we can learn the following five important lessons from the above discussion. First, elasticities are important tools for designing and reforming price and food policies globally, so demand studies are growing. Second, we observe a large variation in both estimated price and income elasticities across countries, so one size (fiscal policy) might not fit for all. Third, if large variation in estimates originates from methodological attributes, then the right approach, quality data and more disaggregated analysis are needed for reducing potential estimation biases. This is very important because biased estimates could lead to designing wrong or inappropriate policies. Fourth, as also pointed out by Cornelsen *et al.* (2015), cross-PE is limited in the demand literature. Finally, since many poor and developing countries have been growing tremendously in recent years, updated estimates are needed with new information to reform policies for further economic development.

2. Materials and methods

2.1 Data

Multiple years (2012, 2014 and 2016) of Vietnam Household Living Standard Survey (VHLSS) data were used for estimating the demand system. The General Statistics Office (GSO) of Vietnam conducts these surveys.[3] Each of these surveys contains information on more than 9,000 households. These households were appropriately selected and sampled from more than 60 provinces, 680 districts and 3,000 communes. Two-thirds of the total samples were from rural areas, which is proportional to the rural–urban population in Vietnam. The collected information covers a wide range of areas, including education, health, employment, income and expenditures and sociodemographic profiles. The main variables of interest for this study are food consumption and expenditures and demographic variables.

The VHLSS contains information on food consumption and expenditures for 54 different food and drink items, including food and drinks away from home. For our study, we include only 25 food items consumed at home, although expenditure on these items incurs around two-thirds of the total household food expenditure. Then, we categorise these items into 15 groups, without aggregating the main items: rice, other cereals (e.g. maize and wheat), noodles, fish, pork, chicken, eggs, fruits, vegetables, cooking oil, cooking sauce, sugar, milk, nonalcoholic drinks (bottled water and soft drinks) and alcoholic drinks (beer and wine) (details on subcommodity groups are at the bottom of Table 1).

In the survey, the sampled respondent was asked: 'how much did your household consume of a food item over the past 30 days and how much was the cost?' Surprisingly, no market price data were reported, which is not unusual like in many other developing countries worldwide. So, we derived the unit value of a food item by dividing the expenditure by the respective physical quantity consumed by a sampled household. Consumption of food items was measured in kilograms (kg) and drinks were in litres, whereas food expenditures were measured in thousand dong (VND). Therefore, unit values are in thousand VND/kg. Since, as before, using these unit values in the demand analysis results in biased estimates, we estimated quality-adjusted unit prices and used those in the demand analysis (Deaton 1990; Hoang 2018). The detailed steps are presented in Appendix S1.

We also found two other problems in the data: missing values and outliers. In many cases, either the physical quantity of consumption or the expenditure values of the specific food item were missing, so we extracted those values using provincial, district or communal mean values following Gibson and Kim (2013b, 2019). With regard to outliers, although the common rule for detecting outliers is to use the 3 standard deviation (SD) rule (Femenia *et al.*

[3] Detailed data collection protocols and methods can be found at http://www.gso.gov.vn.

Table 1 Descriptive statistics of food basket composition and household demographic profiles in Vietnam: 2012–2016

Variables	Rural households				Urban households				All households	Rural–urban difference (t-*test*)
	2012	2014	2016	All rural	2012	2014	2016	All urban		
Budget shares (%)										
Rice	0.354	0.331	0.299	0.329	0.274	0.255	0.225	0.251	0.287	0.077***
Other cereals	0.009	0.009	0.009	0.009	0.009	0.009	0.009	0.009	0.009	−0.000***
Noodles	0.024	0.025	0.024	0.024	0.023	0.024	0.023	0.023	0.022	0.001***
Fish	0.163	0.168	0.182	0.171	0.202	0.210	0.223	0.212	0.170	−0.041***
Pork	0.114	0.118	0.129	0.120	0.118	0.116	0.123	0.119	0.112	0.001
Chicken	0.082	0.085	0.089	0.086	0.069	0.071	0.075	0.072	0.069	0.014***
Eggs	0.017	0.018	0.019	0.018	0.015	0.016	0.017	0.016	0.075	0.002***
Fruits	0.016	0.017	0.017	0.017	0.026	0.027	0.029	0.027	0.016	−0.011***
Vegetables	0.036	0.038	0.038	0.037	0.040	0.042	0.044	0.042	0.018	−0.005***
Cooking oil	0.043	0.042	0.041	0.042	0.038	0.036	0.035	0.036	0.036	0.006***
Cooking sauce	0.010	0.012	0.012	0.012	0.010	0.012	0.012	0.011	0.038	0.000
Sugar	0.010	0.009	0.009	0.010	0.009	0.008	0.008	0.008	0.011	0.001***
Milk	0.077	0.083	0.086	0.082	0.119	0.128	0.129	0.125	0.009	−0.043***
Nonalcoholic drinks	0.021	0.021	0.021	0.021	0.022	0.021	0.021	0.021	0.086	−0.001**
Alcoholic drinks	0.022	0.023	0.024	0.023	0.025	0.026	0.027	0.026	0.020	−0.003***
Quality−adjusted unit prices (1,000 VND per unit)										
Rice	10.76	11.45	11.05	11.09	13.04	13.53	13.14	13.24	11.71	−2.155***
Other cereals	22.21	23.73	23.37	23.10	24.59	26.85	26.34	25.94	23.92	−2.840***
Noodles	25.67	29.52	29.06	28.07	25.21	28.88	28.00	27.39	27.87	0.681***
Fish	47.24	51.43	53.84	50.79	63.51	70.87	75.46	69.99	56.35	−19.193***
Pork	79.02	79.56	79.87	79.48	86.16	85.58	85.93	85.89	81.33	−6.409***
Chicken	90.97	94.32	95.27	93.49	94.42	98.70	100.57	97.92	94.77	−4.428***
Eggs	2.84	3.05	3.02	2.97	2.77	3.01	3.00	2.93	2.96	0.036***
Fruits	11.47	12.67	13.04	12.38	16.67	18.91	19.87	18.50	14.15	−6.111***
Vegetables	8.98	10.29	11.27	10.17	10.77	11.99	13.47	12.09	10.72	−1.920***
Cooking oil	40.57	39.47	39.12	39.73	41.06	40.49	40.94	40.83	40.05	−1.101***
Cooking sauce	21.54	25.44	26.80	24.56	25.85	31.47	33.44	30.28	26.22	−5.723***
Sugar	20.14	18.26	18.46	18.96	20.71	18.68	18.87	19.41	19.09	−0.448***

Table 1 (*Continued*)

Variables	Rural households				Urban households				All households	Rural–urban difference (t-*test*)
	2012	2014	2016	All rural	2012	2014	2016	All urban		
Milk	92.07	97.10	95.69	94.94	103.38	110.70	111.17	108.46	98.85	−13.523***
Nonalcoholic drinks	15.47	15.51	15.63	15.53	15.00	14.99	15.12	15.04	15.39	0.498***
Alcoholic drinks	17.37	18.43	18.78	18.19	22.57	23.73	24.42	23.58	19.75	−5.394***
Demographic variables										
Real total household income (VND 1000/month)	5755	7127	8722	7180	9381	11730	15298	12000	8618	−4819.95***
Real total household expenditure (VND 1000/month)	2334	2534	2619	2494	2770	3031	3172	2993	2638	−498.52***
Age of household head (years)	49.39	50.36	51.26	50.32	50.43	51.24	52.72	51.47	50.66	−1.15***
Male–headed household (yes = 1)	0.79	0.79	0.79	0.79	0.66	0.65	0.66	0.66	0.75	0.13***
Education of household head (years)	1.39	1.47	1.50	1.45	2.81	2.78	2.82	2.80	1.85	−1.35***
Household size (no.)	3.95	3.86	3.84	3.88	3.84	3.83	3.80	3.82	3.87	0.06***
Income group (per capita annual basis)										
Poor (VND 10,000 and below)	0.26	0.26	0.26	0.26	0.06	0.05	0.06	0.06		0.20***
Lower middle (>VND 10,000 and < VND 18,000)	0.24	0.24	0.24	0.24	0.11	0.12	0.12	0.12		0.12***
Middle (>VND 18,000 and < VND 27,000)	0.21	0.21	0.21	0.21	0.19	0.19	0.19	0.19		0.02***
Upper middle (>VND 27,000 and < VND 50,000)	0.18	0.17	0.16	0.17	0.27	0.28	0.29	0.28		−0.11***
Rich (>VND 50,000)	0.13	0.13	0.13	0.13	0.37	0.36	0.34	0.36		−0.23***
	0.39	0.42	0.42	0.41	0.42	0.43	0.43	0.43	0.41	−0.02***

Table 1 (*Continued*)

Variables	Rural households				Urban households				All households	Rural–urban difference (t-*test*)
	2012	2014	2016	All rural	2012	2014	2016	All urban		
Nonfood expenditure share										
Food eaten away from home	0.19	0.19	0.20	0.19	0.26	0.26	0.27	0.27	0.21	−0.08***
Sample size (N)	6,236	6,189	5,975	18400	2,460	2,539	2,500	7499		

Notes: Authors' estimation based on the VHLSS data. The compositions of subgroups are as follows: Rice = plain and sticky rice; Other cereals = maize and wheat (grains, bread and flour); Noodles = flour noodle and instant rice noodle/porridge, and fresh and dried rice noodle; Fish = fish and fresh shrimp; Eggs = eggs of chickens and ducks; Fruits = fresh fruits including banana, orange and mango; Vegetables = potatoes, beans, peas, cabbage, tomatoes, cassava, morning glory vegetables and tofu; Cooking oil = lard and cooking oil; Cooking sauce = fish sauce; Sugar = sugar and molasses; Milk = fresh milk, condensed milk and milk powder; Nonalcoholic drinks = bottled water, juice and soda; and Alcoholic drinks = beers and wines. VND stands for Vietnamese currency (dong), and USD 1.00 = VND 23,000. ***, ** and * denote statistical significance at the 1%, 5% and 10% levels, respectively.

2019), we used 5 SD to identify outliers. Since the nature of consumption behaviour is highly heterogeneous, we might lose some important information if we were to use the 3 SD rule. We found 2,296 observations that featured outliers, and these were excluded. Therefore, our demand analysis included more than 25,899 observations (18,400 rural and 7,499 urban households), covering three periods, 2012, 2014 and 2016, which is the largest data set ever used for food demand analysis in Vietnam.

2.2 Findings from data

The upper section of Table 1 shows the budget shares of the 15 food items across rural and urban residents during 2012–2016. The findings indicate, on average, that Vietnamese spend 60 per cent of their total food budget on three food items (rice, fish and pork), irrespective of urban or rural living. Interestingly, an almost equal budget is allocated together to fish and pork and to rice alone, which implies that rice is the main source of calories and the staple food. Although rural residents spend significantly more on rice (8 percentage points), urban residents spend more on pork consumption (4 percentage points) than their counterparts. No significant difference was found in pork consumption between rural and urban residents. The findings further indicate that food preferences are evolving away from rice towards animal proteins (fish, pork, chicken, eggs and milk), fruits and vegetables. For instance, the expenditure share on rice consumption for rural households declined from 35 per cent in 2012 to 29 per cent in 2016. A similar decline was also witnessed for urban households, for which the

Table 2 Expenditure elasticities for food items in Vietnam over time

Food items	Rural				Urban			
	2012	2014	2016	All	2012	2014	2016	All
Rice	0.326	0.281	0.224	0.280	0.183	0.105	0.010†	0.104
Other cereals	0.563	0.559	0.554	0.559	0.561	0.560	0.555	0.559
Noodles	0.889	0.890	0.887	0.889	0.871	0.874	0.868	0.871
Fish	2.279	2.237	2.180	2.231	2.117	2.067	2.024	2.067
Pork	1.172	1.167	1.158	1.165	1.180	1.175	1.167	1.174
Chicken	0.577	0.592	0.605	0.592	0.468	0.492	0.512	0.492
Eggs	0.757	0.773	0.773	0.768	0.702	0.727	0.725	0.718
Fruits	1.532	1.499	1.487	1.506	1.313	1.300	1.292	1.301
Vegetables	0.801	0.809	0.815	0.808	0.826	0.831	0.837	0.831
Cooking oil	0.660	0.639	0.637	0.646	0.611	0.589	0.592	0.597
Cooking sauce	0.967	0.968	0.969	0.968	0.956	0.960	0.960	0.959
Sugar	1.329	1.352	1.350	1.343	1.359	1.414	1.415	1.394
Milk	1.591	1.541	1.512	1.547	1.317	1.298	1.282	1.299
Nonalcoholic drinks	0.690	0.677	0.668	0.679	0.673	0.658	0.646	0.660
Alcoholic drinks	1.409	1.393	1.372	1.391	1.347	1.335	1.316	1.333

Note: Authors' estimation based on VHLSS data and QUAIDS model. All parameters are statistically significant at the 1% level, whereas †denotes statistically insignificant results.

expenditure share on rice consumption declined from 27 per cent to 22 per cent during the same period. The budget shares for animal proteins increased in both rural and urban areas, but at a faster rate in rural areas. In urban areas, in contrast, consumption of fruits and vegetables increased at a faster rate. Finally, no significant change was observed in spending on the rest of the food items.

The middle section of Table 1 presents quality-adjusted unit prices, which reveals that milk is the most expensive food within the Vietnamese food basket, followed by chicken, pork and fish, whereas rice is the least expensive food, after eggs. We also find that urban residents pay significantly higher food prices than their rural counterparts, except for rice.

The bottom section of Table 1 presents patterns of income, expenditure and demographic profiles of the rural and urban households in Vietnam. On average, the current monthly household income (in 2010 prices) of a Vietnamese household is approximately VND 8.6 million (USD 1.00 = VND 23,000), more than one-third of which is spent for food consumption (15 food items). Household income and food expenditure are significantly less for rural residents than for their urban counterparts. The findings further indicate that household income in both rural and urban households increased during 2012–2016, but at a faster rate for urban residents (increased 1.5 vs. 1.6 times). In contrast, household consumption expenditure increased for both rural and urban residents, but urban residents spent significantly less (11 percentage points) compared to their proportionate increase in income. Note that one-half and one-fifth of the total rural and urban households, respectively, fall into poor and lower-income groups. The results further suggest a very interesting finding that urban residents in Vietnam spend around 27 per cent of their total food expenditure on food eating away from home.[4] This is significantly higher than what urban residents in China spend (22 per cent) (Zheng *et al*. 2018). Rural residents in Vietnam, on the other hand, spend approximately 19 per cent of their total food expenditure, although the shares of food away from home for both urban and rural residents in Vietnam were unchanged during 2012–2016. Finally, overall, the sampled household head is approximately 51 years old with two years of education and four family members exist. Female-headed households are more in urban areas than in rural areas (34 per cent vs 21 per cent), but, surprisingly, the share of female-headed households has been constant over time.

2.3 Demand model

We used a variant of AIDS to estimate price and expenditure elasticities for 15 food items in Vietnam. Recently, QUAIDS variants have become popular for estimating the food demand system in many developing economies,

[4] The total household food expenditure in Table 1 does not include food away from home.

including for Bangladesh by Mottaleb *et al.* (2018), for India by Khanal *et al.* (2016) and for Vietnam by Hoang (2018). The basic model is described below. Suppose the expenditure share equation for food $i(=1,\ldots,N)$ for household $h(=1,\ldots,H)$, w_i^h, is specified as:

$$w_i^h = \alpha_i + \gamma_i' \boldsymbol{p}^h + \beta_i\{x^h - a(\boldsymbol{p}^h,\theta)\} + \lambda_i \frac{\{x^h - a(\boldsymbol{p}^h,\theta)\}^2}{b(\boldsymbol{p}^h,\theta)} + u_i^h \qquad (1)$$

with the nonlinear price aggregators $a(p^h,\theta) = \alpha_0 + \alpha' p^h + \frac{1}{2} p^{h'} \Gamma p^h$ and $b(\boldsymbol{p}^h,\theta) = \exp(\beta' \boldsymbol{p}^h)$, where x^h is the log total expenditure. $\boldsymbol{p}^h$ is the vector of prices of N goods. $\alpha = (\alpha_1,\ldots\ldots,\alpha_N)'$, $\beta = (\beta_1,\ldots,\beta_N)'$, $\Gamma = (\gamma_1,\ldots\ldots,\gamma_N)'$, and θ is the set of all parameters to be estimated. u_i^h is an error term. The parameters must satisfy additivity (all must sum to zero over all equations except the constant term), homogeneity (log price parameters must sum to zero within each equation) and symmetry (the effect of log price i on budget share j must equal the effect of log price j on budget share i) conditions.

Differentiating equation (1) with respect to x and p_j, omitting h superscripts, we obtain the following equations:

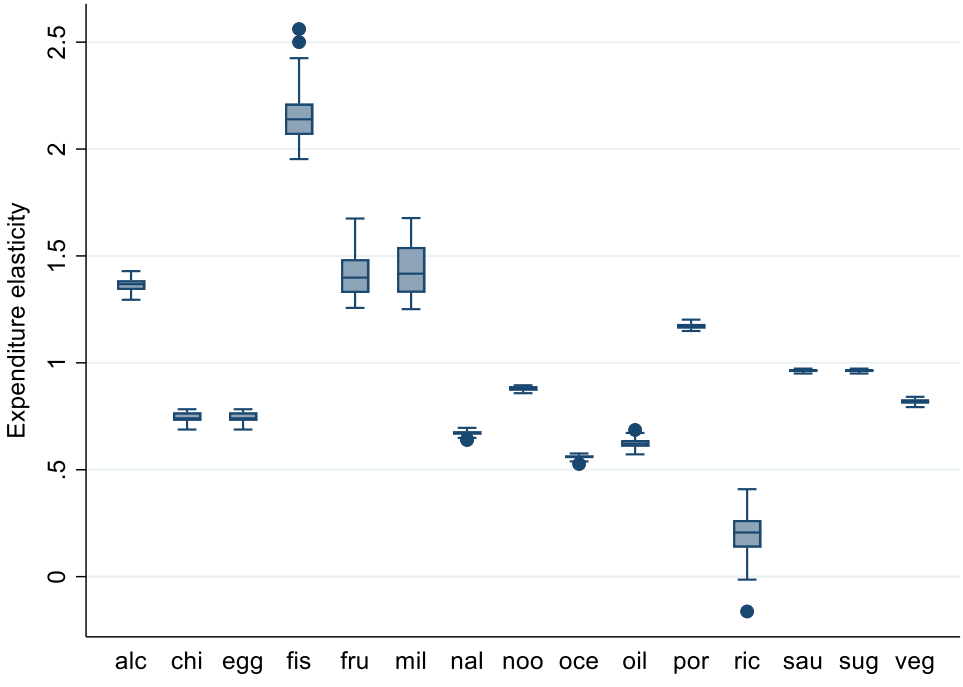

Figure 2 Income elasticities across food items in Vietnam.
Notes: Authors' estimation based on Appendix Tables 3 and 4. ric = rice; oce = other cereals (wheat and maize); noo = noodles; fis = fish; por = pork; bee = beef; chi = chicken; egg = eggs; fru = fruits; veg = vegetables; oil = cooking oil; sau = cooking sauces; sug = sugar; mil = milk; nal = nonalcoholic drinks (e.g. bottled water and soft drinks); alc = alcoholic drinks (e.g. beer and wine). [Colour figure can be viewed at wileyonlinelibrary.com]

Table 3 Expenditure elasticities across various income groups over time in Vietnam

Food items	2012					2014					2016				
	Poor	Lower middle	Middle	Upper middle	Rich	Poor	Lower middle	Middle	Upper middle	Rich	Poor	Lower middle	Middle	Upper middle	Rich
Rural															
Rice	0.409	0.342	0.300	0.265	0.200	0.373	0.294	0.260	0.217	0.136	0.329	0.235	0.194	0.139	0.076*
Other cereals	0.574	0.565	0.562	0.556	0.543	0.567	0.566	0.560	0.550	0.539	0.561	0.562	0.554	0.553	0.527
Noodles	0.883	0.889	0.893	0.893	0.890	0.883	0.891	0.895	0.893	0.892	0.881	0.888	0.891	0.891	0.887
Fish	2.561	2.312	2.212	2.161	2.081	2.500	2.243	2.182	2.139	2.050	2.425	2.177	2.131	2.066	2.033
Pork	1.190	1.175	1.164	1.163	1.160	1.183	1.168	1.161	1.158	1.155	1.172	1.158	1.153	1.149	1.150
Chicken	0.601	0.583	0.569	0.560	0.547	0.616	0.592	0.585	0.576	0.570	0.626	0.604	0.599	0.586	0.591
Eggs	0.768	0.757	0.756	0.749	0.745	0.780	0.772	0.773	0.769	0.766	0.783	0.772	0.770	0.766	0.767
Fruits	1.675	1.561	1.512	1.473	1.416	1.618	1.520	1.485	1.439	1.405	1.609	1.503	1.465	1.428	1.401
Vegetables	0.793	0.799	0.802	0.805	0.810	0.804	0.808	0.809	0.814	0.815	0.810	0.814	0.816	0.820	0.822
Cooking oil	0.686	0.663	0.648	0.644	0.633	0.672	0.639	0.624	0.622	0.608	0.667	0.631	0.630	0.616	0.619
Cooking sauce	0.960	0.967	0.972	0.971	0.969	0.960	0.970	0.973	0.971	0.970	0.961	0.971	0.973	0.973	0.969
Sugar	1.346	1.324	1.330	1.325	1.311	1.351	1.352	1.360	1.359	1.337	1.347	1.352	1.359	1.363	1.326
Milk	1.677	1.612	1.594	1.542	1.497	1.616	1.562	1.545	1.498	1.454	1.564	1.525	1.513	1.480	1.446
Nonalcoholic drinks	0.682	0.691	0.696	0.693	0.693	0.673	0.680	0.679	0.677	0.677	0.667	0.669	0.670	0.665	0.668
Alcoholic drinks	1.429	1.420	1.416	1.397	1.363	1.403	1.405	1.399	1.383	1.358	1.384	1.386	1.377	1.363	1.332
Urban															
Rice	0.303	0.261	0.239	0.196	0.084	0.263	0.201	0.164	0.115	−0.014‡	0.212	0.154	0.074	0.025‡	−0.163
Other cereals	0.558	0.570	0.569	0.561	0.555	0.576	0.569	0.567	0.559	0.553	0.560	0.565	0.559	0.559	0.545
Noodles	0.869	0.876	0.876	0.873	0.866	0.868	0.878	0.877	0.878	0.869	0.858	0.872	0.869	0.870	0.864
Fish	2.289	2.152	2.168	2.139	2.051	2.206	2.112	2.087	2.075	2.021	2.261	2.094	2.058	2.032	1.953
Pork	1.202	1.189	1.182	1.177	1.177	1.196	1.183	1.176	1.170	1.173	1.192	1.174	1.168	1.164	1.162
Chicken	0.530	0.497	0.472	0.463	0.450	0.514	0.513	0.494	0.486	0.485	0.552	0.532	0.515	0.507	0.501
Eggs	0.730	0.714	0.706	0.708	0.688	0.733	0.736	0.729	0.730	0.719	0.735	0.734	0.730	0.724	0.716
Fruits	1.396	1.372	1.348	1.316	1.274	1.370	1.351	1.327	1.306	1.263	1.359	1.343	1.319	1.295	1.257

Table 3 (*Continued*)

Food items	2012					2014					2016				
	Poor	Lower middle	Middle	Upper middle	Rich	Poor	Lower middle	Middle	Upper middle	Rich	Poor	Lower middle	Middle	Upper middle	Rich
Vegetables	0.812	0.813	0.821	0.828	0.832	0.819	0.822	0.827	0.832	0.837	0.829	0.829	0.833	0.839	0.841
Cooking oil	0.658	0.624	0.622	0.614	0.591	0.608	0.609	0.593	0.592	0.573	0.630	0.611	0.604	0.590	0.572
Cooking sauce	0.952	0.961	0.959	0.957	0.953	0.957	0.962	0.963	0.962	0.957	0.950	0.962	0.962	0.962	0.959
Sugar	1.340	1.347	1.363	1.373	1.354	1.363	1.388	1.408	1.440	1.414	1.331	1.382	1.417	1.435	1.428
Milk	1.361	1.388	1.351	1.328	1.271	1.336	1.350	1.333	1.314	1.252	1.263	1.344	1.300	1.292	1.251
Nonalcoholic drinks	0.686	0.689	0.677	0.673	0.665	0.676	0.667	0.661	0.661	0.651	0.665	0.660	0.649	0.642	0.639
Alcoholic drinks	1.382	1.382	1.383	1.353	1.314	1.358	1.373	1.358	1.341	1.307	1.326	1.343	1.337	1.318	1.295

Note: Income levels for poor, lower middle, middle, upper middle income and rich are defined as VND 10,000 and below, VND 10,001–17,999, VND 18,000–27,000, VND 27001–50,000 and VND 50,000 and above, respectively. All parameters are statistically significant at the 1% level; *denotes significance at the 5% levels, respectively, whereas ‡denotes statistically insignificant results.

$$u_i = \beta_i + 2\lambda_i \frac{\{x - a(\boldsymbol{p}, \theta)\}}{b(\boldsymbol{p}, \theta)} \tag{2}$$

and

$$u_{ij} = \lambda_{ij} + u_i(\alpha_j + \gamma_j \boldsymbol{p}) - \lambda_i \beta_j \frac{\{x - a(\boldsymbol{p}, \theta)\}^2}{b(\boldsymbol{p}, \theta)} \tag{3}$$

From equations (2–3), we can compute expenditure elasticities, $e_i = \frac{u_i}{w_i} + 1$, uncompensated price elasticities, $e_{ij}^u = \frac{u_{ij}}{w_i} - \delta_{ij}$ (where δ_{ij} is the Kronecker delta), and compensated price elasticities, $e_{ij}^c = e_{ij}^u + e_i w_j$.

To compute these elasticities empirically, we follow the subsequent steps. First, since we do not have the actual data on market prices, we estimate the quality-adjusted unit prices with equation (A5). We use eight demographic variables (gender, age of the household head (HH), age-squared, education of the HH, education-squared, log household size, urban status and nonfood expenditure shares), a time index, four income group dummies and provincial dummies as exogenous variables (details are in Appendix S1). Second, we estimate an expenditure equation with these eight demographic variables, along with a time index, five regional dummies and an instrumental variable, household income.[5] Third, we estimate a budget share equation (1) with the estimated quality-adjusted prices, along with log expenditure and log-squared expenditure, and residuals from the expenditure equation are also included.[6] The eight demographic variables and the time index are also included in equation (1).[7] We also impose homogeneity and symmetry restrictions. Finally, we compute sample-level price and expenditure elasticities, and then, we derive the conditional elasticities across rural and urban households, and over time.

3. Results and Discussion

Estimated parameters from the expenditure equation and share equations are reported in Tables 1 and 2, respectively. Since price and expenditure

[5] Due to model convergence difficulties, we use five regional dummies instead of 63 provincial dummies. Moreover, we refrain from using income group dummies in the expenditure function because income is already used as an instrument.

[6] u_i^h may be correlated with both $\boldsymbol{x}^h$ and $\boldsymbol{p}^h$; therefore, to control for potential biases, Equation (1) can be augmented with the error vector $\hat{\boldsymbol{v}}^{\boldsymbol{h}}$ estimated from reduced forms of x^h and $\boldsymbol{p}^h$ (Hausman 1978). The error term can be written via the orthogonal decomposition, $u_i^h = \boldsymbol{\rho_i}\hat{\boldsymbol{v}}^{\boldsymbol{h}} + \varepsilon_i^h$, assuming $E(\varepsilon_i^h | x^h, \boldsymbol{p}^h) = 0$ for all i and h.

[7] Demographic variables can be included through the constant term such that $\alpha^h = As^h$, where $A = \alpha_i'$, a linear combination of a set of demographic variables s^h. This approach is called the translating approach (Pollak and Wales 1981), which allows the level of demand to depend upon demographic variables, although it is more restrictive than the scaling approach (Ray 1983).

Table 4 Own-price elasticities for food items in Vietnam over time

Uncompensated	Rural				Urban			
	2012	2014	2016	2012–2016	2012	2014	2016	2012–2016
Rice	−0.430	−0.410	−0.376	−0.407	−0.369	−0.326	−0.273	−0.325
Other cereals	−0.878	−0.879	−0.878	−0.878	−0.884	−0.885	−0.884	−0.885
Noodles	−0.637	−0.650	−0.642	−0.643	−0.621	−0.633	−0.620	−0.625
Fish	−0.725	−0.745	−0.751	−0.740	−0.803	−0.811	−0.815	−0.810
Pork	−0.629	−0.646	−0.667	−0.648	−0.627	−0.641	−0.660	−0.643
Chicken	−0.232	−0.266	−0.289	−0.263	−0.084	−0.126	−0.164	−0.126
Eggs	−0.204	−0.269	−0.272	−0.249	−0.088*	−0.168	−0.169	−0.144
Fruits	−0.395	−0.429	−0.442	−0.423	−0.636	−0.650	−0.657	−0.648
Vegetables	−0.777	−0.786	−0.792	−0.785	−0.803	−0.809	−0.815	−0.809
Cooking oil	−0.314	−0.272	−0.268	−0.285	−0.214	−0.168	−0.174	−0.185
Cooking sauce	−0.360	−0.428	−0.449	−0.414	−0.349	−0.421	−0.442	−0.407
Sugar	−0.461	−0.414	−0.415	−0.431	−0.374	−0.273	−0.263	−0.307
Milk	−0.179	−0.224	−0.260	−0.222	−0.500	−0.522	−0.537	−0.520
Nonalcoholic drinks	−0.891	−0.889	−0.886	−0.889	−0.894	−0.890	−0.888	−0.891
Alcoholic drinks	−0.228*	−0.247*	−0.284	−0.253*	−0.301	−0.321	−0.353	−0.326
Compensated								
Rice	−0.314	−0.317	−0.307	−0.314	−0.316	−0.298	−0.270	−0.298
Other cereals	−0.873	−0.874	−0.873	−0.874	−0.880	−0.880	−0.879	−0.880
Noodles	−0.616	−0.629	−0.621	−0.622	−0.602	−0.613	−0.600	−0.605
Fish	−0.314	−0.325	−0.322	−0.321	−0.355	−0.352	−0.346	−0.351
Pork	−0.493	−0.504	−0.518	−0.505	−0.491	−0.500	−0.513	−0.502
Chicken	−0.187	−0.218	−0.238	−0.215	−0.054†	−0.093	−0.127	−0.092
Eggs	−0.192	−0.255	−0.258	−0.236	−0.078*	−0.156	−0.158	−0.133
Fruits	−0.371	−0.405	−0.417	−0.398	−0.602	−0.615	−0.622	−0.613
Vegetables	−0.748	−0.755	−0.761	−0.755	−0.769	−0.774	−0.778	−0.774
Cooking oil	−0.285	−0.245	−0.242	−0.258	−0.191	−0.147	−0.153	−0.164
Cooking sauce	−0.350	−0.417	−0.437	−0.403	−0.339	−0.410	−0.431	−0.396
Sugar	−0.448	−0.401	−0.403	−0.419	−0.362	−0.263	−0.253	−0.296
Milk	−0.073	−0.116	−0.148	−0.113	−0.359	−0.378	−0.389	−0.376

Table 4 (*Continued*)

Uncompensated	Rural				Urban			
	2012	2014	2016	2012−2016	2012	2014	2016	2012−2016
Nonalcoholic drinks	−0.877	−0.876	−0.873	−0.875	−0.880	−0.877	−0.875	−0.878
Alcoholic drinks	−0.197†	−0.216*	−0.252	−0.222*	−0.269	−0.288	−0.319	−0.293

Note: Authors' estimation based on VHLSS data and QUAIDS model. All parameters are statistically significant at the 1% level; * and †denote significance at the 5% and 10% levels, respectively.

elasticities are the main interest in this study, here we briefly explain the econometric parameters. Results from the expenditure equation reveal that most of the commodity prices are positively and significantly associated with household food expenditure (Table 1). This indicates that consumers respond when commodity prices increase, and thus adjust their choices. Income is positively and significantly correlated with food expenditure, which is consistent with the economic theory, the Engle law: as household income increases, the proportion of income spent on food falls. The urbanity (urban = 1) coefficient is found to be negative and significant, suggesting that rural households spend more on food consumption than their urban counterparts. Finally, the coefficient related to the time index is positive and statistically significant at the 1 per cent level, which suggests that food preferences are changing over time in Vietnam.

Table 1 presents the estimated parameters from QUAIDS.[8] The results suggest rejecting the null hypothesis of total expenditure exogeneity in each equation, as the coefficients of ρ, residuals from the expenditure function, are statistically significant in most of the share equations. The results also suggest that demographic variables play a crucial role in food demand. For example, coefficients related to age and age-squared indicate that older people spend more on rice, chicken and vegetables. Coefficients related to education and education-squared indicate that household heads who are more educated spend more on the following six items: rice, other cereals, fish, sugar and nonalcoholic and alcoholic drinks. It is also found that male-headed households spend more on rice and alcohol consumption than female-headed households, who spend more on high-value nutritious food products such as fish, eggs and fruits. Urban households spend significantly more on fish, fruits, milk and beverages than their rural counterparts. Finally, the time index coefficient indicates that a preference towards animal proteins (fish, pork, chicken, eggs and milk) has been evolving in Vietnam over time.

3.1 Expenditure elasticities

Table 2 presents the expenditure (income) elasticities across time and the rural–urban landscape. The results show that the estimated expenditure elasticities for all food items are positive and statistically significant. The range of expenditure elasticities is found between –0.16 and 2.56, depending on food types, urbanity and income status. Previous demand studies in South and South-East Asia also found large variation in expenditure elasticities of food, from –0.50 to 3.50 (Figure 1). Expenditure elasticities of demand for rice, other cereals, noodles, cooking oil, cooking sauce and vegetables are estimated to be less than 1.00, which means that these are normal goods. Interestingly, the magnitude of the expenditure elasticity of demand for rice is

[8] The estimated price parameters (rows 1–15 of Table 2) do not have an economic interpretation, and thus are used for estimating own- and cross-price elasticities.

the smallest among the entire food items: 0.28 for rural vs 0.10 for urban residents. A 10 per cent rise in food expenditure would lead to around a 1.0 per cent to 2.8 per cent increase in rice consumption. This suggests that rice is the staple food in Vietnam, and thus, various price control measures are effective in Vietnam (Hoang and Meyers 2015). The results also suggest that pork, fish, fruits, milk, sugar and alcohol are luxury (elasticity > 1) foods. The largest expenditure elasticity is found to be for fish demand: 1.90–2.17. This is consistent with a fish demand study that analysed income elasticities for fish demand from nine South and South-East Asian economies and found the expenditure elasticity of fish demand to be greater than 1.00 (Dey *et al.* 2008). The findings further reveal that the expenditure elasticities of rice demand declined for both rural and urban households during 2012-2018, whereas consumption of chicken and eggs increased with expenditure increases. This indicates that a transformation is happening within the food demand system in Vietnam.

We also estimated expenditure elasticities across income groups over time and urban status (Table 3). The main finding is that the expenditure elasticity for rice has recently become close to zero for rural rich residents and negative for urban rich residents (Figure 2 and Table 3). This suggests that rice is an inferior good for rich urban Vietnamese. As income increases in Vietnam, rice consumption in rich households will decline. On the other hand, consumption of chicken, eggs and vegetables will rise. This trend is also observed across all income groups in both rural and urban households, for which the expenditure elasticities for rice over time are declining. Even for the rural poor households, the expenditure elasticity for rice declined from 0.41 in 2012 to 0.33 in 2016. The largest decline was witnessed in the rich urban households, for which the expenditure elasticity declined from 0.08 to –0.16 over the same time. Mottaleb *et al.* (2018) also observed a similar trend among Bangladeshi households, in which rice, the staple food, is becoming an inferior good over time across income groups. Finally, overall, the expenditure elasticities revealed that demand for foods is likely to be less elastic at higher levels of income and for urban households, which is similar to the findings of Hoang (2018) for Vietnam.

3.2 Price elasticities

Table 4 presents the compensated (Hicksian) and uncompensated (Marshallian) own-price elasticities for urban and rural households over time. The own-price elasticities of all food items are found to be negative, which is consistent with the economic theory that the demand for a commodity decreases in general with an increase in price. The compensated elasticities are smaller than the uncompensated elasticities, –0.05 to –0.88 vs. –0.08 to –0.90, which is also consistent as compensated price elasticity considers price changes through income changes. The results of uncompensated price elasticities indicate how much demand for the sampled food items will be

reduced by a 1 per cent increase in prices. The lowest own-price elasticity is (in absolute terms) observed for chicken, followed by eggs, cooking oil and rice. As expected, higher price elasticities are observed for fish, pork, fruits and vegetables. The own-price elasticity of rice is found to be between –0.43 and –0.51, implying that a 1 per cent rise in rice price will decrease rice consumption by about 4.3 per cent to 5.1 per cent in Vietnam. Our estimated rice price elasticities are similar to the estimates by Hoang (2018), from –0.24 to –0.59, but smaller than those by Gibson and Kim (2013b), –0.25 to –0.35, in Vietnam. For China, the mean price elasticity of rice was found to be –0.61, with a 0.38 standard deviation (Chen *et al.* 2016). Higher price elasticities are found for rice, chicken and eggs for rural households than for their urban counterparts. Furthermore, during 2012–2016, own-price elasticities for pork, chicken and eggs increased for both rural and urban households, whereas the price elasticity of rice decreased sharply for urban residents. This suggests a remarkable transformation within the food consumption basket and between rural and urban households.

Cross-price elasticity reflects changes in demand for a particular commodity when prices of other products change. A positive (negative) cross-price elasticity indicates that the food groups are substitutes (complements) for the respective food group. The higher the cross-price elasticity, the greater the shift in purchases as prices change. Therefore, cross-price elasticities are a very important tool for designing policies in that relative shifts in prices due to various policy reforms can affect demand for other products that are not regulated (Andreyeva *et al.* 2010). The upper and lower matrices of Table 4 show the estimated compensated and uncompensated cross-price elasticities, respectively. We find that two-thirds (81 out of 240) of the compensated and three-fourths of the uncompensated cross-price elasticities are significant at the 10 per cent and lower level. Importantly, the signs of the cross-price elasticities are not always the same as those of the matrix of uncompensated elasticities. This suggests a mixture of gross complements and substitutes among the food groups and re-emphasises that expenditure (income) effects are significant and markedly influence the consumption basket in Vietnam. This similar finding was also observed in the food basket in India by Khanal *et al.* (2016).

Since the compensated elasticities provide a more accurate picture of cross-price relationships between commodity groups, we discuss here only compensated cross-price elasticities. We find a significant complementary relationship between rice and fish (–0.03), indicating that they are essential components of the Vietnamese food consumption basket. Recall that rice and fish together account for more than one-half of the total household expenditure (Table 1). The relationships between rice and pork and chicken are substitutable. Although Hoang (2018) found a complementary relationship between rice and pork in Vietnam, our finding is consistent with Khanal *et al.* (2016), who estimated that cereals and meats are substitutes in India. The positive relationship between fruits and vegetables suggests a complementary relationship. Finally, compensated cross-price elasticities by rural

and urban households suggest similar findings. However, higher cross-price elasticities are observed in urban areas (Table 4), indicating that consumption by urban residents changes more with price changes of substitute and complementary goods.

4. Conclusions and policy implications

Vietnam was one of the poorest countries in the world about 30 years ago. However, it is now one of the fastest growing economies globally. Its economy has been growing more than 7 per cent annually (World Bank 2016). Substantial reforms in domestic and trade policies helped achieve this tremendous economic growth. The country's agricultural sector also contributed significantly to this growth by transforming itself from a food-deficit country to a major exporter of agricultural products in the world. In 2018, Vietnam's agricultural exports reached USD 40 billion, according to the Ministry of Agriculture and Rural Development (MARD). The country's economic progress has led to remarkable changes in the composition of the food basket. This study estimates a complete food demand system using multiyear (2012, 2014 and 2016) data from Household Living Standard Surveys (VHLSS). A two-stage almost-ideal demand system was estimated, and the parameters were used to estimate price and expenditure (income) elasticities for 15 food items (rice, wheat and other cereals, noodles, fish, pork, chicken, eggs, fruits, vegetables, edible oil, cooking sauce, milk and nonalcoholic and alcoholic beverages) separately for rural and urban households. In the analysis, demographic variables (such as age, education and household size) and time index variables were included to capture rural–urban differences in preferences.

Expenditure elasticity estimates indicate that rice is already an inferior good for rich urban populations. These households are consuming more high-value food products such as chicken, eggs and vegetables. The positive and declining expenditure elasticities of rural populations suggest that as income increases, rural households will eventually start consuming less rice and more other food products. Since Vietnam's economy is projected to continue to grow, with a doubling of GDP in the next decade, per capita rice consumption in both urban and rural areas and across different incomes will continue to decline. On the other hand, the demand for other high-value products will rise. This changing consumption pattern will have a significant impact on the future food system. In addition, climate change further complicates the situation because Vietnam is one of the countries most vulnerable to climate change and it will be severely affected in the coming years. Therefore, demand-oriented and sustainable food systems are needed. Finally, education, ageing, urbanisation and taste and preferences are found to be important drivers of food demand, which could reshape the future food demand structure in Vietnam. Therefore, the findings from our study will inform policymakers and researchers about how consumer food demand is

evolving and thus help policymakers design an effective food security and nutrition policy for the nation. However, the estimated elasticities need to be used carefully for designing policy, as our study did not consider within-product quality variation, such as normal vs. premium-quality rice.

Conflict of interest

The authors declare no conflict of interest.

Ethical approval

This article does not contain any studies with human participants or animals performed by any of the authors.

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Supporting Information

Additional Supporting Information may be found in the online version of this article:

Appendix S1. Method of estimating quality-adjusted prices, parameter estimates from QUAIDS model, and estimated elasticities.