CONSUMERS’ RESPONSE TO MILK QUALITY: A COMPARISON OF URBAN AND RURAL PAKISTAN

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ABSTRACT

A log-log-inverse econometric model representing non linear Engel curve relationship for fresh milk in Pakistan proved to be a valid estimation technique of quantity and expenditure elasticities with respect to consumers’ income. This model, when used for urban and rural households separately indicated a substantial difference in the quantity and expenditure elasticities of fresh milk between the urban and rural consumers of Pakistan during 2001. The quality elasticity which is the difference between expenditure and quantity elasticity turned out to be positive with an estimated value of 0.3808 and 0.2239 for the urban and rural households respectively indicating an increased responsiveness of the urban consumers to milk quality compared to those in the rural areas.

Key Word: Engel curve, Log-Log-Inverse function, quality elasticity, milk, urban and rural households.


INTRODUCTION

Being the largest sector of Pakistan’s economy, agriculture contributes 23 % to the GDP and involves 42 % of the total labor force. Livestock is the largest of the various sub sectors of agriculture. During 2003-04 net foreign exchange earnings from livestock products and by products were more than Rs. 53 billion which is about 11 % of the overall export earnings of the country (FAO, 2006). Livestock accounts for 46.8 % of agricultural value added and about 10.8 % of the GDP. Milk is the largest commodity from the livestock sector accounting for 51 % of the total value of the sector with an estimated farm gate value of more than Rs. 390 billion. Pakistan is the fifth largest producer of milk in the world with an annual production of 28 billion liter valuing more than the combined value of wheat and cotton, from a total herd size of 27 million milch animals of cows and buffaloes (SMEDA, 2007). During 2006-07 Pakistan produced 33.2 million tons of milk. Milk consumption has shown a steady annual growth of 28.6 % over the last seventeen years between 1991 and 2007 (GoP, 2007).

Milk and milk products form a significant part of the diet in many countries and a substantial part of food expenditure goes on milk and dairy products. Milk and milk based products accounts for around 27% of the total household food expenditure in Pakistan (Anjum et al., 1989, Seale et al., 2003).

In the quest for national food sufficiency, researchers in Pakistan have focused almost exclusively on production and food quality seems to have become the most forgotten area (Khan et al., 1999). Apart from McCarthy (1981) and recently Jan et al. (2008a, 2008b) there seems no empirical work on food quality in Pakistan. Similarly there is no comprehensive study on milk quality (Khan et al., 1999). On the other hand consumers are becoming increasingly concerned with the quality, safety and production attributes of their food (Caswell, 1998). This paper attempts to study and compare consumers’ response to milk quality in the urban and rural areas of Pakistan and estimates quality elasticity with respect to household income.

MATERIALS AND METHODS

Houthakker (1957) in his work on ‘An international Comparison of Household Expenditure Patterns’ expressed that increases in food expenditure could be devoted to increasing the quantity of food consumed, increasing the quality of the diet, or more generally some combination of the two. Hicks and Johnson (1968) provided methodology to separate quality and quantity components of income elasticity which is explained as under:
Consider a particular expenditure on food, F. Let X be the quantity of food in F and Y be the quality of food in F. We assume that F is functionally related to X and Y.

\[ F = g(X, Y) \]  

(1)

In addition, it is assumed that individuals' consumption of food is a function of per capita income. With I denoting the per capita income, this function is specified in the equation (2) as:

\[ F = h(I) \]  

(2)

Taking the total differentials of equations (1) and (2) and setting them equal to each other gives, on a slight rearrangement of terms we get,

\[ (\delta g/\delta X)(dX/dY) + (\delta g/\delta Y) (dY/dI) = h'(I) \]  

(3)

Where \( h'(I) \) is the derivative of the equation (2) with respect to I, dX, dY, and dl are arbitrarily small changes in the noted variables, and \( \delta g/\delta X \) and \( \delta g/\delta Y \) are partial derivatives of equation (1) with respect to X and Y.

Multiplying both sides of equation (3) by I/F yields an expression for the income elasticity for food in terms of a weighted average of two terms as under.

\[ (\delta g/\delta X \cdot X/F)(I/X \cdot dX/dY) + (\delta g/\delta Y \cdot Y/F)(I/y \cdot dY/dI) = h'(I) \cdot I/F \]  

(4)

For sufficiently small changes in X, Y, and I, the two terms on the right-hand side of equation (4) can be interpreted as quantity and quality components of the income elasticity.

The first term in equation (4) is a product of two expressions which are rather easily interpretable. The term \( (\delta g/\delta X \cdot X/F) \) called a quantity weight, indicates how food expenditures change with the quantity of food consumed, and \( (\delta g/\delta Y \cdot Y/F) \) is a quantity elasticity. Together the two terms give the quantity component of the income elasticity.

The second term can be interpreted similarly with respect to quality. The quantity component of the income elasticity decreases in relative importance as the level of income increases.

On the basis of pioneer work of Hicks and Johnson (1968), Gale and Huang (2007) presented methodology to capture effect of quality through a nonlinear Engel relationship. According to their model, Engel curve expresses the relationship between household expenditure and income, as given in equation (5).

\[ e(Y) = pq(Y) \]  

(5)

Equation (5) expresses that expenditure (e), which is a product of price (p) and quantity (q), depends upon income (Y). If prices are held constant, then elasticity of expenditure (e) with respect to Y becomes equal to that of quantity (q) with respect to income (Y); that is:

\[ \delta e/\delta y (Y/e) = \delta q/\delta y (Y/q) \]  

(6)

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 2 can practically be computed. Equation 6 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. Hence, to incorporate the effect of quality, equation (5) would transform, as follows.

\[ e(Y) = v(Y) \cdot q(Y) \]  

(7)

Where \( v(Y) \) represents variation in prices paid for quality.

Taking natural log of equation (7) and then differentiating it with respect to \( \ln y \), we get:

\[ \delta \ln e/\delta \ln y = \delta \ln v/\delta \ln y + \delta \ln q/\delta \ln y \]  

(8)

The left-hand side of equation (8) represents expenditure elasticity (ε), while the first part of the right-hand side represents quality elasticity (θ) and the second part quantity elasticity (η); namely.

\[ \varepsilon = \theta + \eta \]  

(9)

Equation (9) can be re-arranged to compute quality elasticity (θ), as follows.

\[ \theta = \varepsilon - \eta \]  

(10)

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

\[ \ln q = \alpha + \beta_1 (1/Y) + \gamma_1 \ln Y + \mu \]  

(11)

Similarly, for expenditure (e) and income (Y) relationship, equation (11) can be modified as:

\[ \ln e = \alpha + \beta_1 (1/Y) + \gamma_1 \ln Y + \mu \]  

(12)

Estimation of equations (11) and (12) would give values of parameters \( \alpha, \beta, \gamma \) and if \( \beta_1 \) is equal to zero, the LLI model would simplify to double log model, suggesting constant elasticities. Similarly, if \( \gamma \) is equal to zero, LLI
model would simplify to log inverse model. However, if both $\beta$ and $\gamma$ are not equal to zero, then elasticities would be worked out, as follows:

$$\eta = -\beta_q(1/Y) + \gamma_q$$  \hspace{1cm} (13)

$$\varepsilon = -\beta_e(1/Y) + \gamma_e$$  \hspace{1cm} (14)

Substituting values of $\eta$ and $\varepsilon$ from equations (13) and (14) into Equation (9) and (10), the quality elasticity ($\theta$) would be computed.

**Description of Data Used**

It is clear from the previous section that there are mainly two equations that require data on milk consumption, expenditure and income of the households which was obtained from household income and expenditure data of Pakistan Household Integrated Survey (PHIS) 2001, collected by Federal Bureau of Statistics (FBS), Government of Pakistan. This data includes 4697 urban and 6055 rural households from the four provinces of Pakistan excluding Islamabad Capital Territory (ICT). In developing countries like Pakistan consumption is considered to be a better indicator of welfare than income (Ravillion, 1992, Chema, 2005), therefore consumption expenditure is used as a proxy for the household income normalized for the temporal and geographical differences in prices using Paasche price index.

**RESULTS AND DISCUSSION**

The results of the estimated equations 11 and 12 for both the urban and rural areas along with diagnostic statistics (t-ratio, F ratio and $R^2$) are provided in Table I. Using various elasticity estimates from Table I, quantity, expenditure and quality elasticities are estimated using relationships given in equations 9 and 10. The so calculated elasticities are provided in Table II.

These results are discussed and interpreted, as follows.

i. The coefficients $\beta_q$, $\beta_e$, $\gamma_q$ and $\gamma_e$ explained in equation (11) and (12), have turned out to be statistically significant in all the equations suggesting that log-log-inverse (LLI) formulation of the model validate the non-linear behavior of Engel curve for milk consumers in Pakistan.

ii. Statistically the F ratio is highly significant in all the equations showing a good model fit. Similarly, $R^2$ is sufficiently reasonable for the cross sectional survey data (World Bank, 2005).

iii. Quantity and expenditure elasticity of demand for milk with respect to consumer income is estimated at 0.3717 and 0.7525 for the urban areas and 0.6948 and 0.9187 for the rural areas respectively. The quality elasticity is thus positive and is estimated at 0.3808 for urban areas and 0.2239 for rural areas.

### Table I  
**Empirical results of quantity and expenditure elasticity models**

<table>
<thead>
<tr>
<th>Area</th>
<th>Estimated Models</th>
<th>F-ratio</th>
<th>$R^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urban</td>
<td>$lnq = 5.865 - 1263.997 (1/Y) + 0.529 lnY$  \hspace{1cm} (16.25)  (-5.75) \hspace{1cm} (14.3)</td>
<td>1210.66</td>
<td>0.340</td>
</tr>
<tr>
<td>Rural</td>
<td>$lnq = 3.775 - 475.475 (1/Y) + 0.776 lnY$  \hspace{1cm} (8.59) \hspace{1cm} (-2.5) \hspace{1cm} (16.75)</td>
<td>1419.90</td>
<td>0.319</td>
</tr>
<tr>
<td></td>
<td>Expenditure elasticity model (equation 12)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Urban</td>
<td>$lne = 1.461 - 1474.792 (1/Y) + 0.569 lnY$ \hspace{1cm} (4.20) \hspace{1cm} (-6.95) \hspace{1cm} (15.9)</td>
<td>1577.76</td>
<td>0.402</td>
</tr>
<tr>
<td>Rural</td>
<td>$lne = -0.912 - 565.773 (1/Y) + 0.822 lnY$ \hspace{1cm} (-2.20) \hspace{1cm} (-6.95) \hspace{1cm} (15.9)</td>
<td>1784.60</td>
<td>0.371</td>
</tr>
</tbody>
</table>

Figures in parenthesis represent t-ratios

### Table II  
**Quantity, expenditure and quality elasticity of milk**

<table>
<thead>
<tr>
<th>Quantity Elasticity ($\eta$)</th>
<th>Expenditure Elasticity ($\varepsilon$)</th>
<th>Quality Elasticity ($\theta$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urban</td>
<td>Rural</td>
<td>Urban</td>
</tr>
<tr>
<td>0.3717</td>
<td>0.6947</td>
<td>0.7525</td>
</tr>
</tbody>
</table>
CONCLUSION

The quality elasticity of milk is positive for both the urban and rural households suggesting that on the whole Pakistani consumers are responsive to milk quality regardless of being in the urban or rural areas and willing to pay a high price for improved quality of milk that they consume. However, the estimated quality elasticity is more (0.3808) in magnitude for urban households than the rural (0.2239) indicating an increased responsiveness of urban consumers to milk quality compared to those in the rural areas.

REFERENCES


