Research Article

Quality Elasticity of Vegetable Consumption in Pakistan: A Comparison of Urban and Rural Households

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Abstract | The study estimated quantity, expenditure and quality elasticities for five vegetables namely potato, onion, tomato, cabbage & cauliflower and peas, mostly consumed in Pakistan. A comparison of quality elasticity between urban and rural households is provided using Household Integrated Economic Survey (HIES) data from Pakistan Social and Standards Living Measurement (PSLM) 2010-11. The elasticities of interest were obtained via log-log inverse (LLI) functional form of Engel equation. The quantity and expenditure elasticities remained less than unity with reasonable difference in magnitude across urban and rural households. Quantity and expenditure elasticities of all the vegetables were higher for rural households than urban. Quality elasticities for the products under study were calculated as the difference between the expenditure and the corresponding quantity elasticities. Overall, the quality elasticities turned out to be positive (except tomato) with an estimated value of 0.0328, 0.019, 0.0712 and 0.1115 for potato, onion, cabbage & cauliflower and peas respectively implying that households in Pakistan purchase higher quality vegetables as their income rises. To be more specific, the quality elasticities for potato, cabbage & cauliflower and peas were lower for rural households compared to urban ones, suggesting that urban households are spending relatively more on vegetables quality (except onion and tomato). Hence, from the policy point of view, evidence of positive demand for quality vegetables would facilitate devising food policy for the development of food markets in terms of market segmentation and quality improvements in Pakistan.

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Introduction

Vegetables are the fresh and edible portions of herbaceous plants, considered an important food and highly beneficial for the maintenance of health and prevention of diseases (Robinson, 1990). Vegetables are valued in terms of nutrients and therefore, less developed countries, especially South Asian States have vegetable dietary habits. Hence these poor countries grow and consume much more vegetables for their main food requirements. Pakistan has majority of urban and rural population surviving on vegetables, which is relishing food due to nutritive value such as vitamins, proteins, Calcium, Phosphorous, Iron, water and mineral salts etc. (Memon, 2013).

During the last five years per capita income (in dollars) in Pakistan has increased at an annual rate of 6.4 percent (GoP, 2012) and the vegetable per capita monthly consumption has shown an increase of 7.27 percent during the period 2007-08 to 2010-11 (GoP, 2011), that reflects a reasonable boost in the purchasing power and quantity of food consumed in general and vegetables in particular. The notion that a rational consumer shifts from quantity to quality especially when higher quality food becomes more affordable

as income rise and which is a reflection of change in consumer tastes and preferences lies in complete conformity with basic economic theory (Deaton, 1997). Most of the previous studies have concentrated heavily on the relationship between the household income and food consumption in the form of income elasticity that only explains the change in food quantity relative to income ignoring the important quality effect. Thus, a review of the literature shows that only a few studies had focused on the demand for food quality (see Gale and Haung, 2007; Jan et al., 2008a; 2008b and 2009a; Tey et al., 2008 and 2009; Yu and Abler, 2009 and Ogundari, 2012). For example, the study by Jan et al. (2008a; 2008b and 2009a) revealed that Pakistani households are willing to pay a higher price for enhanced quality with the increase in income while Tey et al., (2009) found that Malaysian consumer tend to increase their demand for quality vegetables in response to their income rise. Other studies by Gale and Haung, (2007) and Yu and Abler, (2009) both on Chinese households found that as income rises additional spending on food increase with higher unit value (or quality). Similarly, Ogundari, (2012) concluded that households in Nigeria not only increases the quantity demand but tend to demand higher quality of the selected food items. Apart from Jan et al. (2008a; 2008b and 2009a) there seems a dearth of empirical studies on food quality in Pakistan; however, these studies are focused only on fruits and milk consumption. As Pakistan has majority of urban and rural population surviving on vegetables for their main food requirements, so this study is an effort to contribute to existing literature on the food demand analysis by estimating not only the quantity–income elasticity of demand but also quality–income elasticity of demand for vegetables consumption with aim of improving consumer welfare policy in Pakistan. Therefore, the study is designed to estimate quantity, expenditure and quality elasticities for major vegetables in Pakistan and to provide a comparison of vegetable quality response of urban and rural households.

Methodology

Following the pioneer work of Hicks and Johnson (1968) and Hassan and Johnson (1977) and Gale and Huang (2007) presented methodology to capture effect of quality via log-log inverse (LLI) functional form of Engel equation. The same approach is also followed by Jan et al., (2008a; 2008b and 2009a), Tey et al., (2008 and 2009), Yu and Abler, (2009) and Ogundari (2012) to capture a nonlinear relation of consumption and income that allows the income elasticity to vary with income. Gale and Huang (2007) proposed that nonlinear estimates of Engel curve may reflect physical saturation of demand, which presents more reasonable estimates of demand elasticities. Also the LLI approach is suitable when income elasticities decline to zero with rising income/total expenditure. However, the log-log-inverse (LLI) form of Engel equation does not satisfy the adding up criterion, but this will not be a concern because this study is not going to estimate a complete demand system. According to their model, Engel curve expresses the relationship between household expenditure on particular commodity and income, as given in equation (3.1).

$$E_i(Y)=P_i Q_i(Y).....(3.1)$$

Where E_i is household expenditure on ith vegetable, P_i is the price of ith vegetable, and Q_i is the quantity purchased of ith vegetable. The E_i and P_i is assumed to be independent of household income (Y). By holding prices constant, elasticity of expenditure (E) with respect to income (Y) becomes equal to that of quantity (Q)with respect to income (Y); that is:

$$\partial E_i / \partial Y(Y|E)= \partial Q_i / \partial Y(Y|Q).....(3.2)$$

If cross sectional data is taken on consumption, expenditure, income and prices, then it can be assumed that prices do not change in the same year so relationship in equation (3.2) can practically be computed. Equation 3.2 suggests that if there is any increase in the expenditure that will be explicitly due to an increase in quantity consumed. And if any increase in price is observed that would then be because of the improvement in quality.

In order to get the quality effect in the Engel curve, Gale and Huang (2007) suggested a replacement of unit value $V_i(Y)$ in equation (3.1), as follows.

$$E_i(Y)=V_i(Y)\, Q_i(Y).....(3.3)$$

Where $V_i(Y)$ represents variation in prices paid for quality.

Empirically, taking natural log of equation (3.3) and then differentiating it with respect to *lnY*, we get:

$$(\partial lnE_i / \partial lnY)=(\partial lnV_i / \partial lnY)+(\partial lnQ_i / \partial lnY) .....(3.4)$$

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where $(\partial lnE_i / \partial lnY)$ represents expenditure elasticity (ε_i) and $(\partial lnV_i / \partial lnY)$ represents quality elasticity (φ_i) and $(\partial lnQ_i / \partial lnY)$ quantity elasticity (Θ_i); namely.

$$\varepsilon_i = \varphi_i + \Theta_i \quad .....(3.5)$$

To compute quality elasticity (φ_i) Equation (3.5) can be re-arranged, as follows.

$$\varphi_i = \varepsilon_i - \Theta_i .....(3.6)$$

At low income level when income (Y) rises, the effect of income on quantity (Q_i) is positive ($\delta Q_i | \delta Y > 0$), with the second derivative negative ($\delta x^2 Q_i | \delta x^2 Y > 0$) suggesting that at sufficiently low income level almost all goods are normal. While with the further increase in income, ($\delta Q_i | \delta Y > 0$) drops and at some level reaches zero; so in practice, Engel curve is not linear but nonlinear. Thus to capture a nonlinear relationship of consumption (Q_i) and income (Y), the following log-log-inverse (LLI) form of Engel equation can be used.

$$lnQ_{ij} = \alpha + \beta_Q(1/Y_j) + \gamma_Q \ln Y_j + \epsilon_{ij} .....(3.7)$$

where i represents the ith vegetable, j is the jth household, (Q_i) is the quantity of ith vegetable consumed by household, and ϵ is disturbance term. Similarly, for expenditure (E_i) and income (Y) relationship, equation (3.5) can be modified as:

$$lnE_{ij} = \alpha + \beta_E(1/Y_j) + \gamma_E \ln Y_j + \epsilon_{ij} .....(3.8)$$

where E_i represents household expenditure on ith vegetable and other defined as earlier.

The LLI form of Engel relationship given in equations (3.7) and (3.8) being fairly flexible functional form would give values of parameters α, β, γ and if β is equal to zero, the LLI model would simplify to double log model, suggesting constant income elasticities. Similarly, if γ is equal to zero, LLI model would simplify to log inverse model and income elasticity equals $-\beta_Q(1/Y_j)$ Also income elasticity will vary with income but it will never reach to zero or change sign. However, if both β and γ are not equal to zero, then elasticities would be worked out, as follows:

$$\Theta_i = -\beta_Q(1/Y_j) + \gamma_Q .....(3.9)$$

$$\varepsilon_i = -\beta_E(1/Y_j) + \gamma_E .....(3.10)$$

Substituting values of (Θi) and (ε_i) from equations (3.9) and (3.10) into Equation (3.6), the quality elasticity (φ_i) is computed. Variables other than quality that may affect the unit price of the commodity were not reflected in the model due to non-availability of data.

In addition, this study tested the above given models for structural differences across regions in order to see whether the data on households should be pooled in one data set or different models should be estimated for urban and rural areas. Gujrati (2003) outlined the procedure to test structural difference across models through estimation of Chow's F-value as:

$$F=\{(RSS_\gamma - RSS_{u\gamma})/k\} / \{(RSS_{u\gamma})/(n_1+n_2-2k)\} .....(3.11)$$

where RSS_γ is restricted residual sum of squares obtained from pooled data while is $RSS_{u\gamma}$ unrestricted sum of squares obtained from the sum of RSS_1 (residual sum of squares for urban areas), RSS_2 (residual sum of squares for rural areas), n_1 and n_2 are the number of observation in urban and rural area respectively, and k is the number parameters to be estimated. The above given F ratio follows the F distribution with k in numerator and df ($n_1 + n_2 - 2k$). The statistically significant F values would suggest that there is structural break across regions.

A Choice of Total Expenditure as a Proxy of Income

Total expenditure made by the household on all goods and services is sometimes used instead of income because total expenditure reflects the permanent income of the households (Friedman, 1957). As noted by Tansel (1986); Cinar (1987); Manig and Moneta (2009); Ravillion (1992); Cheema (2005) and Jan et al. (2009b) that total consumption expenditure is better to use as a proxy for total income. Therefore, total monthly expenditure was used as a proxy for the household income and calculated through addition of food expenditures, expenditures on housing & fuel and other expenditures.

Data

Data for this study was taken from Household Integrated Economic Survey (HIES) part of Pakistan Social and Standards Living Measurement (PSLM) for the year 2010-11, collected by Pakistan Bureau of Statistics (PBS), Islamabad. For PSLM 2010-11, the total sample was 16341 households taken from 1180 primary sampling units (PSUs) with urban and rural break up of 564 and 616 respectively from four provinces excluding Federally Administered Tribal Areas

Table 1. *Number of Observations, Households Monthly Mean Consumption and Expenditure for Pakistan and by Urban and Rural Households*

Vegetable	Household	Number of Observations	Mean Consumption (in Kg)	Mean Expenditure (in PKR)
Potato	Overall	16218	8.23	221.61
	Urban	6544	7.77	205.81
	Rural	9674	6.35	232.29
Onion	Overall	16239	6.37	207.26
	Urban	6551	6.35	204.33
	Rural	9688	6.39	209.23
Tomato	Overall	14406	3.99	157.63
	Urban	6174	3.78	152.99
	Rural	8232	4.14	161.63
Cabbage & Cauliflower	Overall	8921	3.48	104.06
	Urban	3770	3.29	100.61
	Rural	5151	3.63	106.58
Peas & Moongra	Overall	5629	2.77	105.90
	Urban	2569	2.72	105.80
	Rural	3060	2.81	105.98

Source: PSLM-2010-11 (Government of Pakistan, 2011)

Table 2. *Estimates of Chow's F-test*

Vegetables	2010-11			
	Quantity		Expenditure	
	F-value	p-value	F-value	p-value
Potato	213.919	0.000	215.507	0.000
Onion	93.899	0.000	101.206	0.000
Tomato	76.9591	0.000	82.777	0.000
Cabbage & Cauliflower	133.718	0.000	75.169	0.000
Peas & Moongra	38.098	0.000	31.770	0.000

(FATA), Azad Jammu & Kashmir, and Northern areas and Islamabad capital territory. PSUs consist of enumeration blocks in urban domain and villages in rural domain selected from each stratum using probability to size method of sampling scheme. Region-wise number of observations, households' monthly mean consumption and expenditure of the mentioned vegetables are given in table 1.

Results and Discussion

Models Estimates and Diagnostics

As this study used cross sectional data, the problem of heteroscedasticity is likely to be encountered. To address the issue, all regression equations were estimated with robust standard errors in STATA-12 version. The robust standard errors can effectively deal with minor concerns about normality, heteroscedasticity, or some observations that exhibits large residuals. The point estimates of the coefficients with the robust standard errors are exactly the same as in OLS but the standards errors take in to account problems concerning heterogeneity and lack of normality (Chen et al., 2003). Further, the reasonably large sample size (>100) used in this study relaxes the normality assumption (Gujrati, 2003). Since this study used household level cross sectional data the problem of autocorrelation was not taken as a priori (Hussain, 1991). The results are discussed and interpreted, as follows.

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Table 3. *Estimates of Quantity Equation*

Item/region		α	Standard Error	β_Q	Standard Error	γ_Q	Standard Error	F-ratio	R^2
Potato	Overall	2.230*	0.329	-6892.79*	477.024	0.016	0.031	1318.28	0.175
	Urban	3.357*	0.366	-8220.37*	609.024	-0.10*	0.034	398.08	0.116
	Rural	-1.619*	0.438	-3600.06*	528.915	0.399*	0.042	1513.57	0.269
Onion	Overall	1.016*	0.268	-6512.17*	392.794	0.115*	0.025	2227.27	0.257
	Urban	1.441*	0.347	-6945.87*	594.370	0.067*	0.032	727.58	0.208
	Rural	-1.020*	0.416	-4835.27*	519.722	0.319*	0.039	1704.44	0.308
Tomato	Overall	-1.049*	0.348	-4932.98*	521.055	0.248*	0.032	1109.74	0.131
	Urban	-0.921*	0.420	-5115.58*	710.884	0.226*	0.038	487.11	0.127
	Rural	-3.240*	0.563	-3171.95*	710.384	0.470*	0.053	753.76	0.156
Cabbage	Overall	0.210	0.350	-3395.81*	493.373	0.112*	0.033	437.22	0.096
	Urban	1.202*	0.513	-4327.41*	872.818	0.006	0.047	108.11	0.053
	Rural	-4.115*	0.491	561.320	610.786	0.539*	0.047	536.94	0.196
Peas	Overall	0.101	0.366	-3699.96*	560.949	0.102*	0.034	311.88	0.106
	Urban	-0.206	0.539	-2721.84*	966.533	0.121*	0.049	95.83	0.072
	Rural	-1.988*	0.586	-2010.78*	786.783	0.311*	0.055	283.10	0.166

(indicates significant at five percent significance level)*

The value of Chow's F-test for all vegetables (see table 2) suggests that significant structural differences between urban and rural quantity/expenditure models exist. Therefore, the models were estimated separately in order to avoid losses of vital information on the exact contribution of explanatory variables towards explained variable in the form of differential intercept or slope or both.

Coefficient of determination R^2 was obtained in reasonable range with good F-statistics in all equations (see table 3 and 4). However, in cross-sectional data (such as household level surveys) empirical observations with low R^2 and good F-statistics are accepted (Gujrati, 2003; World Bank, 2005). Significant F-statistics in all equations indicated a good fit of the model. α, β, Coefficients β_Q, β_E, γ_Q and γ_E illustrated in equations 3.7 and 3.8 in most of the vegetables were statistically significant reflecting that the LLI formulation of the model fits the data well and validate nonlinear behaviour of Engel relationship for vegetables consumption in Pakistan (see table 3 and 4).

Quantity Elasticities

The estimates of quantity-income elasticities of potato, onion, tomato, cabbage and cauliflower and peas & moongra were 0.3533, 0.4485, 0.5860, 0.2762 and 0.2687 respectively in Pakistan (Overall) (see table 5).

For urban households, as per estimated quantity-income elasticity, tomato (0.4377) ranked first, followed by onion (0.3619), peas and moongra (0.2233), cab bage and cauliflower (0.1746) and potato (0.1196). Similarly, for rural households the quantity elasticity of tomato (0.6493) has remained the highest, followed by potato (0.6141), onion (0.6069) and peas & moongra (0.4195) (see table 5).

Expenditure Elasticities

The value of expenditure elasticity for tomato (0.5493) was recorded the highest, followed by onion (0.4681), potato (0.3860), peas & moongra (0.3802) and cabbage & cauliflower (0.3474) in Pakistan (overall).

In urban areas of Pakistan the expenditure elasticities

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Table 4. *Estimates of Expenditure Equation*

Households		α	Standard Error	β_E	Standard Error	γ_E	Standard Error	F-ratio	R^2
Potato	Overall	5.598*	0.340	-7532.04*	482.861	0.008	0.032	1268.77	0.164
	Urban	6.674*	6.674	-9047.04*	656.413	-0.11*	0.037	418.34	0.117
	Rural	1.719*	0.471	-4222.32*	558.315	0.396*	0.045	1388.82	0.249
Onion	Overall	4.381*	0.301	-6780.35*	419.636	0.120*	0.028	1647.07	0.190
	Urban	5.050*	0.427	-7888.18*	702.613	0.049	0.039	550.95	0.151
	Rural	1.927*	0.476	-4686.61*	568.914	0.367*	0.045	1318.67	0.243
Tomato	Overall	2.178*	0.364	-5176.67*	538.112	0.296*	0.034	1240.10	0.155
	Urban	2.478*	0.478	-5691.30*	812.408	0.258*	0.044	502.04	0.143
	Rural	-0.241	0.599	3160.2*	765.330	0.538*	0.057	875.59	0.189
Cabbage	Overall	2.977*	0.372	-3529.66*	552.544	0.177*	0.035	578.64	0.134
	Urban	4.303*	0.482	-5384.63*	833.615	0.045	0.044	214.52	0.102
	Rural	-0.700	0.619	21.281	803.042	0.538*	0.058	498.16	0.199
Peas	Overall	2.480*	0.382	-3377.98*	562.388	0.228*	0.036	549.11	0.177
	Urban	2.38*	0.593	-3229.69*	1063.571	0.230*	0.054	205.62	0.164
	Rural	0.838	0.622	-1980.30*	786.782	0.393*	0.059	393.68	0.215

(indicates significant at five percent significance level)*

for potato, onion, tomato, cabbage & cauliflower and Peas & moongra were; 0.2785, 0.3349, 0.28220.2173 and 0.3519 respectively (see table V). For rural households, the expenditure elasticities in term of magnitudes, tomato (0.7188) was ranked first, followed by potato (0.6477), onion (0.6460) and peas & moongra (0.4997).

Quality Elasticities

Quality elasticities in Pakistan (overall) for the products under study were calculated as the difference between the expenditure and the corresponding quantity elasticities. In general, the quality elasticities of most of the vegetables during 2010-11 have remained positive except tomato. The quality elasticities with positive signs implied that Pakistani households are more likely to purchase high quality vegetables.

For urban households, the value of quality elasticities for potato (0.1589), peas & moongra (0.1286), cabbage & cauliflower (0.0427), have remained positive while negative quality elasticities were obtained for onion (-0.0269) and tomato (-0.1555). With respect to the positive magnitudes of quality elasticities in rural Pakistan, peas & moongra (0.0802) was ranked first, followed by tomato (0.0696) onion (0.0392) and potato (0.0336). However, constant quantity and expenditure income elasticities were observed for cab bage & cauliflower. The constant expenditure elasticities implied that an increase in household income would cause no change in consumption of cabbage & cauliflower. The quality elasticity for cabbage & cauliflower is zero given equivalent output and expenditure elasticities.

The findings of this study are in line with the results of Gale and Haung (2007); Jan et al., (2008a; 2008b and 2009a); Tey et al., (2008 and 2009); Yu and Abler

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Table 5. *Quantity, Expenditure and Quality Elasticity of the Selected Vegetables*

Vegetable	Households	Quantity Elasticity	Expenditure Elasticity	Quality Elasticity
Potato	Overall	0.3533	0.3860	0.0328
	Urban	0.1195	0.2785	0.1589
	Rural	0.6141	0.6477	0.0336
Onion	Overall	0.4485	0.4681	0.0196
	Urban	0.3619	0.3349	-0.0269
	Rural	0.6069	0.6460	0.0392
Tomato	Overall	0.5860	0.5493	-0.0367
	Urban	0.4377	0.2822	-0.1555
	Rural	0.6493	0.7188	0.0696
Cabbage & Cauliflower	Overall	0.2762	0.3474	0.0712
	Urban	0.1746	0.2173	0.0427
	Rural	0.5386	0.5376	-0.0010
Peas & Moongra	Overall	0.2687	0.3802	0.1115
	Urban	0.2233	0.3519	0.1286
	Rural	0.4195	0.4997	0.0802

(2009) and Ogundari (2012). Regression results obtained for quantity elasticities in their study showed that the log-log inverse specification fits the food consumption data well, indicating a greater similarity to our findings. A notable difference in urban/rural household income, food consumption and elasticities were observed in the reference studies, which is another finding very similar to ours. The estimates of quantity and expenditure elasticities obtained in our study are different in magnitudes but still consistent with the results of their study in terms of being inelastic. The quality elasticities calculated in their study are similar in signs to our estimates but different in magnitudes.

Conclusions and Recommendation

Empirical results reflect that the log-log-inverse (LLI) formulation of the model fits the data well and validates nonlinear behaviour of Engel relationship for vegetable consumption in Pakistan. Generally, the estimates of quantity and expenditure elasticities remained less than unity, indicating that the vegetables under study were treated as essential. The quantity and expenditure elasticity of rural households is generally larger than the urban ones for all the vegetables, suggesting that rural households are more sensitive in vegetable consumption to changes in their income. The magnitude of quality elasticity for the vegetables under study except onion and tomato decreased for rural households compared to urban ones. In general, the estimates of quality elasticities of most of the products were positive. The evidence of positive quality elasticities indicate that consumers in Pakistan pay a premium price for quality vegetable. Therefore an extensive study is recommended to identify those quality attributes of all the vegetables studied for which the consumers are willing to pay a higher price. Hence, from the policy point of view, evidence of positive demand for quality vegetables would facilitate devising food policy for the development of food markets in terms of market segmentation and quality improvements in Pakistan.

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