International Food Research Journal 16: 313-327 (2009)

Demand for quality vegetables in Malaysia

[1*]Tey, Y.S., [2]Mad Nasir, S., [3]Zainalabidin, M., [4]Jinap, S., and [5]Abdul Gariff, R.

[1]*Institute of Agricultural and Food Policy Studies,*
[2]*Faculty of Environmental Studies,*
[3]*Faculty of Agriculture,*
[4]*Faculty of Food Science and Technology,*
Universiti Putra Malaysia, 43400 UPM Serdang, Selangor Darul Ehsan, Malaysia
[5]*Market Intelligence Division,Federal Agriculture Marketing Authority (FAMA), Lot 17304*
Jalan Persiaran 1, Bandar Baru Selayang, 68100 Batu Caves, Selangor, Malaysia

Abstract: The objective of this study is to investigate the demand for quality vegetables in Malaysia. This study estimates quality elasticities from the difference between expenditure and quantity elasticities in order to show the demand for quality vegetables in Malaysia. By using the Household Expenditure Survey 2004/2005, expenditure and quantity Engel equations are estimated via two stage least square. The positive estimated quality elasticities (except root and tuberous vegetable) show that Malaysian consumers tend to increase their demand for quality vegetables in response to their incomes rise. To be more specific, urban consumers are expected to demand more of higher quality vegetables (except root and tuberous vegetable) than rural consumers.

Keywords: **Vegetables, expenditure elasticity, quantity elasticity, quality expenditure**

Introduction

Continuous income growth has seen diversification in the structure of Malaysian diets. The diversification can be characterized by more consumption of wheat, meats, fish, vegetables and fruits, while per capita consumption of traditional staple-rice has been showing downward trend over the years. The changes are well recorded by Ishida *et al.* (2003). However, the growth of per capita consumption of vegetable has not been as much as higher value food products (meats and fish). Per capita consumption of vegetable (excluded flavoring category) in Malaysia was 40.58kg in 2001 (Ministry of Agriculture and Agro-based Industry) from 27.25kg in 1982 (FAMA, 1993). Comparatively, per capita consumption of meat and fish has increased from 24.8kg and 43.3kg in 1982 to 47.5kg and 58.1kg in 2001 respectively (FAO, 2007).

The distinctive difference in the growth of per capita consumption between vegetables and meats is probably better explained by the low estimates of expenditure elasticity of demand for vegetables. By using the Household Expenditure Survey 1990 data, Radam *et al.* (2005) reported that the estimate of expenditure elasticity for vegetables is 0.0449 and it is the lowest estimate amongst all the foods. Though food is normal goods or necessities, it is rare to obtain such extremely inelastic expenditure elasticity for vegetables. However, there are different estimates from the Household Expenditure Survey 2004/2005 data. Tey *et al.* (2008a and 2008b) estimated that expenditure elasticity for vegetables is 1.341 and 1.1729

*Corresponding author.
Email: tyeong.sheng@gmail.com

by using different estimation method respectively.

The change in the expenditure elasticities perhaps indicate a change in the form of demand for vegetables when viewing there were not much increase in per capita consumption of vegetables over the years. In simple terms, the form can be expressed as a shift from quantity to quality, especially when higher quality vegetables become more affordable in accordance with income rise. Thus, the objective of this study is to investigate the demand for quality vegetables in Malaysia. As defined by FAO (2009), vegetable quality encompasses both product attributes and process attributes. The product attributes can be described by colour, flavour and texture. The process attributes include place of origin, method of processing, and environmental impact of production. Both of the attributes are important determinants in protecting consumers' health and influencing a product's value to consumers.

Development in vegetable sector

Malaysian agri-food industry is increasingly market-led, with consumers being the core driving force in determining desirable vegetables to be offered in the market. To name a few, common higher quality vegetables in Malaysia stand from organic vegetables, good agricultural practiced vegetables, and processed vegetables. The potential of organic vegetables sector is forecasted to worth RM800 million in 2010 under the Ninth Malaysian Plan. Under the third Malaysian National Agricultural Policy, farmers are encouraged to adopt Farm Good Agricultural Practice Scheme to overcome the challenges pose by the requirements of domestic hypermarkets and trade. There are also increasing number of processor that adopts Hazard Analysis and Critical Control Points (HACCP) in producing processed vegetables.

The changes in the form of demand for vegetables are also meaningful to prepare the country to cope up with the challenge by World Trade Organization (WTO) for the concept of free trade worldwide, as well as to meet the requirements imposed by ASEAN Free Trade Area (AFTA), especially of that Malaysia target to increase her agricultural exports value by achieving 108% self-sufficiency level in vegetables by 2010. Previous studies (Swinnen, 2007; Reardon *et al.*, 2003; World Bank, 2007) found that food quality is increasingly becoming important determinant in food trade. This is because trade regulations and requirements have direct influential impacts on exports markets. In view of the demand for trade, quality in vegetables is indeed an important intrinsic attribute that enhances product differentiation, which is seen as a tool to gain competitive advantage in food trade.

The force of market trend that requires higher quality vegetables is also increasingly significant in domestic agri-food market. Recent previous studies (Traill, 2006; Reardon and Timmer, 2005; World Bank, 2007) suggested that the force is highly attributed to super- and hypermarkets that play remarkably role in food systems, especially in developing and emerging economies, like Malaysia. The emphasis on vegetable quality is a crucial strategy to stay competitive while offering cost efficient fresh products in order to overcome the stiff competition in the liberalized food market. The influence of the strategy is reported in Shamsudin and Selamat (2005). It was reported that 70% of Malaysians prefer to purchase fresh food products at super- and hypermarkets.

Estimation procedures

This study adopts the theoretical framework developed by Hassan and Johnson (1977) which is based on Engel theory to undertake cross-sectional demand analyses, with respects to obtain expenditure, quantity, and quality elasticities. The same approach is also empirically used by Sarma *et al.* (1979), Alderman and Garcia (1993), Douglas and Isherwood (1996), and Gale and Huang (2007). The Engel curve can be expressed as:

$$e_i(y) = p_i q_i(y) \quad (1)$$

where e_i is consumer expenditure on *i*th vegetable, p_i is price of *i*th vegetable, and q_i is quantity purchase of *i*th vegetable. The e_i and p_i are assumed to be independent of y, which is consumer income. By holding price constant, the equation reflects changes in the quantity purchased, while viewing the relationship between e and y.

In order to obtain the quality effect in the Engel curve, Gale and Huang (2007) suggested a replacement of unit value , $v'_i(y)$, for price in equation 1:

$$e_i(y) = v_i(y) q_i(y) \quad (2)$$

A derivation of equation 2 will have:

$$\frac{d \ln e_i}{d \ln y} = \frac{d \ln v_i}{d \ln y} + \frac{d \ln q_i}{d \ln y} \quad (3)$$

which can be further expressed as:

$$\varepsilon_i = \theta_i + \eta_i \quad (4)$$

where the expenditure elasticity, ε_i, is the sum of the quality elasticity, θ_i, and the quantity elasticity, η_i. By using equation 4, the quality elasticity, θ_i can be obtained from:

$$\theta_i = \varepsilon_i - \eta_i \quad (5)$$

This study extends the framework used in previous studies (Hassan and Johnson, 1977; Sarma *et al.*, 1979; Alderman and Garcia, 1993; Douglas and Isherwood, 1996; Gale and Huang, 2007) by including demographic variables in the estimation procedures. As suggested by Pollak and Wales (1992), the demand for food is not only determined by economic factors, but also by demographic factors. For example, older group of consumers are generally more health conscious and consume more vegetables than younger group of consumers. The omission of these demographic in a demand model may have the effects of income on food demand overestimated.

While most of the previous studies (Hassan and Johnson, 1977; Sarma *et al.*, 1979; Alderman and Garcia, 1993; Douglas and Isherwood, 1996) estimated linearized Engel curve, recent previous study by Gale and Huang (2007) obtained the elasticities via non-linear Engel estimation procedures. Banks *et al.* (1997) argued that a complete description of consumer behavior requires a specification of both Engel curve and relative price effects consistent with utility maximization. To be more specific, a linear Engel curve does not provide an accurate picture of individual behavior. Gale and Huang (2007) suggested that non-linear Engel relationships may reflect physical saturation of demand, which produces more plausible estimates of demand elasticities. This is because such functional form preserves the flexibility of Engel curve while permitting consistency with utility theory and is shown to allow flexible relative price effects (Banks *et al.*, 1997). Hence, the Engel equations in this study can be estimated via weighted least squares. A non-linear expenditure equation is specified and can be expressed as:

$$\ln e_{ij} = \alpha_i + \gamma_1 (1/y_j) + \gamma_2 \ln y_j + \gamma_i D_j + u_{ij} \quad (6)$$

where *i* represents the *i*th vegetable, *j* is the *j*th household, *e* represents per capita expenditure on *i*th vegetable, *y* is the per capita income, *D* is a set of demographic variables (household size, employment

status, urban region, race, age and gender of respondent), and u is a random disturbance term.

From Equation 6, the expenditure elasticity of the ith vegetable, ε_i, can be estimated by:

$$\varepsilon_i = -\gamma_1 / y_j + \gamma_2 \quad (7)$$

A non-linear quantity equation can be expressed as:

$$\ln q_{ij} = \alpha_i + \beta_1 (1/y_j) + \beta_2 \ln y_j + \beta_i D_j + u_{ij} \quad (8)$$

where q is the per capita quantity of the vegetable consumed and other variables are as defined earlier.

From Equation 8, the quantity elasticity of the ith vegetable, η_i, can be estimated by:

$$\eta_i = \beta_1 / y_j + \beta_2 \quad (9)$$

After obtaining the estimates of quantity (η_i) and expenditure elasticities (ε_i), quality elasticity, θ_i, can be derived from the difference between of the estimates:

$$\theta_i = \varepsilon_i - \eta_i \quad (10)$$

Data

The estimation procedures above are estimated with Household Expenditure Survey 2004/2005 data. The survey consists of 14,084 sample size in total that formed by 9,467 and 4,617 respondents from urban and rural regions. Similarly, the analyses are done based on three bases, namely nationwide, urban and rural regions. The reason for such classification is two-fold. One, per capita income of Malaysian in urban region is generally higher than those in rural region. Statistically, average per capita monthly income in urban region was RM620.89 compared to RM367.12 in rural region. Second, most of the super- and hypermarkets are located in urban, which can in turn result in higher demand for quality vegetables amongst consumers in urban region.

The selected demographic variables are per capita monthly income, household size, age of respondent, employment status of respondent, gender of respondent, and race of respondent. Definitions of these variables and their selected sample statistics are presented in Table 1.

Results and Discussion

Appendix tables 1, 2, and 3 present the regression results for expenditure Engel equations of urban, rural, and Malaysia (total) respectively. Both the γ_1 and γ_2 parameters are statistically significant in most of the equations. It is noteworthy that there is negative relationship between expenditures on vegetable and household size in all cases due to the economies of scale enjoyed as household size expands. The estimate of age is positive and significant in most cases, except in root and tuberous vegetable and processed vegetable in urban region. This suggests that older consumers spent more on vegetables than younger consumer. There are variation of significance level and sign in the cases of gender, employment status, and ethnic. It is also observed that estimate of urban dummy variable are significant and negative in most cases of Malaysia, suggesting that consumers in rural region expend more on vegetables than those in urban region.

Table 2 presents the estimated expenditure elasticity for the various vegetables. Overall, all the estimates of expenditure elasticity are inelastic. These results indicate that consumers tend to spend slightly more on root and tuberous vegetable than other vegetables as their incomes rise. The expenditure elasticity for vegetables ranges from 0.1399 to 0.3870 in total (whole Malaysia). The comparison of the estimated expenditure elasticities between urban and rural regions show that the magnitude of the elasticities decreases as consumers move

Table 1. Variable definition and selected sample statistics

Variable	Definition	Urban (N=9467)		Rural (N=4617)		Total (N=14084)	
		Mean	Std. Deviation	Mean	Std. Deviation	Mean	Std. Deviation
Y	Per capita monthly income (RM)	620.8875	602.3059	367.1226	311.1814	537.6986	508.5365
HHSIZE	Household size	4.3062	2.2077	4.4462	2.2445	4.3521	2.2207
AGE	Age of respondent	45.3314	13.7066	49.9391	14.2706	46.8419	14.0609
EMPLOYED	1 if respondent is employed, 0 otherwise.	0.7918	0.4060	0.7901	0.4073	0.7913	0.4064
MALE	1 if respondent is male, 0 otherwise.	0.8398	0.3668	0.8410	0.3657	0.8402	0.3665
MALAY	1 if household head is Malay, 0 otherwise. Base = household head is other race/ethnic	0.4918	0.5000	0.7169	0.4505	0.5656	0.4957
CHINESE	1 if household head is Chinese, 0 otherwise. Base = household head is other race/ethnic	0.2934	0.4554	0.0914	0.2882	0.2272	0.4190
INDIAN	1 if household head is Indian, 0 otherwise. Base = household head is other race/ethnic	0.0696	0.2545	0.0327	0.1779	0.0575	0.2328
URBAN	1 if household resides in urban region, 0 otherwise.	-	-	-	-	0.6722	0.4694
E1	Expenditure (RM) on leafy and salad vegetable	4.1905	4.7842	3.7508	3.5716	4.0463	4.4281
E2	Expenditure (RM) on bulb and stem vegetable	1.4061	2.3959	1.5466	1.8241	1.4521	2.2256
E3	Expenditure (RM) on Fruiting and flowering vegetable	2.3002	3.2758	2.2880	2.7118	2.2962	3.1021
E4	Expenditure (RM) on root and tuberous vegetable	1.1149	2.0142	0.9421	1.4417	1.0583	1.8479
E5	Expenditure (RM) on podded vegetable	0.9823	1.5235	1.0753	1.5318	1.0128	1.5268
E6	Expenditure (RM) on processed vegetable	1.4801	3.6031	1.0686	1.9438	1.3452	3.1626
Q1	Quantity (kg) purchased-Leafy and salad vegetable	2.2307	2.4334	2.1833	2.0686	2.2151	2.3202
Q2	Quantity (kg) purchased-Bulb and stem vegetable	0.4263	0.6086	0.4877	0.5949	0.4464	0.6048
Q3	Quantity (kg) purchased-Fruiting and flowering vegetable	1.0842	1.9028	1.0325	1.4753	1.0673	1.7742
Q4	Quantity (kg) purchased-Root and tuberous vegetable	0.4505	0.8562	0.4080	0.7011	0.4366	0.8089
Q5	Quantity (kg) purchased-Podded vegetable	0.3173	0.5099	0.3324	0.4839	0.3222	0.5016
Q6	Quantity (kg) purchased-Processed vegetable	0.5275	1.3388	0.4285	0.8704	0.4951	1.2063

Table 2. Expenditure elasticity of vegetables

	Urban	Rural	Total
Leafy and salad vegetable	0.1612	0.2389	0.2142
Bulb and stem vegetable	0.1120	0.2483	0.1399
Fruiting and flowering vegetable	0.2240	0.2722	0.1975
Root and tuberous vegetable	0.3178	0.3077	0.3870
Podded vegetable	0.1592	0.1746	0.2537
Processed vegetable	0.2417	0.3083	0.3747

Table 3. Quantity Elasticity of Vegetables

	Urban	Rural	Total
Leafy and salad vegetable	-0.2250	0.0286	-0.1599
Bulb and stem vegetable	-0.0156	0.4222	0.1197
Fruiting and flowering vegetable	0.0252	0.2677	0.0265
Root and tuberous vegetable	0.3800	0.8253	0.5054
Podded vegetable	-0.0806	-0.1201	0.1692
Processed vegetable	-0.0788	0.3604	0.2455

from rural to urban (except in root and tuberous vegetable). The reasoning of these results is built on the estimates of quantity elasticity.

Appendix tables 4, 5, and 6 present the regression results for quantity Engel equations of urban, rural, and Malaysia (total) respectively. Per capita monthly income is found to be positively and significantly related to the quantity consumed in most cases (except in leafy and salad vegetable of rural and Malaysia (total). Consistent with the *priori* expectation, estimate of household size is significant and negative in all cases. This can be because large households may consume more variety of vegetables or replace with other foods, like vegetable, owing to possible different preferences. As expected, the estimate of age is positive and significant in most cases. Higher consumption of vegetables amongst older consumers is probably mostly attributed to health consciousness and nutrition and diet needs. The sign and significance of estimates for gender, employment status, and ethnic variables vary across cases. It is also found there is negative relationship between urban dummy variable and quantity consumed in Malaysia. These results are consistent with economists' observation that urban population consumes more meat than vegetables.

Table 3 presents the estimated quantity elasticity for the various vegetables. Overall, all the estimates of expenditure elasticity are less than 1 but the sign of magnitude varies across the cases. Quantity-income elasticities decrease in magnitude as they move from rural to urban. For example, the leafy and salad vegetable is positive at 0.0286 in rural region and decline to negative at -0.2250 in urban region. To be more specific, the estimated quantity elasticities are negative or close to zero for most food items (except root and tuberous vegetable) in urban region. This suggests that urban population is approaching saturation levels of quantity consumed. Such results explain why the estimated

Table 4. Quality Elasticity of Vegetables

	Urban	Rural	Total
Leafy and salad vegetable	0.3862	0.2102	0.3741
Bulb and stem vegetable	0.1277	-0.1739	0.0202
Fruiting and flowering vegetable	0.1988	0.0044	0.1710
Root and tuberous vegetable	-0.0623	-0.5176	-0.1184
Podded vegetable	0.2399	0.2947	0.0845
Processed vegetable	0.3206	-0.0521	0.1292

expenditure elasticities between urban and rural regions show that the magnitude of the elasticities decreases as consumers move from rural to urban in earlier session. Most estimated quantity elasticities are smaller in magnitude than the corresponding estimated expenditure elasticities, reflecting a "quality" effect whereby quantity purchased decreases observing expenditures on most vegetables increase at the same time. These results indicate that urban consumers tend to spend slightly more on vegetables (except root and tuberous vegetable) as their incomes rise, although they reduce the amount of most vegetables they purchase.

The difference between the estimated expenditure and quantity consumers yielded estimates of quality elasticities as presented in Table 4. In total, all but one of the vegetable categories have positive quality elasticities greater than zero, suggesting that Malaysian consumers purchase higher quality vegetables, especially leafy and salad vegetable as their incomes rise. It is observed that urban consumers tend to demand higher quality in most of the vegetables (except root and tuberous vegetable) while rural consumers tend to demand higher quality in leafy and salad vegetable, fruiting and flowering vegetable and podded vegetable. Consistent with *priori* expectation, urban consumers tend to demand for higher quality vegetables than rural consumers (except podded vegetable). The most significant difference is found in the case of bulb and stem vegetable and processed vegetable. The difference in the quality elasticities also reflects a change in the demand for quality as they move from rural to urban region. This is probably caused by the higher income level in urban, as well as change in lifestyle.

Conclusions

This study estimates quality elasticities from the difference between expenditure and quantity elasticities in order to show the demand for quality vegetables in Malaysia. By using the Household Expenditure Survey 2004/2005, expenditure and quantity Engel equations are estimated via two stage least square. The positive estimated quality elasticities (except root and tuberous vegetable) show that Malaysian consumers tend to increase their demand for quality vegetables in response to their incomes rise. To be more specific, urban consumers are expected to demand more of higher quality vegetables (except root and tuberous vegetable) than rural consumers.

Increasing consumer demand for quality vegetables would entail for the development of food markets in terms of market segments and quality improvements. For example, vegetables in the segment of organic fresh produce market are generally perceived to be higher quality. One of the most important attributes of quality is food safety. The force of demand for quality can be observed from the findings in this result. It can be predicted that the change in the form of demand will facilitate a better

designed food, agricultural, and trade policies, both domestically and internationally.

On the other hand, there is a vital challenge in convincing consumers to pay for higher quality fresh produce. Product developments in terms of quality, safety, and certification are costs to producers. The marketability of quality fresh produce is not laid on the demand only, but also the pricing strategy. Casswell and Joseph (2007) found out that though the more elite market segments are thriving and reaching growing numbers of consumers, the basic price/quality markets remain strong, especially where lower income consumers face increasing budget challenges. The best solution is probably to do mass production which is able to reduce the total production cost marginally and subsequently more affordable to consumers. Geeroms *et al.* (2008) suggested that there is positive relationship between attitude toward advertising targeted to the segment's health-related motives and behavioural intention. Further initiative like advertising can be useful in persuading consumers to consume higher quality vegetables, which are seen as health foods.

References

Alderman, H. and Garcia, M. 1993. Poverty, household food security, and nutrition in rural Pakistan. International Food Policy Research Institute, Research report: No. 96.

Banks, J., Blundell, R. and Lewbel, A. 1997. Quadratic Engel curves and consumer demand. The Review of Economics and Statistics 79 (4): 527-539.

Caswell, J.A. and Joseph, S. 2007. Consumer demand for quality: Major determinant for agricultural and food trade in the future? University of Massachusettes Amherst, Working paper No. 2007-4.

Douglas, M. and Isherwood, B. 1996. The world of goods: Towards an anthropology of consumption. (2nd ed.). Routledge, London.

FAMA 1993. Time series data: Vegetables, 1982-1991. Agricultural Marketing Information System, Ministry of Agriculture, Malaysia.

Food and Agriculture Organization of the United Nations 2007. FAO statistical yearbook - Country profiles. Downloaded from http://www.fao.org/ES/ESS/yearbook/vol_1_2/pdf/Malaysia.pdf on 25/06/2007.

Food and Agriculture Organization of the United Nations 2009. FAO's Food Quality and Standards Service. Downloaded from ftp://ftp.fao.org/es/esn/food/meetings/2005/tanzania/ffv_info_note.pdf on 25/02/2009.

Gale, F. and Huang, K. 2007. Demand for food quantity and quality in China. Economic Research Service, United States Department of Agriculture, Economic Research Report Number 32.

Geeroms, N., Verbeke, W. and Van Kenhove, P. 2008. Health advertising to promote fruit and vegetable intake: Application of health-related motive segmentation. Food Quality and Preference 19: 481-497.

Hassan, Z.A. and Johnson, S.R. 1977. Urban food consumption patterns in Canada: An empirical analysis, Agriculture Canada Publication No. 77/1.

Ishida, A., Law, S.H. and Aita, Y. 2003. Changes in food consumption expenditure in Malaysia. Agribusiness 9 (1): 61-76.

Ministry of Agriculture and Agro-based Industry. 2006. Agriculture Statistical Handbook, Putrajaya.

Radam, A., Arshad, F.M. and Mohamed, Z.A. 2005. The fruits industry in Malaysia: Issues and challenges. (Ed.). UPM Press.

Reardon, T., Timmer, P., Barrett, C. and Berdegué, J. 2003. The rise of supermarkets in Africa, Asia, and Latin America. American Journal Agricultural Economics 85 (5): 1140-1146.

Reardon, T. and Timmer, P. 2005. Transformation of markets for agricultural output in developing countries since 1950: How has thinking changed? In (Eds.) Evenson, R.E., Pingali, P. and Schultz, T.P. Handbook of agricultural economics: Agricultural development: Farmers, farm production and farm markets. Elsevier Press, Amsterdam.

Sarma, J. S., Shyamal, R. and George, P.S. 1979. Two analyses of Indian foodgrain production and consumption data. International Food Policy Research Institute. Research report: No. 12.

Shamsudin, M.D. and Selamat, J. 2005. Changing retail food sector in Malaysia. Paper presented at the PECC Pacific Food System Outlook 2005-06 Annual Meeting, May 11–13, 2005. Kun Ming, China.

Swinnen, J. 2007. Global supply chains, standards and the poor. (Ed.). CABI Publishing.

Pollak, R.A. and Wales, T.J. 1992. Demand system specification and estimation. Oxford: University Press.

Tey, Y. S., Mad Nasir S., Zainalabidin M., Amin Mahir A. and Alias R. 2008a. A complete demand system of food in Malaysia. ICFAI University Journal of Agricultural Economics 5 (3): 17-29.

Tey, Y.S., Mad Nasir S., Zainalabidin M., Amin Mahir A. and Alias R. 2008b. Complete demand systems of food in Malaysia. Agricultural Economics - Czech 54 (10): 467-475.

Traill, B. 2006. The rapid rise of supermarkets? Development Policy Review 24 (2): 163-174.

World Bank. 2007. World development report 2008: Agriculture for development, World Bank/Oxford University, Washington DC.

Appendix tables 1

Expenditure model estimates for urban region

	Leafy and salad vegetable	Bulb and stem vegetable	Fruiting and flowering vegetable	Root and tuberous vegetable	Podded vegetable	Processed vegetable
	Coefficient (Std. Error)	**Coefficient (Std. Error)**	**Coefficient (Std. Error)**	**Coefficient (Std. Error)**	**Coefficient (Std. Error)**	**Coefficient (Std. Error)**
Intercept	-0.0740	-1.0764	-1.4133	-2.2501	0.2884	-1.2108
	(0.3502)	(0.3295)***	(0.4160)***	(0.4530)***	(0.4114)	(0.4824)**
1/Y	-30.5542	25.4134	-26.7224	70.4017	-40.6236	16.9797
	(9.7770)***	(7.9585)***	(12.5047)**	(12.9249)***	(10.6994)***	(12.1284)
LOG(Y)	0.1556	0.3175	0.1994	0.4995	0.0639	0.3545
	(0.0431)***	(0.0411)***	(0.0535)***	(0.0583)***	(0.0532)	(0.0596)***
LOG(HHSIZE)	-0.4229	-0.6421	-0.4403	-0.6149	-0.6596	-0.5400
	(0.0249)***	(0.0266)***	(0.0290)***	(0.0344)***	(0.0292)***	(0.0361)***
LOG(AGE)	0.3432	0.1107	0.4794	0.0530	0.1355	-0.0238
	(0.0446)***	(0.0472)**	(0.0508)***	(0.0579)	(0.0519)***	(0.0650)
MALE	-0.0828	-0.0664	-0.0334	0.0448	0.0523	0.0657
	(0.0347)**	(0.0390)*	(0.0404)	(0.0451)	(0.0412)	(0.0493)
EMPLOYED	0.0250	0.1255	0.0606	-0.0955	0.0194	-0.0295
	(0.0333)	(0.0366)***	(0.0382)	(0.0441)**	(0.0417)	(0.0488)
MALAY	-0.4644	-0.2159	-0.4105	-0.3273	-0.3396	-0.2378
	(0.0320)***	(0.0309)***	(0.0355)***	(0.0371)***	(0.0316)***	(0.0387)***
CHINESE	0.1043	-0.2254	-0.1972	-0.0157	-0.0838	0.3290
	(0.0472)**	(0.0530)***	(0.0564)***	(0.0600)	(0.0579)	(0.0673)***
INDIAN	-0.3059	-0.0981	-0.0821	0.2584	0.0562	0.1699
	(0.0662)***	(0.0807)	(0.0833)	(0.0995)***	(0.0873)	(0.1097)

Note: Significance levels are denoted by *** for 1%, ** for 5%, and * for 10%

Appendix tables 2

Expenditure model estimates for rural Region

	Leafy and salad vegetable	**Bulb and stem vegetable**	**Fruiting and flowering vegetable**	**Root and tuberous vegetable**	**Podded vegetable**	**Processed vegetable**
	Coefficient (Std. Error)	**Coefficient (Std. Error)**	**Coefficient (Std. Error)**	**Coefficient (Std. Error)**	**Coefficient (Std. Error)**	**Coefficient (Std. Error)**
Intercept	0.4173	-0.0712	-0.9591	-1.5996	0.4008	-0.5444
	(0.2533)*	(0.2451)	(0.2941)***	(0.3181)***	(0.3106)	(0.3596)
1/Y	-83.8867	-40.1372	-80.2516	-30.0431	-93.8355	-43.4115
	(9.7949)***	(7.6193)***	(10.6822)***	(10.4993)***	(9.7868)***	(13.7968)***
LOG(Y)	0.0261	0.0474	0.0948	0.2694	0.0081	0.1718
	(0.0297)	(0.0292)	(0.0350)***	(0.0378)***	(0.0374)*	(0.0434)***
LOG(HHSIZE)	-0.3438	-0.5956	-0.3230	-0.4033	-0.5611	-0.5695
	(0.0203)***	(0.0209)***	(0.0236)***	(0.0266)***	(0.0252)***	(0.0297)***
LOG(AGE)	0.4212	0.3024	0.4707	0.2026	0.1873	0.1394
	(0.0363)***	(0.0369)***	(0.0419)***	(0.0480)***	(0.0465)***	(0.0532)***
MALE	-0.0257	0.0033	-0.0396	-0.0441	0.0879	0.1273
	(0.0273)	(0.0272)	(0.0319)	(0.0351)	(0.0335)***	(0.0388)***
EMPLOYED	-0.0465	0.0696	-0.0090	0.0076	-0.0771	-0.1048
	(0.0264)*	(0.0268)***	(0.0310)	(0.0344)	(0.0330)**	(0.0381)***
MALAY	-0.5021	-0.2138	-0.3115	-0.5026	-0.4516	-0.1865
	(0.0274)***	(0.0262)***	(0.0319)***	(0.0324)***	(0.0299)***	(0.0385)***
CHINESE	0.1117	-0.2464	0.0063	0.1414	-0.0991	0.2373
	(0.0308)***	(0.0324)***	(0.0377)	(0.0395)***	(0.0386)**	(0.0440)***
INDIAN	-0.2614	-0.0231	0.2327	0.2949	0.2337	0.0121
	(0.0401)***	(0.0481)	(0.0497)***	(0.0606)***	(0.0611)***	(0.0626)

Note: Significance levels are denoted by *** for 1%, ** for 5%, and * for 10%

Appendix tables 3

Expenditure model estimates for Malaysia

	Leafy and salad vegetable	**Bulb and stem vegetable**	**Fruiting and flowering vegetable**	**Root and tuberous vegetable**	**Podded vegetable**	**Processed vegetable**
	Coefficient (Std. Error)	**Coefficient (Std. Error)**	**Coefficient (Std. Error)**	**Coefficient (Std. Error)**	**Coefficient (Std. Error)**	**Coefficient (Std. Error)**
Intercept	0.4253	-0.0743	-0.5697	-2.0459	-0.5838	-1.6151
	(0.2011)**	(0.2101)	(0.2393)**	(0.2430)***	(0.2472)**	(0.3006)***
1/Y	-67.6103	-24.5767	-63.3632	12.2316	-32.9081	-15.0237
	(7.1175)***	(6.2901)***	(7.7589)***	(6.7526)*	(7.2528)***	(10.3300)
LOG(Y)	0.0884	0.0942	0.0797	0.4097	0.1925	0.3468
	(0.0240)***	(0.0257)***	(0.0285)***	(0.0282)***	(0.0298)***	(0.0367)***
LOG(HHSIZE)	-0.3621	-0.6175	-0.4050	-0.4537	-0.5724	-0.5026
	(0.0154)***	(0.0166)***	(0.0184)***	(0.0202)***	(0.0189)***	(0.0240)***
LOG(AGE)	0.3251	0.2187	0.4288	0.1171	0.1604	0.1101
	(0.0279)***	(0.0292)***	(0.0332)***	(0.0354)***	(0.0342)***	(0.0408)***
MALE	-0.0222	-0.0067	0.0210	-0.0318	0.0170	-0.0274
	(0.0214)	(0.0224)	(0.0252)	(0.0270)	(0.0263)	(0.0314)
EMPLOYED	-0.0236	0.0875	-0.0130	-0.0338	-0.0384	-0.0202
	(0.0205)	(0.0221)***	(0.0244)	(0.0262)	(0.0251)	(0.0307)
MALAY	-0.4792	-0.1791	-0.3014	-0.5208	-0.4124	-0.1991
	(0.0209)***	(0.0198)***	(0.0247)***	(0.0246)***	(0.0227)***	(0.0299)***
CHINESE	0.1654	-0.2169	-0.0217	0.1129	-0.0959	0.3984
	(0.0251)***	(0.0273)***	(0.0309)	(0.0311)***	(0.0312)***	(0.0365)***
INDIAN	-0.2482	0.0025	0.2759	0.0800	0.1891	0.0534
	(0.0347)***	(0.0409)	(0.0430)***	(0.0500)	(0.0484)***	(0.0532)
URBAN	-0.1010	-0.0389	-0.1093	0.0131	-0.1503	-0.0179
	(0.0160)***	(0.0164)**	(0.0185)***	(0.0199)	(0.0187)***	(0.0241)

Note: Significance levels are denoted by *** for 1%, ** for 5%, and * for 10%.

Appendix tables 4

Quantity model estimates for urban region

	Leafy and salad vegetable	Bulb and stem vegetable	Fruiting and flowering vegetable	Root and tuberous vegetable	Podded vegetable	Processed vegetable
	Coefficient (Std. Error)	**Coefficient (Std. Error)**	**Coefficient (Std. Error)**	**Coefficient (Std. Error)**	**Coefficient (Std. Error)**	**Coefficient (Std. Error)**
Intercept	-0.4208	-2.5917	-3.1984	-3.2210	-0.2767	-1.0603
	(0.3544)	(0.3679)***	(0.4950)***	(0.4842)***	(0.3725)	(0.4973)**
1/Y	-32.6283	22.9962	-2.7329	109.3708	-48.5783	35.4045
	(9.9078)***	(8.8870)***	(13.8917)	(12.4721)***	(9.0468)***	(10.9546)***
LOG(Y)	0.1175	0.3595	0.2752	0.5274	0.0122	0.2639
	(0.0437)***	(0.0458)***	(0.0645)***	(0.0628)***	(0.0504)*	(0.0627)***
LOG(HHSIZE)	-0.4405	-0.6240	-0.4201	-0.6951	-0.6027	-0.7270
	(0.0252)***	(0.0297)***	(0.0362)***	(0.0378)***	(0.0271)***	(0.0388)***
LOG(AGE)	0.3629	0.0664	0.5647	0.0619	0.1246	-0.1748
	(0.0450)***	(0.0527)	(0.0618)***	(0.0623)	(0.0474)***	(0.0688)**
MALE	-0.0874	-0.0762	0.0226	0.0921	0.0488	0.2221
	(0.0352)**	(0.0436)*	(0.0508)	(0.0492)*	(0.0404)	(0.0540)***
EMPLOYED	0.0316	0.1206	0.0606	0.0107	-0.0275	-0.1071
	(0.0338)	(0.0409)***	(0.0486)	(0.0497)	(0.0432)	(0.0563)*
MALAY	-0.4803	0.0543	-0.5702	-0.6841	-0.6893	-0.2076
	(0.0321)***	(0.0345)	(0.0394)***	(0.0398)***	(0.0290)***	(0.0399)***
CHINESE	0.0070	-0.0331	-0.2135	-0.1978	-0.2672	0.5096
	(0.0479)	(0.0592)	(0.0700)***	(0.0636)***	(0.0593)***	(0.0773)***
INDIAN	-0.3038	0.1678	-0.3522	-0.2684	-0.1177	0.0224
	(0.0681)***	(0.0901)*	(0.1093)***	(0.1166)**	(0.1020)	(0.1378)

Note: Significance levels are denoted by *** for 1%, ** for 5%, and * for 10%

Appendix tables 5

Quantity model estimates for rural region

	Leafy and salad vegetable	**Bulb and stem vegetable**	**Fruiting and flowering vegetable**	**Root and tuberous vegetable**	**Podded vegetable**	**Processed vegetable**
	Coefficient (Std. Error)	**Coefficient (Std. Error)**	**Coefficient (Std. Error)**	**Coefficient (Std. Error)**	**Coefficient (Std. Error)**	**Coefficient (Std. Error)**
Intercept	0.4782	-1.6981	-2.6193	-3.3071	-0.9285	-0.0742
	(0.2510)*	(0.2684)***	(0.3711)***	(0.3449)***	(0.3045)***	(0.4142)*
1/Y	-92.3781	-50.5926	-78.5507	10.8753	-80.6520	-67.8520
	(9.5634)***	(7.5399)***	(13.0843)***	(10.8866)	(9.0638)***	(15.1947)***
LOG(Y)	-0.0762	0.0658	0.1517	0.3625	0.0493	0.0304
	(0.0293)***	(0.0326)**	(0.0446)***	(0.0414)***	(0.0370)	(0.0507)
LOG(HHSIZE)	-0.3987	-0.5258	-0.1954	-0.3634	-0.5267	-0.6678
	(0.0203)***	(0.0227)***	(0.0296)***	(0.0286)***	(0.0247)***	(0.0347)***
LOG(AGE)	0.4413	0.3180	0.5229	0.2373	0.1760	0.0261
	(0.0362)***	(0.0406)***	(0.0524)***	(0.0516)***	(0.0458)***	(0.0610)
MALE	-0.0177	-0.0405	-0.0539	0.0650	0.1113	0.2402
	(0.0272)	(0.0300)	(0.0400)	(0.0376)*	(0.0330)***	(0.0460)***
EMPLOYED	-0.0325	0.0973	-0.0358	0.0063	-0.0911	-0.1668
	(0.0263)	(0.0295)***	(0.0389)	(0.0373)	(0.0325)***	(0.0437)***
MALAY	-0.4997	0.0236	-0.3584	-0.7149	-0.5357	-0.3333
	(0.0271)***	(0.0264)	(0.0401)***	(0.0350)***	(0.0296)***	(0.0438)***
CHINESE	0.0012	-0.0658	0.1452	-0.0720	-0.1779	0.2313
	(0.0306)	(0.0354)*	(0.0481)***	(0.0437)*	(0.0401)***	(0.0521)***
INDIAN	-0.2785	0.2770	0.0568	-0.0439	0.1119	-0.1615
	(0.0401)***	(0.0661)***	(0.0652)	(0.0713)	(0.0736)	(0.0809)**

Note: Significance levels are denoted by *** for 1%, ** for 5%, and * for 10%

Appendix tables 6

Quantity model estimates for Malaysia

	Leafy and salad vegetable	Bulb and stem vegetable	Fruiting and flowering vegetable	Root and tuberous vegetable	Podded vegetable	Processed vegetable
	Coefficient (Std. Error)	**Coefficient (Std. Error)**	**Coefficient (Std. Error)**	**Coefficient (Std. Error)**	**Coefficient (Std. Error)**	**Coefficient (Std. Error)**
Intercept	0.5620	-1.9124	-2.0043	-2.9446	-1.7855	-1.6017
	(0.2018)***	(0.2250)***	(0.3015)***	(0.2665)***	(0.2409)***	(0.3369)***
1/Y	-77.9300	-19.6552	-58.4970	38.2769	-27.5927	-8.3575
	(7.0928)***	(6.2296)***	(9.4566)***	(7.1834)***	(6.7324)***	(11.1106)*
LOG(Y)	-0.0150	0.1562	0.1353	0.4342	0.2205	0.2610
	(0.0240)*	(0.0284)***	(0.0360)***	(0.0312)***	(0.0295)***	(0.0420)***
LOG(HHSIZE)	-0.4052	-0.6331	-0.2871	-0.4342	-0.5452	-0.6606
	(0.0156)***	(0.0179)***	(0.0233)***	(0.0219)***	(0.0183)***	(0.0275)***
LOG(AGE)	0.3297	0.2309	0.4243	0.0872	0.1561	0.0088
	(0.0281)***	(0.0311)***	(0.0418)***	(0.0387)**	(0.0330)***	(0.0456)
MALE	-0.0110	-0.0453	0.0090	0.0249	0.0493	0.0520
	(0.0216))	(0.0238)*	(0.0318)	(0.0293)	(0.0254)*	(0.0359)
EMPLOYED	-0.0272	0.1544	-0.0526	-0.0290	-0.0609	-0.0515
	(0.0206)	(0.0245)***	(0.0310)*	(0.0286)	(0.0247)**	(0.0352)
MALAY	-0.4819	0.1193	-0.3255	-0.7703	-0.5939	-0.2428
	(0.0208***	(0.0191)***	(0.0301)***	(0.0264)***	(0.0213)***	(0.0323)***
CHINESE	0.0476	-0.0756	0.1324	-0.1064	-0.2417	0.4542
	(0.0251)*	(0.0298)**	(0.0387)***	(0.0342)***	(0.0311)***	(0.0412)***
INDIAN	-0.2526	0.2863	0.1328	-0.3358	-0.0048	-0.0807
	(0.0350)***	(0.0550)***	(0.0570)**	(0.0588)***	(0.0567)	(0.0653)
URBAN	-0.1059	-0.0630	-0.1152	0.0097	-0.1181	-0.0206
	(0.0161)***	(0.0179)***	(0.0233)***	(0.0218)	(0.0180)***	(0.0269)

Note: Significance levels are denoted by *** for 1%, ** for 5%, and * for 10%.