Research Article

Does the Quantity and Quality of Cereal Respond to Changes in Income? Evidence from Pakistan

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Abstract | This study used log-log-inverse specification of Engel curve for cereals' quantity and quality response to households' income in Pakistan. The elasticities of interest (quantity, expenditure and quality) were inelastic with reasonable difference in magnitude across urban and rural households. Overall, the quality elasticity turned out to be positive with an estimated value of 0.0061 and 0.2375 for wheat & wheat flour and rice & rice flour, respectively. The estimation of quality elasticity based upon income quintiles revealed that the magnitude of quality elasticity increases for rice & rice flour (0.2019 to 0.2639) while decreases for wheat & wheat flour (0.0160 to -0.0012) as household move from poorest to richest quintile indicating an increased responsiveness of the high-income households to rice quality compared to wheat.

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Introduction

Pakistani populace has a high dependence on cereals to meet the daily requirement of food energy. Cereals account for 47 percent of the total per capita calorie supply and 46 percent the per capita protein supply in Pakistan (FAO, 2011). Similarly, expenditure on cereal consumption accounts for about 20 percent of total household food expenditure (approximately 15 percent on wheat and 4 percent on rice) in Pakistan. Poor households spend a larger proportion (23%) of their income on wheat. However, the share of expenditure on rice (4 percent) is almost the same for households in different income groups (GoP, 2009).

Per capita income (in dollars) of Pakistan has increased at an annual rate of 6.4 percent during the last half decade (GoP, 2012), shows a reasonable boost in the purchasing power. The concept that a rational consumer moves from quantity to quality especially when higher quality food becomes more affordable with higher income, reflecting change in consumer tastes and preferences consistent with basic economic theory (Deaton, 1997). Household income and food consumption has been investigated worldwide extensively and systematically since long with focus mainly on income and expenditure elasticity ignoring the important factor of quality. A review of literature is evidence for the limited studies with focus on quality effect in food consumption, concluding that households are willing to pay a higher price for enhanced quality with the increase in income. Apart from Jan et al. (2008a), Jan et al. (2008b) and Jan et al. (2009) there is no empirical work on food quality in Pakistan; however, these studies are focused only on fruits and milk consumption. Furthermore, these studies have highlighted the need for further exploration of quality

response to changes in household income on the basis of income quintiles and urban/rural comparisons to have a deeper insight of the issue. Keeping in view the importance of cereals in households' food consumption that has shaped a higher demand for cereals in Pakistan, the study in hand is designed with the following objectives:

1. To estimate quantity, expenditure and quality elasticity for cereals in Pakistan.
2. To provide a comparison of cereals quality response of urban and rural households.
3. To assess the cereals quality response across income quintiles.

Data and Methodology

This study used Log-log inverse (LLI) form of Engel curve to study cereals' quantity and quality response to households' income as linear and semi-logarithmic forms have some conceptual problems. For example, in Linear Engel equation the inferior goods tend to become luxuries with increasing expenditure (Dawoud, 2005), which do not reflect an exact picture of the individual behaviour (Tey et al., 2009). Similarly, the semi-log functional form assumes constant income elasticity overall level of income, which is not conceivable.

Log-log inverse (LLI) functional form of Engel equation was presented by Hicks and Johnson (1968) and Hassan and Johnson (1977) followed by Gale and Huang (2007), to capture the quality effect. Similarly, Jan et al. (2008a), Jan et al. (2008b), Jan et al. (2009), Tey et al. (2008), Tey et al. (2009), Yu and Abler (2009) and Ogundari (2012) used the same methodology to capture a nonlinear relation of households' consumption and income that let the income elasticity to vary with income level. The nonlinear estimates of Engel curve may reflect physical saturation of demand, which presents more reasonable estimates of demand elasticities. Additionally, the LLI approach is suitable when income elasticities decline to zero with rising income/total expenditure (Gale and Huang, 2007). Following their models, a nonlinear relationship of consumption (Q_j) and income (Y), the following models can be used.

$$lnQ_{jk} = \alpha + \beta_Q \left(\frac{1}{Y_k}\right) + \gamma_Q \ lnY_k + \epsilon_{kj} \ \dots\dots (i)$$

Where;
j represents the *j*th cereal, *k* is the *k*th household, Q_j is the quantity of *j*th cereal consumed by household, α, β and γ are the coefficients to be estimated and ϵ is disturbance term. Similarly, for expenditure (E_j) and income (Y) relationship.

Equation (*i*) can be modified as:

$$lnE_{jk} = \alpha + \beta_E \left(\frac{1}{Y_k}\right) + \gamma_E \ lnY_k + \epsilon_{jk} \ \dots\dots (ii)$$

Where;
E_j represents household expenditure on *j*th cereal and other defined as earlier.

Equations (i) and (ii) would give estimates of parameters α, β, γ. If β is equal to zero, the LLI model turns to double log model, indicating constant income elasticities. Similarly, if γ is equal to zero, LLI model turns to log inverse model and income elasticity equals $-\beta_Q (1/Y_k)$. Also income elasticity varies with income but it never reaches to zero or change sign. However, if both β and γ are not equal to zero, then elasticities are worked out, as follows:

Quantity elasticity (θ_j):

$$\theta_j = -\beta_Q \left(\frac{1}{Y_k}\right) + \gamma_Q \ \dots\dots (iii)$$

Expenditure elasticity (ε_j):

$$\varepsilon_j = -\beta_E \left(\frac{1}{Y_k}\right) + \gamma_E \ \dots\dots (iv)$$

Quality elasticity (φ_j) is computed as the difference between Expenditure elasticity (ε_j) and Quantity elasticity (φ_j):

$$\varphi_j = \varepsilon_j - \theta_j \qquad (v)$$

Additionally, this study follows Gujrati (2003) procedure for testing structural differences across regions in order to check whether pooled (urban and rural) data on households or different models should be estimated for urban and rural areas.

Households' Income

To reflect the permanent income of the households, total expenditure was used as proxy of income in this study (Friedman, 1957). Similarly, Tansel (1986), Cinar (1987), Manig and Moneta (2009), Ravillion (1992), Cheema (2005) and Jan et al. (2009) also used the same proxy to reflect the households' income. Further, the respondents were divided in to five equal

groups/quintiles based on the values of total expenditure, similar to Jan et al. (2009). The quintiles are describes as follow:

1st Quintile (Q_1) = Lowest 20% - Poorest
2nd Quintile (Q_2) = Low middle 20%
3rd Quintile (Q_3) = Middle 20%
4th Quintile (Q_4) = Upper Middle 20%
5th Quintile (Q_5) = Highest 20% - Richest

Table 1: *Number of observations, households' monthly mean consumption and expenditure*

Cereals	Region	Number of Observation	Mean Consumption (in Kg)	Mean Expenditure (in PKR)
Wheat & Wheat Flour	Overall	16181	54.718	1572.94
	Urban	6506	48.986	1448.806
	Rural	9675	58.573	1656.415
	Q1	6165	39.511	1125.566
	Q2	3895	54.874	1582.904
	Q3	2915	64.203	1859.419
	Q4	2124	75.746	2169.93
	Q5	1082	73.970	2125.312
Rice & Rice Flour	Overall	15262	7.512	401.814
	Urban	6312	6.560	380.75
	Rural	8950	8.184	416.670
	Q1	5791	4.812	235.039
	Q2	3683	7.872	400.559
	Q3	2759	9.305	492.250
	Q4	2008	10.982	618.347
	Q5	1021	9.862	682.039

Source: *PSLM-2010-11*

Data Used

Household Integrated Economic Survey (HIES) part of Pakistan Social and Standards Living Measurement (PSLM) 2010-11 data set including a sample size of 16341 households was used for this study. Data available on cereals (wheat & wheat flour and rice & rice flour) consumption is given in Table 1.

Results and Discussion

Models Estimates and Diagnostics

Keeping in view the nature of the data used all the equations were estimated using STATA-12 version with robust option. This option gives robust standard errors that can effectively deal with normality, heteroscedasticity, or some observations that exhibits large residuals. However, a fairly large sample size (> 100) relaxes the normality assumption (Gujrati, 2003).

The models were estimated separately for urban and rural region as the Chow's test p-value of 0.000 (Table 2) suggesting that statistically significant difference between urban and rural quantity/expenditure models exists.

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

Cereals	Quantity		Expenditure	
	F-value	p-value	F-value	p-value
Wheat & Wheat Flour	560.524	0.000	411.822	0.000
Rice & Rice Flour	115.516	0.000	104.632	0.000

Empirical observations with reasonable range of Coefficient of determination (R^2) along with significant F-statistics in all equations (Table 3 and 4) are accepted (Gujrati, 2003; World Bank, 2005) for good fitness of the model.

Coefficients given in equations (iii) and (iv) were found statistically significant (p-value less than significance level (0.05)) that confirm the LLI functional form of the Engel curve fits the data well for cereals in Pakistan (Table 3 and 4).

Quantity, Expenditure and Quality Elasticities

The estimates of quantity income elasticities of wheat & wheat flour, rice & rice flour were 0.3269 and 0.4917,

Table 3: *Estimates of quantity equation*

Item/region		α	Standard Error	β_Q	Standard Error	γ_Q	Standard Error	F-ratio	R^2
Wheat & Wheat flour	Overall	5.893*	0.388	-9119.534*	557.03	-0.141*	0.036	1180.15	0.216
	Urban	7.525*	0.409	-11408.6*	654.439	-0.316*	0.038	402.47	0.128
	Rural	0.469	0.436	-4503.227*	536.624	0.394*	0.041	2218.64	0.407
Rice & Rice flour	Overall	1.606*	0.344	-9792.172*	505.772	0.057	0.032	1518.07	0.148
	Urban	1.510*	0.470	-9788.489*	847.492	0.053	0.043	532.04	0.141
	Rural	-1.319*	0.632	-7361.599*	781.352	0.353*	0.060	1131.86	0.179

*: *significant at five percent significance level*

Smith & Franklin

Table 4: *Estimates of expenditure equation*

Item/region		α	Standard Error	β_Q	Standard Error	γ_Q	Standard Error	F-ratio	R^2
Wheat & Wheat Flour	Overall	9.260*	0.389	-9333.805*	562.133	-0.145*	0.036	1251.23	0.225
	Urban	11.056*	0.399	-11669.56*	638.701	-0.329*	0.037	429.49	0.132
	Rural	4.165*	0.449	-4888.287*	555.885	0.361*	0.043	2137.91	0.395
Rice & Rice Flour	Overall	3.478*	0.326	-9002.603*	478.332	0.277*	0.030	2793.02	0.252
	Urban	3.352*	0.444	-9061.377*	785.357	0.278*	0.041	1087.23	0.256
	Rural	1.187*	0.594	-7118.716*	737.089	0.510*	0.056	1835.54	0.273

*: *indicates significant at five percent significance level*

respectively. For urban households, the estimated quantity-income elasticity of wheat & wheat flour and rice & rice flour were 0.1681 and 0.4093 respectively. Similarly, for rural households the quantity elasticity of wheat & wheat flour and rice & rice flour were calculated 0.6634 and 0.7836, respectively (Table 5). The higher values of quantity elasticity in term of magnitude for rural households compared to the urban households showing that rural households are more sensitive in cereals consumption to changes in their income. Quantity income elasticities calculated at various quintiles decreased from 0.7501 to 0.0157 for wheat & wheat flour and 0.9331 to 0.1645 for rice & rice flour as household move from the poorest quintile to richest (Table 5).

Table 5: *Quantity, expenditure and quality elasticity of the cereals*

Cereal Region		Quantity Elasticity	Expenditure Elasticity	Quality Elasticity
Wheat & Wheat Flour	Overall	0.3269	0.3330	0.0061
	Urban	0.1681	0.1661	-0.0020
	Rural	0.6634	0.6522	-0.0111
	Q1	0.7501	0.7661	0.0160
	Q2	0.4221	0.4304	0.0083
	Q3	0.2805	0.2855	0.0050
	Q4	0.1662	0.1685	0.0023
	Q5	0.0157	0.0144	-0.0012
Rice & Rice Flour	Overall	0.4917	0.7292	0.2375
	Urban	0.4093	0.6569	0.2475
	Rural	0.7836	0.9261	0.1426
	Q1	0.9331	1.1350	0.2019
	Q2	0.5932	0.8225	0.2293
	Q3	0.4446	0.6859	0.2413
	Q4	0.3234	0.5744	0.2511
	Q5	0.1645	0.4284	0.2639

The expenditure elasticities in term of magnitudes were 0.1661 for wheat & wheat flour and 0.6569 for rice & rice flour in case of urban households. For rural households, the estimates of expenditure elasticities were 0.6522 for wheat & wheat flour and 0.9261 for rice & rice flour. Generally, the magnitudes of expenditure elasticities for urban households were lower than rural households. Similar to Quantity elasticities, expenditure elasticities at different income quintiles also decreased as households move from lowest quintile to highest.

The quality elasticity for rice & rice flour was positive for both urban (0.2475) and rural (0.1426) households while negative quality elasticities were obtained for wheat & wheat flour in case of urban households (-0.0020) and as well as rural (-0.0111) ones. The quality elasticity estimated across the income quintiles has increased in term of magnitude for rice & rice flour (0.2019 to 0.2639) while decreased for wheat & wheat flour (0.0160 to -0.0012) as households move from poorest quintile to richest one. The estimation of quality elasticity based upon income quintiles reveal that the magnitude of quality elasticity increases for rice & rice flour while decreases for wheat & wheat flour as household move from poorest to richest quintile. This shows that Pakistani households are paying higher prices for quality rice as compare to wheat among cereals. The findings of this study are parallel to the results of Gale and Haung (2007), Jan et al. (2008a), Jan et al. (2008b), Jan et al. (2009), Tey et al. (2008), Tey et al. (2009), Yu and Abler (2009) and Ogundari (2012). Empirical results for quantity elasticities in their study showed that the log-log inverse specification fits the food consumption data well, showing a greater similarity to the findings of this study. Comparison on the basis of urban/rural household income, food consumption and elasticities in this study is another similarity to the findings of the reference studies. The estimates of quantity and expenditure elasticities obtained in our study are different in magnitudes but still consistent with the re-

sults of their studies in terms of being inelastic. The quality elasticities calculated in their studies are similar in signs to our estimates but different in magnitudes.

Conclusion

Overall, the estimates of quantity and expenditure elasticities remained less than unity, indicating that cereals were treated as essential. The larger estimates of quantity and expenditure elasticity of rural households compared to the urban for both the cereals indicated that households in rural region more sensitive in cereals consumption to changes in their income. The magnitude of quality elasticity for the rice & rice flour remained positive and decreased for rural households compared to urban ones. The estimation of quality elasticity based upon income quintiles revealed that the magnitude of quality elasticity increased for rice & rice flour while decreased for wheat & wheat flour as household moved from poorest to richest quintile. This implies that household tends to spend more on rice & rice flour compared to wheat & wheat flour as their income rise. In general, the evidence of positive quality elasticities indicates that consumers in Pakistan pay a higher price for quality cereals. Therefore, an extensive study is recommended to identify those quality attributes for which the consumers are willing to pay a higher price. Furthermore, all the stakeholders involved in the cereals supply chain should focus on quality enhancement if they are going to harvest increased earnings.

Authors' Contribution

This paper is a part of first author's PhD research work. Dr. Abbas Ullah Jan was major supervisor in PhD research and Dr. Dawood Jan was member supervisory committee from major field. Dr. Ghaffar Ali and Dr. Yousaf Hayat helped in data compilation and analysis.

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