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Assessment of Quality Elasticity for Tea Consumption in Pakistan: Insights from HIES Data

Dr. Dawood Jan[1], Dr. Muhammad Fayaz[2], Dr. Abbas Ullah Jan[3], Dr. Ghaffar Ali[4], Dr. Sajid Rahman Khattak[5], Dr. Farhana Gul[6]

Abstract
The study estimated quantity, expenditure and quality elasticities for tea (black & green) in Pakistan. A comparison of quality elasticity between urban and rural households is provided using data from the Households Integrated Economic Survey (HIES) part of Pakistan Social and Standards Living Measurement (PSLM) 2010-11. The elasticities of interest were obtained via log-log inverse functional form of Engel equation. Coefficients of parameters were found statistically significant reflecting that the log-log-inverse (LLI) formulation of the model fit the data well and validate nonlinear behavior of Engel relationship for tea consumption in Pakistan. The quantity and expenditure elasticity remained less than unity suggesting that the product under study were treated as essential. Quantity and expenditure elasticities were higher for rural households than urban ones. The quality elasticity, which is the difference between expenditure and quantity elasticity, turned out to be positive with an estimated value of 0.0137 for households in Pakistan (overall), 0.0022 for urban households and negative (-0.002) for rural ones. Overall, the quality elasticity with positive signs implied that Pakistani households in general and urban households in particular are more likely to purchase high quality tea as their income rise.
Keywords: Tea Consumption, quantity elasticity, expenditure elasticity, quality elasticity, urban/rural households, Pakistan

1. Introduction

Tea is the world most favored and drunk beverage after water due to its general acceptability, comparative cheapness, and advantageous effect. Tea prevents dental decay and depositions of cholesterol on the artery wall, which can in turn avoid heart diseases. Tea is also useful in combating bacterial diseases and in the control of diseases caused by radiation. Pakistan has a long tradition in tea consumption, which has become an essential part of everyday culture. In Pakistan, every guest in a home is most likely to ask for cup of tea to relax after a tiring journey. This trend has always created a strong demand for tea in Pakistan and ranked it the world's third largest importer of tea (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 tea per capita monthly consumption has shown an increase of 4.24 percent during the period 2007-08 to 2010-11 (GoP, 2011), that reflects a reasonable boost in the purchasing power and quantity of tea consumed. 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 2009; Tey *et al.*, 2008 and 2009; Yu; Abler, 2009; Ogundari, 2012; Okurut & Mbulawa, 2018; Zafar & Younis, 2020; Wiafe, 2018; Andreou, 2021). For example, the study by Jan *et al.*, (2008a; 2008b and 2009) 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 2009) 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 a long tradition in tea consumption, which has always created a strong demand for tea in Pakistan, so this study is motivated to estimate not only the quantity–income elasticity of demand but also quality–income elasticity of demand for tea consumption with aim of improving consumer welfare policy in Pakistan. Therefore, the present study is designed with the following objectives:

- To estimate quantity, expenditure and quality elasticity for Tea in Pakistan.
- To provide a comparison of Tea quality response of urban and rural households.

2. Data and Methodology

Following the pioneer work of Hicks and Johnson (1968) and Hassan and Johnson (1977), 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 & 2009), Tey *et al.*, (2008 & 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

[1] Professor, Institute of Business and Management Sciences, The University of Agriculture, Peshawar-Pakistan, jandawood@aup.edu.pk
[2] Corresponding Author, Associate Professor, Department of Agricultural & Applied Economics, The University of Agriculture, Peshawar, Pakistan, mfayaz@aup.edu.pk
[3] Professor, Department of Agricultural & Applied Economics, The University of Agriculture Peshawar, Pakistan, abbasjan@aup.edu.pk
[4] Professor, Department of Agricultural & Applied Economics, The University of Agriculture, Peshawar, Pakistan, ghaffarali@aup.edu.pk
[5] Assistant Professor, IBMS, The University of Agriculture, Peshawar, Pakistan, sajidktk99@yahoo.com
[6] Lecturer, Department of Agriculture, The University of Swabi, Pakistan, farhana@uoswabi.edu.pk

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).

$$E_i(Y) = P_i Q_i(Y) \quad \ldots\ldots (3.1)$$

where E_i is household expenditure on ith commodity, P_i is the price of ith commodity, and Q_i is the quantity purchased of ith commodity. 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:

$$\frac{\partial E_i}{\partial Y}(Y|E) = \frac{\partial Q_i}{\partial Y}(Y|Q) \quad \ldots\ldots (3.2)$$

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.

$$E_i(Y) = V_i(Y)Q_i(Y) \quad \ldots\ldots (3.3)$$

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:

$$\frac{\partial lnE_i}{\partial lnY} = \frac{\partial lnV_i}{\partial lnY} + \frac{\partial lnQ_i}{\partial lnY} \quad \ldots\ldots (3.4)$$

where $\frac{\partial lnE_i}{\partial lnY}$ represents expenditure elasticity (ε_i) and $\frac{\partial lnV_i}{\partial lnY}$ represents quality elasticity (φ_i) and $\frac{\partial lnQ_i}{\partial lnY}$ quantity elasticity(θ_i); namely.

$$\varepsilon_i = \varphi_i + \theta_i \quad \ldots\ldots (3.5)$$

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

$$\varphi_i = \varepsilon_i - \theta_i \quad \ldots\ldots (3.6)$$

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.

$$lnQ_{ij} = \alpha + \beta_Q \left(\frac{1}{Y_j}\right) + \gamma_Q \, lnY_j + \epsilon_{ij} \quad \ldots\ldots (3.7)$$

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

$$lnE_{ij} = \alpha + \beta_E \left(\frac{1}{Y_j}\right) + \gamma_E \, lnY_j + \epsilon_{ij} \quad \ldots\ldots (3.8)$$

where E_i represents household expenditure on *i*th commodity 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$-\beta_Q \left(\frac{1}{Y_j}\right)$. 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:

$$\theta_i = -\beta_Q \left(\frac{1}{Y_j}\right) + \gamma_Q \quad \ldots\ldots (3.9)$$

$$\varepsilon_i = -\beta_E \left(\frac{1}{Y_j}\right) + \gamma_E \quad \ldots\ldots (3.10)$$

Substituting values of θ_i and ε_i from equations (3.9) and (3.10) into Equation (3.6), the quality elasticity (φ_i) is computed.

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:

$$F = \frac{(RSS_r - RSS_{ur})/k}{(RSS_{ur})/(n_1+n_2-2k)} \quad \ldots\ldots (3.11)$$

where RSS_r is restricted residual sum of squares obtained from pooled data while $RSS_{ur}$is 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.

3. 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 & Moneta (2009); Ravillion (1992); Chema (2005) and Jan *et al.* (2009) that total consumption expenditure is better to used 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.

3.1. Data Used

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 except FATA, Azad Jamu & 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. Data available on tea consumption is given in below table 1.

Table 1: Region-wise Number of Observations, Households Monthly Mean Consumption and Expenditure

Vegetable	Region	Number of Observations	Mean Consumption (in mg)	Mean Expenditure (in PKR)
Tea	Overall	16054	538.785	238.535
(black & green)	Urban	6487	517.986	231.596
	Rural	9567	552.89	243.241

Source: PSLM-2010-11

4. Results and Discussion

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 in STATA-12 version with robust command. Such robust standard errors can deal effectively with a collection of minor concerns, such as minor problems about normality, heteroscedasticity, or some observations that exhibits large residuals. The point estimates of the coefficients with robust option are exactly the same as in OLS but the standards errors take in to account problems concerning heterogeneity and lack of normality. Further, the reasonably large sample size (> 100) used in this study relaxes the normality assumption (Gujrati, 2004). 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,

- The value of Chow's F-test (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.
- Most of the coefficients β_Q , β_E , γ_Q and γ_E illustrated in equations 3.7 and 3.8 were statistically significant reflecting that the LLI formulation of the model fits the data well and validate nonlinear behavior of Engel relationship for tea consumption in Pakistan (see table 3 and 4).
- Quantity and expenditure elasticity of tea with respect to income is estimated at 0.3585 and 0.7233 for the urban areas and 0.3607 and 0.7213 for the rural areas respectively (see table 5).
- Quality elasticity was calculated as the difference between the expenditure and the corresponding quantity elasticities (see table 5). The quality elasticity is estimated positive 0.0137 for households in Pakistan (overall), 0.0022 for urban households and negative (-0.002) for rural ones. Overall, the quality elasticity with positive signs implied that Pakistani households are more likely to purchase high quality tea as their income rise. The results of this study are in line with the findings of Gale and Haung (2007); Jan *et al.*, (2008a; 2008b and 2009); Tey *et al.,* (2008 and 2009); Yu; Abler (2009) and Ogundari (2012).

Table 2: Estimates of Chow's F-test

Item	Quantity		Expenditure	
	F-value	p-value	F-value	p-value
Tea	146.3	0.000	148.564	0.000

Table 3: Estimates of Quantity Equation

Item/region		Empirical Results/Estimated Model	F-ratio	R^2
Tea	Overall	$lnQ = 4.850 - 6610.335(1/Y) + 0.168lnY$ $(0.420)^*$ $(623.550)^*$ $(0.039)^*$	1566.96	0.177
	Urban	$lnQ = 6.009 - 8471.368(1/Y) + 0.049lnY$ $(0.424)^*$ $(702.336)^*$ (0.039)	597.83	0.153
	Rural	$lnQ = 1.418 - 3589.076(1/Y) + 0.510lnY$ $(0.574)^*$ $(727.523)^*$ $(0.054)^*$	1394.62	0.228

(Figures in parenthesis are standard errors)
(* indicates significant at five percent significance level)

Table 4: Estimates of Expenditure Equation

Item/Region		Empirical Results/Estimated Model	F-ratio	R^2
Tea	Overall	$lnE = 3.926 - 6630.082(1/Y) + 0.180lnY$ $(0.398)^*$ $(590.678)^*$ $(0.037)^*$	1769.60	0.198
	Urban	$lnE = 5.004 - 8521.187(1/Y) + 0.070lnY$ $(0.404)^*$ $(668.129)^*$ (0.037)	703.54	0.175
	Rural	$lnE = 0.816 - 3873.729(1/Y) + 0.491lnY$ (0.544) $(694.107)^*$ $(0.051)^*$	1531.14	0.247

(Figures in parenthesis are standard errors)
(* indicates significant at five percent significance level)

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

Item	Region	Quantity Elasticity	Expenditure Elasticity	Quality Elasticity
Tea	Overall	0.5054	0.5191	0.0137
	Urban	0.3585	0.3607	0.0022
	Rural	0.7233	0.7213	-0.002

5. Conclusion

Empirical results reflect that the log-log-inverse (LLI) formulation of the model fits the data well and validate nonlinear behavior of Engel relationship for tea consumption in Pakistan. Generally, the estimates of quantity and expenditure elasticities remained less than unity, indicating that tea were treated as essential commodity by Pakistani households. The quantity and expenditure elasticity of rural households is generally larger than the urban ones suggesting that rural households are more sensitive in tea consumption to changes in their income. The quality elasticity of tea turned out to be positive for the urban and negative for the rural households indicating that urban households tend to increase their demand for quality tea in response to their income rise. Overall, the quality elasticity with positive signs implied that Pakistani households in general and urban households in particular are more likely to purchase high quality tea as their income rise. The evidence of positive quality elasticities indicate that consumers in Pakistan pay a premium price for quality tea. Therefore an extensive study is recommended to identify those quality attributes for which the consumers are willing to pay a higher price. Hence, from the policy point of view, evidence of positive demand for quality tea 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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