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HEDONIC PRICING OF MILK AT RETAIL LEVEL: A Case of Faisalabad, Pakistan

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The study investigates as to how different attributes influence the retail price using milk as a case study. The analysis of this study is based on the 'revealed preference theory' using 'hedonic price analysis'. For this purpose the data was collected by use of a questionnaire and by obtaining milk samples from the household consumers of Faisalabad city of Pakistan. Linear functional form was used to estimate influence of milk components and sensory variables as perceived by consumers on the price of milk. Findings of the study indicate that various attributes (i.e., fat, solid-not-fat, total plate count, aroma, color, etc.,) has significant impact on the price of milk. The results suggest that the government should take appropriate measures to improve the quality of milk through check-points and installation of milk testing laboratories. Provision of cooling tanks/chilling units should be installed at producer-centres/associations; and refrigerated transportation would also help to improve the quality of milk and prevent milk spoilage.

I. Introduction

The livestock sub-sector contribute 11.8 per cent to the Pakistan's Gross Domestic Product (GDP) and 55.9 per cent to the GDP generated in agriculture [Government of Pakistan (2014)]. Approximately 30-35 million of rural population is involved in raising livestock [Burki, et al. (2005)]. Further, the gross value addition of livestock sector was 776.5 billion in 2013-14 which shows 2.7 per cent growth as compared to the previous year. This sector contributes toward foreign exchange earnings through export of various livestock products like leather, woolen carpets, hides, skins etc., (Government of Pakistan (2014). The total milk production was estimated to 780 million tonnes in the world in 2013 of which the developing countries account for 51 per cent [FAO (2013)]. Pakistan contributes about 4.9 per cent towards the total milk production produced in the world [Hassan, et al. (2014)]. Pakistan is the fourth largest producer of milk and produces 40 million tonnes (ACIAR (2015)].

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Milk is used in a variety of ways for preparation of indigenous products like khoa (evaporated milk), makkhun (butter), ghee (butter oil), lassi (butter milk), kulfi (form of ice cream), daie (yoghurt), cheese, rabri (clotted cream), etc. Key components of milk which make these products are butterfat (BF), solid not fat (SNF), and water. These components have different compositions in various milk products and each component of milk has an implicit value which can be derived either at the farm level where milk is sold to dodhi (milkman – the first stage milk collector) or dairy processors [Ladd and Martin (1976); or at the retail level, Ladd and Suvannunt (1976) and Xiao (2012)]. If the dairy marketing system is efficient and transmits efficiently the price signals for raw milk from the retail market products to the farm market, the implicit value of these components at the farm level will be equal to the value derived from the retail market [Gillmeister, et al. (1996).

In Pakistan butterfat differential pricing system is used by the processing sector, which adjusts the price of milk in accordance with relative share of butterfat to skim milk. No adjustment is made for the relative value of butterfat to solid-not-fat, butterfat to water or solid-not-fat to water, etc. Under the *dodhi* milk collection system the price system has no link to butterfat percentage or with other components of milk. Many studies indicate that ignoring butterfat volume is an inefficient pricing system [Jacobson and Walker (1973), Ladd and Dunn (1979), Perrin (1980), Kirkland and Mittelhammer (1986), Lenz, et. al. (1991), LeGault, et al. (2004), Brandt, et al. (2009), Xiao (2012)]. Similarly, price system which totally ignores all key components of milk is still more inefficient. To overcome these inefficiencies, multiple component pricing has been suggested as an alternative system that would pay explicit price for various components of milk. The multiple components pricing at retail level can provide necessary signals to dairy producers which would efficiently match to their milk components production at retail level components demand; which is implicit for dairy demand production [Cook (1954), Hiller, et al. (1980), Kirkland and Mittelhammer (1986) and Xiao, (2012)]. Perrin (1980) suggested that for determining retail level milk component values, product characteristics framework could be useful but this topic has not been paid due attention, especially in the developing countries. The present study is therefore directed to develop a model for determining retail level milk component values by using the household survey data and suggest policy measures for future research.

A number of studies were conducted with the applications of hedonic model to various commodities [Cook (1954), Hiller, et al. (1980), Jacobson and Walker, (1973), Smith and Snyder (1978), Kirkland and Mittelhammer (1986), Lenz, et al. (1991), Lenz, et al. (1994), Perrin (1980) Cropper, et al. (1988), Paker and Zilberman (1993), Bowman and Ethridge (1992), Gillmeister, et al. (1996), Richards and Jeffrey (1996), Combris, et al. (1997), McConnell and Strand (2000), Oczkowski (2001), Whitley (2002), Rudstrom (2004), Silvente and Walker (2006), Petrick and Latruffe (2006), Ahmad and Anders (2012)]. However, no study has been conducted

on milk which pertains to a developing country where milk components and sensory variables are important to determine the price of milk.

II. Material Review and Conceptual Methods

The conceptual model for the present study is based on economic theory, relating to hedonicz analysis of household consumption decision. This approach is also used in various economic studies like Ahmad and Anders (2012), Roheim, et al. (2007), and, Kristofersson and Rickertsen (2007). In this approach, the consumer tries to maximize the utility. It is assumed that utility of a product depends on consumption of various attributes, i.e., consumers do not maximize their utility with consumption of a commodity - rather they maximize the utility with consumption of its various combination of attributes. In the hedonic price model, if P_i is the price of a commodity purchased by *ith* consumer and let X_i (X_{i1}, X_{i2}, ...X_{in}) be the different characteristics of that commodity, then the hedonic price equation can be written as $P_i = F(X_i)$ where F shows some functional relationship. Therefore, the general functional form in matrix notation can be written as:

$$p_i = x_i' \beta + \varepsilon_i$$

where ε_t is the vector of error term, x_i is the vector of the level of characteristics for the *ith* transaction, and β is the vector of parameters.

Aggregate milk commodity can be defined in a way that variation in milk price can be explained in terms of characteristics embodied in milk and the sensory variables. One would expect that variation in milk price is closely related to nutrients present in milk (fat, solid-not-fat) and the sensory variables (roma, color, taste, etc). It may be pointed out that studies conducted earlier [Hiller, et al. (1980), Jacobson and Walker (1973), Kirkland and Mittelhammer (1986), Lenz, et al. (1991), Lenz, et al. (1994), Perrin (1980), Gillmeister, et al. (1996)], included only the components of milk as independent variables. Non-nutrient sensory variables like color, aroma, etc., were not included in the list of independent variables probably due to the fact that processing firms of milk has to meet some standards. In a country like Pakistan where 98 per cent milk is consumed in raw form, sensory variables are very important. Since one would expect a positive/negative correlation of sensory variables with butterfat and solid-not-fat, thus excluding such variables will result in specification bias/omitted variable bias [Asteriou (2005)]. It is hypothesized that butterfat and solid-not-fat contents will have positive impact on the price of milk. Milk with high contents of each butterfat and solid-not-fat indicate higher quality is liked by most consumers in Pakistan; and therefore, should have a higher selling price. Milk with high total plate count is more susceptible to spoilage and therefore is expected to be sold at lower price. Thus, for milk, hedonic price functions in linear form can be written as:

$$Price = \beta_1 Fat + \beta_2 Solid\text{ - }not\text{ - }fat + \beta_3 Water + \beta_4 Total\ Plate\ Count + \beta_5 Color + \beta_6 Aroma + \beta_7 Taste + \beta_8 Perceived\ Freshness + \varepsilon_t \quad (1)$$

Variables definitions and expected signs are given in Table 1. Since the sum of the proportions of butterfat, solid-not-fat and water is equal to one, therefore inclusion of the intercept term in Equation (1) will generate a matrix which is singular and thus the intercept is excluded.

TABLE 1

Variable Definitions and Expected Signs

Variable	Variable Description	Expected Sign
Price	Milk price per liter in Rs	
Fat	Butterfat content in per cent	+
Solid-not-fat	Solid-not-fat content in per cent	+
Water	Water content in per cent	+
Total Plate Count	Total plate count (million)	-
Dummy Color	Dummy color = 1 if color is good, zero otherwise	+
Dummy Aroma	Dummy aroma = 1 if aroma is good, zero otherwise	+
Dummy Taste	Dummy taste = 1 if taste is good, zero otherwise	+
Dummy Perceived Freshness	Dummy perceived freshness = 1, zero otherwise	+

An important assumption of OLS is the homoscedasticity where variance of disturbance term should be equal for all observations. The coefficients of OLS in presence of heteroscedasticity give consistent but inefficient estimates of parameters and inconsistent covariance matrix estimates. As a result, one would draw faulty inferences [White (1980), Gujarati and Sangeetha (2007)]. Since data of the present study is cross-sectional, the problem of heteroscedasticity can be faced. To address this issue Breusch-Pagan test is used; where null hypothesis of the test is that variance of error term is constant. Their devise is a Lagrange multiplier test - the test statistic of which is as follows:

$$LM = \frac{1}{2}\left[g' Z(Z'Z)^{-1} Z'g\right] \quad (2)$$

where Z is $m \times n$ matrix of observations on vector of independent variables, and g is vector of observations and is denoted as:

$$g = \frac{e_i^2}{\left(\frac{ee}{n}\right)} - 1 \quad (3)$$

where e denotes the vector of error term [Greene (2008)].

III. Data Collection

The data about different variables identified was collected through the use of questionnaire by collecting milk samples from the household consumers of Faisalabad city, which is the third largest city in Pakistan, with a total population of around 7.4 million. Raw milk is sold to consumers by a large number of retailers; most of them buy the milk from the producers.

The milk retailers move from house to house to sell their milk to consumers. For the purpose of sampling Faisalabad was stratified into various residential areas on the basis of socioeconomic characteristics. A total of 98 households were selected from the three residential areas, each of high, middle and low income categories. Information was obtained from respondents about the color of milk (desirable and undesirable), taste (good or not good), aroma (good or not good) and the perceived freshness (yes or no). Sample milk was also obtained from the respondent to determine the milk ingredients i.e., fat, solid-not-fat, water, total plate count, etc. The National Institute of Food Science and Technology, University of Agriculture, Faisalabad, played the key role in data collection and the laboratory analysis.

Descriptive statistics for various variables considered in this study are given in Table 2. The average values of fat and solid-not-fat contents are 3.77 and 7.21 per cent, respectively, which are lower than the minimum standard values. However, the mean value of water and total plate-counts were higher than the maximum value which should have been present in the milk. This is a serious problem of adulteration. As most households are poor and their per capita income is low therefore, they are generally less conscious about components and hygienic conditions of milk. Mixing water in milk by the informal traders and farmers is a common trend. It is easy on the part of farmers to add water to milk while selling it to informal traders. Further, the mid-

TABLE 2

Descriptive Statistics for Milk

	Mean	Median	Maximum	Minimum	Std. Dev.
Price	45.31	44	60	30	5.07
Fat	3.77	3.7	6.16	1.2	0.88
Solid-not-fat	7.21	7.01	9.62	5.02	1.07
Water	89.02	89.37	92.75	85.13	1.70
Total Plate Count	51.21	4.85	781.00	0.18	138.08
Dummy Color	0.68	1	1	0	0.47
Dummy Aroma	0.78	1	1	0	0.42
Dummy Taste	0.74	1	1	0	0.44
Dummy Perceived Freshness	0.76	1	1	0	0.43

dleman knows that quality of milk will not be checked by any one and therefore, to increase the quantity of milk they add water to milk – hence more income. A study conducted under similar conditions in Indian Punjab mentioned unhygienic conditions and the problem of milk adulteration [Candler and Kumar (1998)].

IV. Results and Discussion

In the hedonic model the value of R^2 shows that 99.2 per cent variation in milk price is due to variables relating to different components of milk (fat, solid-not-fat, water, and total plate count) and sensory variables (color, aroma, taste, perceived freshness). The estimated F-value (1832.11) is significant at one per cent level of significance and shows that, to test the omission of a relevant variable all variables have jointly significant impact on the price of milk. The present study also applied Ramsey RESET test. The test statistics is 1.37 which is not significant and shows that there is no problem of omitted variable bias. To detect the problem of multicollinearity, the study uses the Klien's rule of thumb. According to this rule, the multicollinearity is not a troublesome problem as R^2 values of different auxiliary regressions are less than R^2 of the model [Gujarati and Sangeetha (2007)]. However, correlation matrix shows a negative correlation between water and fat, as well as between water and solid-not-fat. To overcome the multicollinearity, exclusion of water variable led to the problem of misspecification of the model, as indicated by the Regression Equation Specification Error Test. For addressing the issue of heteroscedasticity, the present study used the Breusch-Pagan/Cook-Weisberg test; the results of which shows that there is no problem of heteroskedasticity (Table 3). Further, results of the Wald test shows that each category of attributes has significant impact on the price of milk (Table 4).

The estimated coefficient of fat was not significant, which is against our expectations. It shows that consumers are not paying any premium or their discounted price on milk which contains varying level of fat percentage. Economic literature concludes that consumers give less preference to fat percentage in milk, as relative to the other components, such as, protein, calcium etc., [Lenz, et al. (1994)]. The parameter estimate for solid-not-fat is positive and has a significant impact on price. The coefficient of solid-not-fat is 1.310 and shows that consumers are paying premium price to milk having more solid-not-fat in it. Economic literature has reported similar findings [Perrin (1980)], St-Pierre and Scobie (1987), and Gillmeister, et al. (1996)].

The value of water is often assumed to be zero in the retail market. However, water and price have direct relationship and the parameter estimate of it is significant. Gillmeister, et al. (1996) also shows that there is positive relationship between the price and water percentage which suggest that milk marketing system is inefficient in its component value transmission [Perrin (1980)]. The sign of total plate count is negative which means that there is an inverse relationship between the total

TABLE 3

OLS Estimates of Hedonic Pricing Model of Milk

Variable	Parameter	Stand. Error	t-test
Fat	0.464	0.583	0.797
Solid-Not-Fat	1.310*	0.466	2.813
Water	0.319**	0.033	9.784
Total Plate Count	-0.012**	0.003	-3.619
Dummy Color	2.255**	0.974	2.316
Dummy Aroma	3.509**	1.348	2.602
Dummy Taste	1.135	1.258	0.902
Dummy Perceived Freshness	1.533	1.032	1.486

$R^2 = 0.9922$
$F = 1832.11$**
Breusch-Pagan / Cook-Weisberg $\chi^2 = 0.77$
Ramsey RESET test 1.37

**, * statistical significance at 1 and 5 % level respectively, of significance based on robust procedure.

TABLE 4

Wald Test for Category of Attributes

Attribute Category	H_0: Attribute category does not have any impact on the price of milk
Components of milk	239.10**
Sensory variables	5.73**

**statistical significance at 1% level of significance based on robust procedure.

plate count and the price of milk. It shows that as value of the total plate count increases, customers have to pay the discounted price. This is due to the fact that milk with higher total plate counts is more susceptible to spoilage problems and has a significant negative impact on the productivity of milk on consumers [Gillmeister, et al. (1996)].

Food related sensory variables like color, aroma, taste and the perceived freshness can be used as proxies for quality when objective quality measures are not available as these variables have direct effect on milk intake. Dummy variable for good color has significant positive parameter estimate. This shows that milk color affects consumers' judgment about its quality and hence, influences its intake and price. Parameter estimate for dummy variable aroma is positive and significant. It

shows that good aroma of milk has direct influence on the price of milk. The coefficient of aroma is 3.509 which is significant at one per cent level of significance. It shows that consumers are paying premium price of Rs.3.509/- if milk does not have good aroma. This is probably due to the effect that milk intake depends on pleasantness of the aroma. Further, pleasant aroma associated with milk increases consumers' quality evaluation and willingness to purchase. Other milk variables, i.e., dummy taste and dummy perceived freshness have positive but non-significant parameter estimates.

V. Conclusion

The present study determines relationship between the price and various attributes of milk at the retail level. Since the present study is based on revealed preference, a structured questionnaire was used to collect the information regarding the price and sensory attributes of milk. Samples were taken for analysis to determine the embodied characteristics of milk. Hedonic price analysis was used to determine the relationship between price and various characteristics of milk. This method allows the monetary impact of each characteristic and sensory variable on the price of milk which should be determined.

Results of the study suggest that average value of different components of milk was not up to the mark. The average value of fat content in the sample showed that its value is lower than even the minimum value of fat contents which should have been present in the buffalo milk. The mean value of water depicts that mostly the sample data had more water percentage than the standard milk. Thus, it can be concluded that milk was adulterated with water. The results of the hedonic price model showed that all signs of various attributes were according to expectations of this study. The sign of coefficients of fat, solid-not- fat and water showed positive impact while total plate count coefficient had negative influence on the price of milk. The positive coefficient of fat and solid-not-fat depicts that consumers are paying premium price for these attributes, while the estimated sign of total plate count shows that consumers are paying discounted price for milk having more total plate count. Coefficients of various sensory variables, such as color, aroma, taste and perceived freshness have positive signs, which shows that consumers are paying premium price for these sensory variables.

As the milk moves from producer to consumer, its quality deteriorates because of poor refrigeration facilities. The middlemen also remove the cream from milk and sell it separately. In order to increase fat percentage, the middlemen add cooking oil to milk which also results in lowering the quality of milk. In order to improve the quality of milk the government should take proper measures for checking milk quality when it moves from producers to consumers by installation of different check points. Further, to avoid deterioration of milk due during hot weather the

middlemen add ice to milk for chilling purpose, which also dilutes the milk. In order to overcome this problem the government should provide cooling tanks/chilling units to producers associations and refrigerated transportation measures. This will help to prevent milk spoilage and improve the quality of milk.

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