

Impact of Embodied Characteristics and Sensory Variables on the Price of Milk at Retail Level

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Abstract

The study is concerned with the valuation of various components of milk at retail level. To understand this relationship, cross sectional data at retail level are obtained and Hedonic model is applied to value different components of milk (fat, solid-not-fat, water, total plate count). The study further uses sensory variables (color, aroma, taste and freshness) to determine their impact on the price of milk. Results of the study show that fat and solid- not- fat contents have positive impact on price of milk, which means consumers pay premium price for milk having higher fat and solid- not- fat contents. Further the study shows that consumers pay premium price to milk having desirable color, aroma, taste and freshness.

Keywords: Retail level, Embodied characteristics, Sensory variables, Milk, Consumers

JEL classification: D12, Q13, P42

1. Introduction

Agriculture is the mainstay of Pakistan's economy. About 22 percent of gross domestic product (GDP) and 43.7 percent of total employment is generated in agriculture. Nearly 70 percent of country's population is directly or indirectly linked for their livelihood with agriculture. Within the agriculture sector, livestock sector contributes 11.8 percent to GDP and 55.9 percent to the value addition in the agriculture sector. Within the livestock sector, milk is the most important commodity and Pakistan has been placed at number five in terms of milk production in the world (Government of Pakistan, 2014). Milk production is increasing consistently over time in Pakistan².

In order to increase the production of livestock products, government of Pakistan has taken a number of initiatives which include: duty free import of dairy and livestock machinery/equipment not manufactured locally; import of more

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² For detail see appendix Table-1

efficient animals, semen and embryos for an improvement of dairy animals; import of high quality feed for an improvement of nutritional quality of dairy animals; initiation of micro credit schemes in order to provide access to credit to small farmers and finally encouragement in the establishment of value added industry in the dairy sector. (Government of Pakistan: 2014).

Milk is the most important commodity in Pakistan in terms of its contribution to GDP. Because of its perishable nature, it must be promptly collected from the producers and quickly distributed. Milk is produced by millions of small land holders or landless people. These households produce milk either for consumption or to supplement their income. Different marketing channels have been developed which often involves many intermediaries in the marketing chains. Intermediaries are 'Katcha dodies' (rural milk collector), 'Pacca dodies' (highway milk collectors), processors, commission agents, urban wholesalers, shopkeepers and door-to-door vendors. The most important intermediary is 'Katcha dodie'. He collects milk normally in the morning and transport to the urban center. In order to prevent deterioration, 'Katcha dodies' add preservatives and certain quantities of ice especially during summer. Addition of ice results in an increase in milk volume and shelf life (Zia, 2006; Adam, 2009). 'Kacha dodie' collects milk from the producers and transport it either directly to consumers or to the milk collection centers (Zia, 2006).

The milk supplied to the consumers is not standardized in any respect. Quality of milk varies in terms of its constituents i.e. butterfat, solid-not-fat etc. and in terms of sensory variables i.e. color, aroma, taste and freshness. Milk ranges in color from yellowish creamy white (cow milk) to creamy white (buffalo milk). The intensity of the yellow color of cow milk depends on breed, fat percentage etc. However the color of milk may change due to external environment. The color of food including milk plays a key role in food choice by influencing sweetness perception, food preference acceptability, judgment and food perception (Pangborn, 1984; Clydesdale, 1993; Zia, 2006). Aroma may be directly related to milk or to external environment which influence its odor. Spoilage of milk decreases aroma pleasantness rating. Similarly change in taste in milk due to spoilage has a negative impact on consumer's quality evaluation. Consumers pay the price depending upon the perceived level of butterfat, freshness, color of milk etc. The volume butterfat differential pricing system adjusts the price of milk in accordance with the 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 present traditional milk collection system, the pricing system has no connection with the butterfat

percentage or with other components of milk. Many studies have concluded that the volume butterfat differential pricing system is inefficient (Jacobson and Walker, 1973; Ladd and Dunn, 1979; Perrin, 1980; Kirkland and Mittelhammer, 1986; Lenz et al., 1994; Brandt et al., 2009; Xiao, 2012). Pricing system which ignores various components of milk and sensory characteristics is still more inefficient. Perrin (1980) has argued that product characteristics framework should be used for determining the values of various components of milk. The studies conducted in advanced countries do not take into account the sensory variables due to the fact that standard quality milk under different brands is available and expiry dates are displayed. The present study is expected to make significant contribution as it estimates the effect of various milk characteristics including sensory attributes on its price.

The rest of the study is follows as: section II give brief review of literature, section III provides material and method, section IV deals with data, section V is specified for results and discussion,

2. Review of Literature

A significant amount of literature exists that applies hedonic model on food products. Ward et al., (2008) and Schulz et al., (2012) applied hedonic price method on the beef. Both of these studies concluded that various attributes such as beef cut, package size, brand name, quality grade, presence of bone in the beef have significant impact on the price. Ahmad and Anders, (2012) and Roheim et al., (2007) studied the impact of various attributes of processed food products on the retail price. The results of the studies concluded that various attributes such as brand name, product form, and process form and package size have significant impact on the product price.

Gillmeister et al., (1996) studied the impact of various attributes on the price of milk at the farm level. The study was based on the dataset obtained from four states of US and concluded that different attributes such as fat, solid- not- fat, plate count, semantic cell count and water has significant impact on the price of milk. Xiao, (2012) estimated the relationship between various attributes of packaged milk and price at the retail level. The study used the dataset of package size, fat, protein, carbohydrate, region, organically produced milk, brand name and price. The results of the study showed that different attributes of milk has significant impact on the price. Gulseven and Wohlgenant, (2014) also studied the relationship of various attributes of milk and price. The study concluded that various attributes of milk has significant impact on the price of milk.

Most of the studies done in the literature were on the packaged milk. None of the studies estimated the relationship between the attributes of raw milk and price at the retail level. In a developing country, milk supplied at the retail level is not standardized and the quality of milk varies in terms of its attributes such as fat, solid not fat, water etc. Different sensory variables such as color, aroma, taste and freshness also play an important role in the consumers' valuation of milk. To the best of our knowledge none of the studies have been undertaken to study the relationship between various attributes of milk such as fat, solid not fat, water, plate count, color, taste, aroma and freshness on the price of milk. The present study contributes in the literature by estimating the relationship between these attributes and price of milk at retail level.

3. Material and Method

Hedonic pricing models can be used for valuing the characteristics of product. Following Lucas (1975), the quality characteristic for a product can be defined by a $n \times 1$ vector of characteristics $Z = Z_1, Z_2, Z_3, \dots, Z_n$. Where Z_j denotes the j th characteristic of a product, the characteristics could have positive or negative impact on the consumer's utility. This also require the assumption that saturation in Z_j is not arrived.

The price function of a product can be modified in order to allow price to be a function of quality characteristics, i.e.

$$P = F (Z_1, Z_2, Z_3, \dots, Z_n, \varepsilon) \quad (1)$$

Where P is the price of commodity, Z_j is the quantity of j^{th} characteristic in the product and ε is the error term.

Implicit price can be found by differentiating (1) with respect to each quality characteristic. It is expected that price of milk depends on different ingredients of the milk and sensory attributes of milk. For milk, hedonic model can be specified as:

$$\text{Price} = P(\text{Fat, Solid-Not-Fat, Water, Total Plate Count, Dummy Color, Dummy Aroma, Dummy Taste, Dummy Perceived Freshness})^3. \quad (2)$$

The mathematical functional form of the hedonic price model of milk can be written as:

³ For variable definitions and their expected signs, see appendix Table 2.

$$\ln Price = \beta_0 + \beta_1 F + \beta_2 SNF + \beta_3 W + \beta_4 TPC + \beta_5 DC + \beta_6 DA + \beta_7 DT + \beta_8 DPF + \varepsilon_i \quad (3)$$

Since in the present study some explanatory variables are dummy variables, we can choose either from linear or log linear model. On the basis of the theory, it is expected that non-linear functional form will provide better estimates (Steiner 2004). The present study estimate log linear functional form of hedonic model which assumes that prices paid to an additional unit of characteristics belongs to some product's bundle and the price varies due to change in the proportion of the characteristic in the product (Ahmad and Anders 2012). Further, in the log linear model, the relative impact of different dummy variables can be obtained by following Ahmad and Anders (2012) and using the expression as under:

$$g = \exp \left(\hat{\beta} - \frac{1}{2} \text{var} (\hat{\beta}) \right) - 1 \quad (4)$$

The relative value of each attribute estimate the impact of an attribute on the price of retail milk. Present study further estimates the relative value in percent terms and in monetary terms (the monetary value is evaluated at the sample mean).

4. Data

To study the impact of various milk characteristics and sensory variables on the price of milk, the data about the different variables such as price, fat, solid-not-fat, water, aroma, taste, freshness and color were collected through the use of questionnaire and by taking milk sample from the randomly selected household consumers from Faisalabad city. As the milkman moves from house to house to sell milk to the consumers, therefore, consumers from various households having different levels of income were selected from different locations. Information about the price paid per liter, color of milk (i.e. desirable or undesirable), taste (i.e. good or not good), Aroma (i.e. good or not good) and perceived freshness (i.e. yes or no) were collected from the respondent. Sample milk was also obtained from the respondent to determine the milk ingredient i.e. fat, solid-not-fat, water, total plate count etc.

The descriptive statistics for various variables are presented in Table-1. The descriptive statistics show that on an average consumers pay rupee 45 per liter, the minimum and maximum statistics show that the retail price of fresh milk varies from 30 to 60 rupee per liter. The average value of fat content present in the milk is 3.7 percent and varies from 1.2 to 6.16 percent. The solid-not-fat value varies from 5.02 to 9.62 percent with an average value 7.21 percent. The

average value of total plate count is 48 million. About 68 percent consumers are of the view that the color of the milk is desirable, 77 percent say that the aroma is good, 75 percent consumers are of the view that the taste of milk is good and 76 respondents report that the milk is fresh. The average value of water is 89.02 percent and comparison of composition of milk supplied by various sources show that with the exception of milk supplied by the vendor, water contents in the present study were higher than those reported by other researchers as shown in Table-2.

Table 1: Descriptive Statistics for Various Variables

Variable	Mean	Minimum	Maximum
Price (Rs.)	45.3	30	60
Fat (%)	3.70	1.20	6.16
Solid-Not-fat (%)	7.21	5.02	9.62
Water (%)	89.02	85.13	92.75
Total Plate Count	48085750	180000	7.81E+08
Dummy Color	0.68	0	1
Dummy Aroma	0.77	0	1
Dummy Taste	0.75	0	1
Dummy Perceived Freshness	0.76	0	1

Table 2: Composition of Milk Supplied by Various Sources

Source	Fat	Solid-Not-Fat	Water
Rural Milk Producer	5.81	9.43	84.76
Milk Collector	5.70	8.66	85.64
Urban Milk Producer	4.70	7.78	87.41
Milk Vendor	3.68	6.03	90.29
Processed Milk	3.49	9.00	87.51
NARC Dairy Farm Buffalo Milk	6.50	10.15	83.35
Cow Milk	3.81	9.03	87.15
Dairy Coop	5.78	8.73	85.49
Results of this study	3.76	7.21	89.02

Source: Sharif et al., 2003; Athar and Ali, 1986

This is perhaps due to the fact that watering of milk by the informal traders and the farmers is a common problem. It is easy on the part of farmers to add water to the milk while selling to the informal traders. Further, the middlemen know that their milk will not be checked for quality by any one; therefore, there is great incentive to add water. A study conducted by Candler and Kumar, (1998) in Jaipur in India showed that the addition of water to milk is a common practice (Table-3). Adulteration of milk is a long standing problem in Pakistan, like other developing countries. As the per capita income is low, people are generally less conscious about the components and hygienic condition of the milk. Study conducted under similar conditions in Indian Punjab indicates that 70 percent of the consumers indicated that there is a problem of adulteration and 68.8 percent mentioned unhygienic milk and problems of taste (Candler and Kumar, 1998).

Table 3: Adulteration of Water in Milk

Item	Percent
No Adulteration	17
0.1-20.0 percent water added	40
20.1-40.0 percent water added	35
40.1 and up water added	8

Source: Candler and Kumar, (1998)

It may be pointed out that in many cases milk is sold in adulterated form by saying that it is “buffalo milk”, while it originated from cow. Further, there is wide variation in the price that is paid by the consumers. Generally the consumers pay what they receive. It is a common practice that each “dudhiya” supplies more than one kind of milk and he charges according to the kind he supplies to the consumer. Consumers are also aware what kind of milk they are buying i.e. they pay a fairly high price for pure milk, lower price for adulterated milk and still lower price for more adulterated milk.

5. Results and Discussion

The empirical results of the present study show that different explanatory variables such as fat, solid-not-fat, water, total plate count and different sensory variables (color, aroma, taste, perceived freshness) have significant impact on the price of milk. The signs of these variables are according to our expectations (table 6). The fat content has positive impact on the retail price of milk. The coefficient of fat is 0.034823 and it is significant at 1 percent level of significance. Coefficients of both solid-not-fat and water are positive and significant at 1 percent level of significance. It is generally assumed that the value of water to be

zero but present study shows the coefficient of water is positive. The coefficient of total plate count is $-2.81E-10$ percent and is highly significant. This is due to the fact that an increase in total plate count in the milk will result in more chances of spoilage of milk.

Table 6: OLS Estimates of Log Linear Hedonic Model for Milk

Variable	Coefficient	Standard Error	t statistics	Relative Impact	
				% age	Rupee
Fat	0.0348**	0.014	2.486		
Solid- Not- Fat	0.0458**	0.015	3.005		
Water	0.0284**	0.001	33.916		
Total Plate Count	$-2.81E-10$ **	$7.94E-11$	-3.540		
Dummy Color	0.0500**	0.019	2.635	5.11 %	2.31
Dummy Aroma	0.0687**	0.026	2.693	7.07 %	3.20
Dummy Taste	0.0368	0.024	1.566	3.72 %	1.69
Dummy Perceived Freshness	0.0358	0.025	1.455	3.61 %	1.63

White's (1980) heteroskedasticity consistent standard errors are used for computing t statistics and ** shows that the coefficient is significant at 1% level of significance.

The coefficient of dummy color is 0.049993 and is significant at 5 percent level of significance. The coefficient shows that consumers are willing to pay high price if the color of milk is desirable. Relative value of dummy color shows relative impact of desirable color on the consumer buying behavior. We further computed the monetary value of desirable color; it shows consumers are paying 2.31 rupees premium price for the milk having desirable color. This is consistent with the marketing research which emphasizes that color influence the purchasing behavior (Pangborn, 1984). Dummy coefficient of aroma shows that consumers pay premium price for the milk having good aroma. The coefficient shows that consumer pay premium price of 3.2 rupees to the milk having good aroma. The relative comparison of dummy color and dummy aroma shows that consumers are giving more importance to the aroma. The coefficients of taste dummy and perceived freshness dummy are not significant. It may be noted that the good flavor of milk which is composed of aroma and taste can be maintained if the milk is not subject to spoilage. However changes in the flavor of milk may occur due to type of feed fed to dairy animals, stage of lactation, condition of udder, sanitation during milking and subsequent handling of milk in the marketing chain.

6. Conclusion

Agriculture plays an important role in the economy of Pakistan by providing livelihood to 70 percent of country's population. Within the agriculture, livestock sector contributes by providing different products like meat, bones, milk etc. Pakistan has fifth rank in the milk production in the world. Milk is being collected from a large number of small land holders or landless people. The milk marketing channel involves a large number of intermediaries such as rural milk collectors, highway milk collectors, processors, commission agents, urban wholesalers, shop keepers and door to door vendors. The milk supplied to the consumers is not standardized, so the quality of milk varies in terms of its components i.e. butterfat, solid-not-fat etc. and sensory attributes i.e. color, aroma, taste and perceived freshness. To understand how consumer value different components of milk and sensory attributes while buying milk from the door to door vendors, the present study uses hedonic pricing model.

For this purpose, the primary data were collected from Faisalabad market. The milk samples were also collected to compute the value of various attributes of milk. The results of the study show that different attributes such as fat, solid-not-fat, water etc. have a significant impact on the price of milk. Fat, solid-not-fat and water has positive impact on the price of milk. The study further computed the relative value of different sensory variables. The results show that consumers pay premium price for milk having good aroma and desirable color. The findings of the study suggests that government must take appropriate steps to overcome the quality problems associated with clean milk production, unhygienic practices in milk handling, poor transportation facilities, and mal practices in milk (i.e. addition of water to increase volume, addition of vegetable shortening to increase fat content, uncontrolled use of milk powder, addition of undesirable preservative to avoid spoilage, addition of starch to increase solid content).

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Appendix

Table 1: Milk Production in Pakistan Overtime.

Year	Production (000 tons)
2001-02	27031
2002-03	27811
2003-04	28624
2004-05	29438
2005-06	31,970
2006-07	32,986
2007-08	34,064
2008-09	35,160
2009-10	36,299
2010-11	37,475
2011-12	38,617
2012-13	39,855

Source: Government of Pakistan, 2014

Table 2: Variable Definitions and Expected Signs.

Variable	Variable description	Expected sign
Price	Milk price per liter in Rs	
Fat (F)	Butterfat content in percent	+
Solid-Not-Fat (SNF)	Solid-not-fat content in percent	+
Water (W)	Water content in Percent	+
Total Plate Count (TPC)	Total Plate Count	-
Dummy Color (DC)	Dummy = 1 if color is desirable otherwise zero	+
Dummy Aroma (DA)	Dummy = 1 if aroma is good otherwise zero	+
Dummy Taste (DT)	Dummy = 1 if taste is good otherwise zero	+
Dummy Perceived Freshness (DPF)	Dummy = 1 if perceived fresh otherwise zero	+