

## **Quality Attributes and Hedonic Price Analysis of Ghee**

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### **Abstract**

In the post-WTO scenario processed food industry is witnessing intra-industry trade, i.e., trade in similar products. It also means that there will be intense competition between foreign and Indian companies in the domestic market. This competition will compel companies to focus their attention on product differentiation and branding. This is possible if companies prepare themselves to be quality competitive. In order to be quality competitive, firms have to understand consumers' perception and valuation of various quality attributes. Hedonic price analysis, a methodology used for this purpose, is extensively used for processed food products in developed countries. However, it has not been applied to Indian food markets.

We conduct a hedonic price analysis of a typical Indian processed food product – ghee. Results indicate that consumers are willing to pay a premium for branded over non-branded ghee, and, for corporate brands over cooperative brands. Flavour is an important quality attribute valued by consumers. While texture is not that important, an agreement needs to be developed on whether or not there is an ideal colour attribute for ghee. The results imply that branding generates reputation, and, cooperatives may want to enhance their brand equity. Firms may do well in improving flavour to enhance ghee quality. Another implication is that large firms and other organizations need to generate data on measurements of food quality attributes so that hedonic price analysis can be effectively used for strategic food quality management.

## **1. Introduction**

The processed food sector in India is in a state of flux. In the post-WTO regime, trade in this sector seems to exhibit intra-industry (Helpman and Krugman, 1985) character where similar goods are both imported and exported. In 1999-2000, while exports of fruit juices have crossed Rs. 10 crores, imports have crossed Rs. 20 crores. Exports of beer increased to Rs. 12 crores but imports also surged to almost Rs. 5 crores. In dairy products, chocolates and confectionary imports and exports were Rs. 26 crores and Rs. 33 crores respectively. India has been exporting milk powder to other developing nations but our imports until recently have been very moderate. However, in 1999-2000 total imports of milk powder exceeded Rs. 100 crores. In fact, United States (US) has identified prospects for exports of butter and margarine to India (USDA, 1999). If one adds numerous such sub-sectors of the processed food industry, then the intra-industry trade in processed food sector is very significant.

Significant growth in intra-industry trade implies that in the domestic market there will be intense competition between imported and domestically produced similar food products. In such a market, while price competitiveness would matter, firms would increasingly focus their attention on selling branded, differentiated food products. Product differentiation and branding is possible if firms build quality competitiveness of their food products. And, building quality competitiveness implies analysing various quality attributes of a given product and incorporating consumers' perceptions about the quality attributes in their products. In developed countries, many studies have been carried out that identify the quality attributes, and the consumers' perceptions and valuations of these attributes. No such studies have been conducted in India. Moreover, ethnic Indian food products are least studied in this context. Domestic processed food industry must pay attention to such studies to develop strategic food quality management practices.

We pick-up one such ethnic Indian food product for our study - desi ghee. In recent times, desi ghee has been manufactured by many companies under their own brand names. Corporate giants such as Nestle and Britannia, and cooperative giants such as Amul are already in the fray. The competition is getting intense. In fact, with the intent of giving a helping hand to US companies, even USDA has established guidelines for its firms on the quality parameters of ghee. Consumer organizations are also involved in testing quality of ghee. Recently, Consumer Education and Research Centre (CERC, 2001) has tested samples of ghee that constitute more than 80 percent of the brands available in India. In this context, the plan of the paper is as follows: In Section 2 we review the past literature that has used hedonic price analysis to elicit consumers' valuation of various quality attributes of a given product. In Section 3 we discuss the methodology of estimation. Section 4 covers data description and the regression analysis for ghee. Finally, Section 5 summarizes and draws conclusions.

## **2. Literature review**

Hedonic price analysis is based on the hypothesis that every good can be treated as a bundle of quality attributes that differentiates related goods from one

another. In the early part of the last century, Waugh (1928) formulated hedonic price analysis based on the observation that the different lots of tomatoes, asparagus and cucumbers in the vegetable market in Boston, Massachusetts, showed considerable variations in price. Waugh tried to identify those quality traits that were significantly influencing daily market prices. Later, Rosen (1974) presented a model of product differentiation based on the hypothesis that any good is valued for its utility generating attributes. According to him consumers evaluate product quality attributes when making a purchase decision. The observed market price is the sum of implicit prices paid for each quality attribute. Hence, price variable could be regressed on quality attributes as independent variables, where the coefficients would indicate valuation of each quality attribute in the price of the product.

Rosen, however, recognized an identification problem for the hedonic price functions. Product prices are equilibrium prices jointly determined by supply and demand conditions. Hence, implicit prices may reflect not only consumer preferences but also factors that determine production. In order to solve the identification problem it was necessary to separate supply and demand conditions. Nerlove (1995) examined the Swedish wine market which had no domestic producers and the wine prices were controlled by government. This allowed him to presume that prices were exogenous (as opposed to assuming supply is exogenous) and to estimate a reduced form hedonic price function regressing quantities sold on various quality attributes and prices. In effect, Nerlove assumed that wine consumers in Sweden express their valuation of a particular quality attribute by varying the derived hedonic demand for it.

In an analysis of the U.S. wine market, Schamel, Gabbert and Witzke (1998) estimated a hedonic pricing model based on sensory quality ratings, individual wine quality and regional reputation indicators for two premium wine varieties: Chardonnay (white wine) and Cabernet Sauvignon (red wine). The estimated price elasticity of sensory quality was larger for white wine, indicating that U.S. consumers were willing to pay a higher quality premium for white wine compared to red wine. The results also suggest regional reputation and individual quality indicators seem to be more important to U.S. consumers of red wine. They concluded that that differentiating wines on the basis of regional origin as a quality attribute may have a higher payoff for regions primarily growing red wine. The authors allude to the identification problem resulting out of implicit price being jointly determined by demand and supply. However, they assumed that production of quality wines was a highly technical job and supply cannot be altered in a short period of time.

Among other studies, Shapiro (1983) presented a theoretical framework to examine reputation effects on prices. He developed an equilibrium price-quality schedule for high-quality products assuming competitive markets and imperfect consumer information to demonstrate that reputation allows high-quality producers to sell their items at a premium that may be interpreted as revenue for investment in reputation. Similarly, Oczkowski (2000) examined hedonic price functions for Australian wines, and found significant reputation effects but insignificant quality effects. Recently, Weemaes and Riethmuller (2001) investigated the role of quality attributes on the consumption of fruit juices. The study involved market valuation of the various fruit juice characteristics, although it did not consider consumers' attribute valuation via their preferences. Among other sources, quality attributes are generated

using information from the product label. According to the results, consumers pay a premium for nutrition, convenience and information.

Studies such as the ones mentioned above are an important tool for agribusiness managers. Estimation of implicit prices for quality attributes is potentially useful for strategic quality management where a firm can innovate its product by incorporating consumers' quality perceptions. No such studies have been carried out for the processed food products in India in general, and, for ethnic Indian processed food products in particular. Precisely for this reason, we conduct the hedonic price analysis for ghee in the Indian market. We turn to the details of the methodology next.

### 3. Methodology

We have adopted the model suggested by Lancaster (1966) and Rosen (1974), and use the notation given by Schamel, Gabbert and Witzke (1998). According to the model, the utility is enhanced not by the consumption of an economic good but by the characteristics of that good. Therefore, the market price of the good is the sum of the prices consumers are willing to pay for each characteristic that enhances its utility. The demand function derived from maximizing consumer utility function provides the foundation for Hedonic price analysis.

The Hedonic price function for the  $i^{\text{th}}$  brand of ghee can be described as a function of its characteristics:

$$(1) \quad P g_i = P g ( z_{i1}, \dots, z_{ij}, \dots, z_{in} ),$$

where  $z_1, \dots, z_n$  are ghee characteristics. The utility maximization problem for a representative individual can be formulated as:

$$(2) \quad \text{Max } U = U ( X, \mathbf{Z} ) \quad \text{s.t. } M - P g_i - X = 0,$$

where  $X$  is a composite, numeraire commodity and  $M$  is income. An implicit assumption is that each individual purchases only one unit of ghee in a given period. Applying first order condition for the choice of characteristics  $z_j$  we get:

$$(3) \quad \frac{\delta U / \delta z_j}{\delta U / \delta X} = \frac{\delta P g}{\delta z_j}$$

Equation (3) is nothing but stating the law of equimarginal utility between two goods,  $X$  and  $z_j$ .  $\delta P g / \delta z_j$  is the marginal implicit price for characteristic  $z_j$  and corresponds to the regression coefficients when estimating equation (1). Further, the utility function  $U$  can be rewritten as:

$$(4) \quad U = U ( M - P g_i, z_{i1}, \dots, z_{ij}, \dots, z_{in} ).$$

Inverting equation (4) and solving for  $P g_i$  with  $z_j$  as a variable and  $U^*$  and  $\mathbf{z}_{-j}^*$  being held constant at their

optimal values associated with problem in (2), we can write a bid curve  $B_j$  as follows:

$$(5) \quad B_j = B_j(z_j, z_{-j}^*, U^*)$$

Holding other things at the optimal level, (5) describes the maximum amount an individual would be willing to pay for a unit of ghee as a function of  $z_j$ . A well-behaved bid curve is ought to exhibit a diminishing willingness to pay with respect to  $z_j$ . Based on their individual preferences and/or incomes consumers can have different bid curves  $B_j^1(z_j)$  and  $B_j^2(z_j)$  as shown in Figure 1.

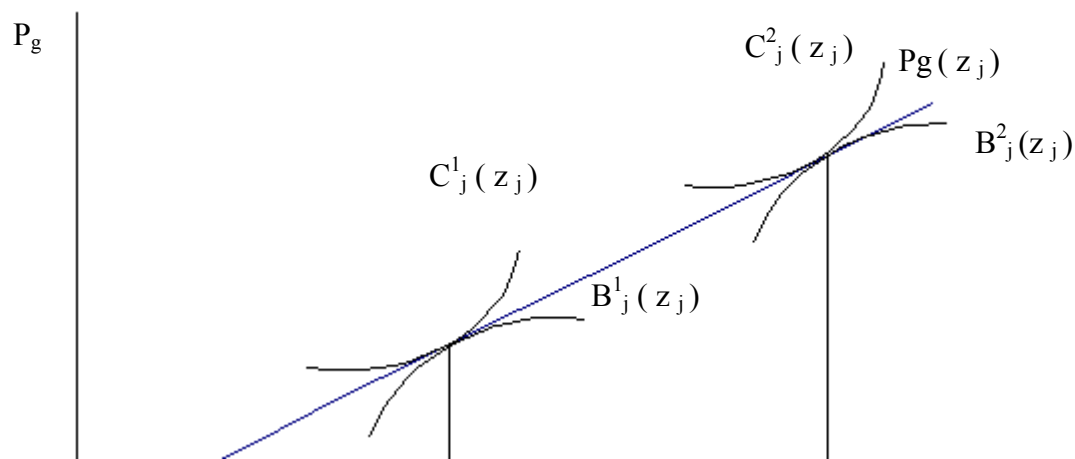
On the supply side as well, firm's cost of production depends on the characteristics of the product. Offer curve for the characteristic  $z_j$  derived from the firm's cost function can be represented by:

$$(6) \quad C_j = C_j(z_j, z_{-j}^*, \pi^*)$$

Equation (6) explains the minimum price a firm would accept to sell a unit of ghee as function of  $z_j$ , holding other attributes and profit at the optimal level. Offer curves  $C_j^1(z_j)$  and  $C_j^2(z_j)$  for two individual ghee producers are also shown in Figure 1. Now, the equilibrium condition is that bid and offer curves for all quality attributes and for each market participant must be tangent to the Hedonic Price Function  $P_g(z_j)$ , which is an equilibrium locus for all individual bid and offer curves.

Ideally, to study the valuation of quality characteristics by the buyers of ghee one would like to model both the demand and supply sides. However, for estimation purpose we have considered only the demand side of the ghee market. Freeman (1992) shows that assuming the markets to be competitive and in equilibrium, implicit price of an  $i^{\text{th}}$  brand of a product can be specified without modelling the supply side. Also, with no significant changes expected in the branded ghee supply in the short-run, and, only a cross-sectional data at a point in time being available for the analysis, we assume that supply is exogenously determined. Moreover, only the data on sensory and other attributes relevant for the demand side estimation were available.

**Figure 1: Bid and Offer Curves in Hedonic Pricing\***



$$z_j^1 \qquad z_j^2 \qquad z_j$$

\* Adapted from Schamel, Gabbert and Witzke (1998).

#### 4. Data and Regression Analysis

Our objective is to estimate a hedonic price line as discussed in equation (1) and as shown in Figure 1. It involves regressing ghee prices on explanatory variables that are measures of quality attributes for ghee. There are various sensory and analytical quality attributes of ghee. The sensory attributes are essentially the organoleptic attributes which a consumer is able to detect. The analytical attributes are related to contamination of ghee with pesticide and heavy metal residues and adulteration which consumers cannot detect. One of the quality attributes of ghee is its flavour. Flavour is a combination of smell and taste. Ghee is flavourful if it does not have burnt, rancid, curdy, oxidized, or smoky smell. Traditionally, home-made or desi ghee is supposed to have 'grainy' texture or feel. Lack of grainy texture indicates presence of excess oxygen which may give a bad smell due to oxidation. One more sensory attribute is the colour.

Data for this empirical study has been taken from a test report published by CERC (2001). The report covers almost more than 80 percent of the ghee brands available in India. Although it reports scores for both the sensory and the analytical quality attributes, we use only the sensory scores as consumers' perception is based mainly on organoleptic quality attributes. Their perception is not based on analytical attributes simply because then cannot detect these attributes while consuming. While CERC gives subjective weights to each quality attribute, we give equal weight to all sensory attributes. Further, we hypothesize that consumers' perception and hence the price will also be determined by two other factors, namely, whether the ghee is branded or not, and, whether the ghee is sold by corporate entities or co-operatives. There were 15 branded ghee samples and 2 were sold loose. Moreover, 10 samples were from corporate sector (Nestle, Britannia, and others), 5 from cooperative sector (Amul and others), and 2 from the unorganised sector. The description of variables is provided in Tables 1.

Given the data above, we estimate the Hedonic Price function in (1) in the following form:

$$(6) \quad P_{gi} = \alpha_0 + \alpha_1 Z_{i1} + \alpha_2 Z_{i2} + \alpha_3 Z_{i3} + \alpha_4 Z_{i4} + \alpha_5 Z_{i5} + e_i$$

The estimation of regression equation and its diagnostic tests are reported in Table 2 and Table 3 respectively.

The multiple coefficient of correlation,  $R^2$  is 0.76 and the adjusted  $R^2$  is 0.66. The regression equation meets the goodness of fit test. In fact, the F statistics of 7.1 is significant even at a very stringent significance level of 0.003. Cross sectional data is prone to heteroscedasticity problem. Hence, we test the regression equation for heteroscedasticity using B-P-G and Glejser tests. The estimated  $\chi^2$  values are not

significant both at 0.01 and 0.05 significance levels. Hence we cannot reject the null hypothesis of homoscedasticity.

The regression equation indicates that consumers are willing to pay a premium of about Rs. 24 for a branded ghee over an unbranded ghee sold loose in the market. Moreover, corporate brands too command a premium. Consumers are willing to pay a premium of about Rs. 20 for a corporate brand of ghee over a co-operative brand.

**Table 1: Description of Variables\***

Variable	Description	Mean	St. Dev.
$P_g$	Max. retail price of ghee/500 gm	82.42	12.02
$Z_1$	A score for the attribute: Flavour	9.23	0.64
$Z_2$	A Score for the attribute: Texture	7.77	0.11
$Z_3$	A Score for the attribute: Colour	8.98	1.32
$Z_4$	= 1 if Corporate, = 0 otherwise	0.71	0.47
$Z_5$	= 1 if branded, = 0 if sold loose	0.88	0.33

\* Adapted from CERC (2001) for variables  $P_g$  and  $Z_1$  to  $Z_3$ .

**Table 2: Regression Estimate**

Variable	Coefficients	Std. Error
Constant	183.76	140.04
$Z_1$	9.56 <sup>a</sup>	4.55
$Z_2$	-21.77 <sup>b</sup>	18.31
$Z_3$	-6.21 <sup>c</sup>	2.07
$Z_4$	20.27 <sup>c</sup>	4.63
$Z_5$	23.90 <sup>c</sup>	5.73

<sup>a</sup> Significant at 0.03 one tail test and 0.06 two tailed test. <sup>b</sup> Not significant even at 0.10 two tailed test <sup>c</sup> Significant at 0.01 two tailed test.

**Table 3: Evaluation of the Regression Equation**

	Diagnostics	Test	Value
1.	Homoscedasticity Tests:	B-P-G $\chi^2$ Glejser $\chi^2$	3.8 <sup>d</sup> 4.0 <sup>d</sup>
2.	Goodness of Fit Test:	F statistics	7.1 <sup>e</sup>
3.	Correlation Coefficient:	$R^2$ Adjusted $R^2$	0.76 0.66

<sup>d</sup> not significant at 0.01 and 0.05. <sup>e</sup> Significant at 0.003.



Both the coefficients in the regression are significant at 0.01. This indicates that brand and the nature of firm contribute to the reputation premium. This result is similar to that of Shapiro (1983) and Oczkowski (2000) as mentioned earlier in the literature review. Flavour has a considerable and significant impact on price. For a unit improvement in the flavour score consumers are willing to spend additional Rs. 9.60. Texture on the other hand does not seem to be influencing the willingness to pay as its coefficient is not statistically significant. As regards the colour attribute, it appears that consumers are willing to pay Rs. 6 less for every improvement in the colour quality.

Although Rs. 6 is a small amount, this negative relation needs some discussion. There seems to be some ambiguity regarding the colour attribute of ghee. The CERC defines 'creamy' as the ideal colour of ghee. However, we wonder how consumers interpret the creamy colour. Is it creamy white or creamy yellow or something in between? A leading corporate brands mentions their ideal colour of ghee which is different than 'creamy.' Moreover, we are given to understand that ghee made from cow milk is yellow in colour as against the white colour for the ghee made from buffalo milk. To complicate matters further, the milk used in ghee production could be a mixture of cow and buffalo milk. Hence, 'not-creamy' need not have received a lower score on the colour attribute.

## **5. Summary and Conclusion**

The recent post-WTO experience shows that processed food industry is showing features of intra-industry trade. Presence of intra-industry trade implies that there will be intense competition between Indian and foreign processed food companies in the domestic market as well. In this context, product differentiation and emphasis on quality competitiveness will assume importance. Enhancing quality competitiveness requires understanding of consumers' perceptions and valuation of variety of quality attributes and incorporating the important ones in the product during manufacturing and/or marketing operations.

We apply the hedonic price analysis to the Indian desi ghee to understand consumers' perception and valuation of various quality attributes of ghee. Results show that consumers put a premium not only on branded ghee but on the nature of firm as well, i.e., corporate brands earn a premium over brands sold by cooperatives. Moreover, flavour is the dominant quality attribute for which consumers are willing to pay more. Texture does not appear to be that important an attribute. Moreover, colour attribute shows a negative relation to price, although we wonder whether there could be a unique ideal colour attribute for ghee. Implications of these observations are the following: Building brand reputation is extremely important. Moreover, cooperatives need to enhance their reputation through marketing and advertising to effectively compete against corporate entities. Amul might be the only exception to suggestion. In terms of sensory attributes, ghee manufacturers would do well to focus more on flavour attribute than other attributes. There seems to be a need to develop an agreement on what would be the ideal colour attribute for ghee.

There are some general implications as well. In the developed countries, numerous such studies have been done. Food processing firms benefit from such studies as they are able to identify the quality attributes of a product that consumers value most and work on improving these attributes of their food products. In the post-WTO liberalized environment, managers and professionals associated with the Indian food industry must incorporate this strategic food quality management tool if they have to effectively compete with foreign brands. Moreover, as a prerequisite, it is imperative that efforts be made to identify quality attributes of variety of processed food products, identify tests to measure these attributes quantitatively, and perform consumer preference surveys on various brands. This could be done by large companies themselves or as is done by food laboratories and organizations such as CERC.

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