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Determinants of Milk Price in India: An Exploratory Study

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Milk market in India is in a demand-led growth phase due to increasing income levels and lifting of ban on export of skim milk powder. This has resulted in an unprecedented and continual rise in domestic milk price causing anxiety to consumers. It has also become a major concern for policy makers dealing with food inflation as milk forms an integral part of Indian diet. Studying this price rise is crucial because the two long-term supply side determinants of milk which are female bovine animal population and milk production per animal are exhibiting reversal in growth trend, since 2007. This paper identifies the determinants of milk price on the supply and demand side. Using Error Correction Model on monthly time-series data, we find that skim milk powder, butter and per capita income have significant influence on milk price in the long and short-term. Price of beef is found to have a significant long-term influence. The paper concludes by suggesting a few policy areas that require attention to augment the much needed growth in milk supply.

Keywords: Milk price, key determinants, Policy

1 Introduction

India is the largest producer of milk in the world with an estimated production of 135.76 million tonnes in 2013[i] accounting for 17% of world's total dairy production (Mani, 2013). India is also the biggest consumer of milk with over 80 million tonnes of milk consumed in 2007[ii]. Milk production process employs 14.9 million people in rural areas[iii]. This constitutes 54.6% of the total workforce in the country[iv]. Milk contributed 7% to 8% of the total household expenditure in 2011-12. The national averages of milk consumption per capita in 2011-12 were 218 and 162 grams in urban and rural areas, respectively[v], which is lower than 250 grams being consumed in developed nations. This gap in per capita consumption and high population indicates scope for increase in total demand for milk. World Bank considers increasing milk production as an important pathway to alleviate poverty and enable inclusive growth in India[vi].

India is self-sufficient in terms of its milk production and consumption through many years of long and concerted nation-wide efforts, one that began with Operation Flood programme in the 1970s. This programme assured a ready market for any quantity of milk supplied right in the village, linking the marketable surplus simultaneously with the consumption centres in urban areas. Export and import of milk powder was banned after ensuring sufficient domestic buffer stock. This helped in reducing seasonal fluctuation in milk price at the producer and consumer end. This ensured that there was incentive for milk production and milk was available through the year and its price did not become a major factor in food inflation.

The domestic demand for milk is estimated to be growing at 4.8% per annum,[vii] while supply grew at 3.5% in 2012-13 and expected to grow by 4.2% in 2013-14[viii]. Some industry estimates have put the growth in demand over the last one decade at 6.8% per annum (Mani, 2013). According to National Dairy Development Board reports, past annual growth level in milk production of 4% would have to increase to 6% to meet the rising demand[ix]. The need for a higher growth in milk production was also highlighted by the Economic Survey of 2010-11. In fact, the consumption of milk and dairy products in the entire developing world including India and China the two most populous countries is expected to continue rising till 2030 (Alexandratos, 2008).

The mismatch between demand and supply for milk has been and continues to be a matter of concern for this would make the country rely on imports from the limited world market (Punjabi, 2009; Yaron, 2014). If India becomes a net deficit country for milk, the large volume of skim milk powder (SMP) and butter required on a continual basis is expected to have adverse implication on the global market prices. This is due to the fact that less than 5% of total world production is traded in the international market (Ranawana, 2008) and only four suppliers USA, European Union, New Zealand and Australia account for 85% of the world SMP export[x], resulting in highly volatility[xi] of international prices.

On the contrary, India is fortunate to have the largest bovine population with low productivity per animal. This offers tremendous opportunity to enhance domestic milk production both in the short and long term. This becomes crucial for managing price and food inflation[xii] while managing exports. Hence, understanding the domestic price of milk price and factors that influence its supply and demand requires a deeper and continuous attention from researchers as well as practitioners, from a public policy perspective. We identify here the key determinants of the demand and supply for milk in India and their influence on price and analyse some of the factors that may be acting as supply side constraints.

The determinants of milk price can be divided into long and short term as well as demand and supply side. This is shown conceptually in Figure 1.

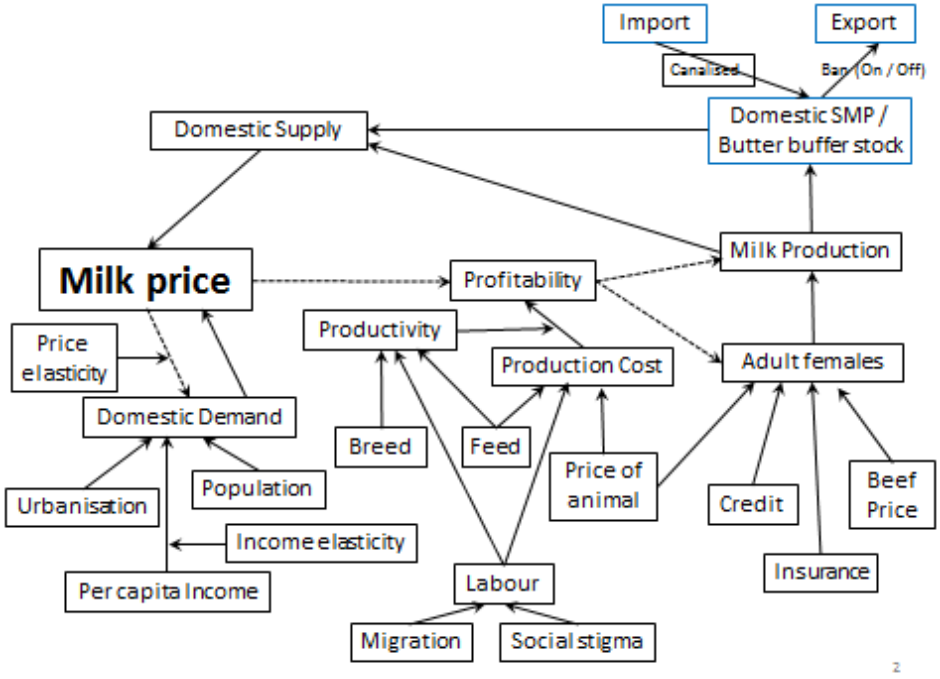

Figure 1 Determinants of Milk Price

On the long-term demand side, growing per capita income is the major driving force (Nair, 2013), indicating a demand shift. The causes for increase in demand have been identified and defined as growth in population, urbanisation, changing demography, increasing per Capita GDP, widespread and 24 × 7 availability of liquid milk / milk products, changing food consumption patterns, high income elasticity of demand for milk and regional imbalances in income / consumption(Sharma, 2003). Further, income elasticity for milk is generally more than 1 and higher in rural areas(Saxena, 1996) and as high as 2.3 for lower income class(Kumar *et al.*, 2011) indicating that with the rise in consumer income, the share of expenditure on milk would go up. Kumar et. al (2011) also estimate that the uncompensated own price elasticity of milk is -0.8 for the very poor. In addition, lifting of ban on export of SMP affects milk price as it immediately affects the buffer domestic buffer stock available.

Domestic supply is determined by average production per animal and number of animals in milk. Availability of credit and risk cover facility and its market price have a positive relationship while beef price is expected to have negative effect. The capital asset formation by way of formal credit for dairy animal purchase is very low as indicated by the small and reducing proportion of refinance by NABARD. It came down to 4.3% in 2013-14 from 5.8% in 2011-12[xiii]. This in spite of the established positive effects of credit on rural income (Abedullah *et al.*, 2009)..

Since the source of milk is the female dairy animal, it is crucial to understand the factors that impact their population. The profitability is moderated by productivity in terms of breed, feed and management. The number of female animals is also adversely affected by high beef price as it results in increased attrition. Feeding and labour are the major costs of rearing dairy animal, apart from cost of ownership and availability of labour is affected by social factors such as stigma associated with farming and preference for employment in urban areas.

In the long-term, milk supply is also a function of the proportion of the three classes of female bovine animals viz. buffaloes, indigenous cows and crossbred cows. Any ban on cow slaughter is expected to create additional demand for carabeef which is beef from buffaloes, adversely affecting their live numbers. Buffaloes have a high milk production capacity and produce 55% of the total milk in India. Hence, any reduction in their population is expected to adversely affect total milk production, imparting an upward pressure on milk price.

In the short-term, it is the domestic stock level of SMP and butter that determines the price of milk. Their stocks can be manipulated quickly and easily by way of exports or imports. This impact gains importance from the fact

that the option of enhancing growth rate in domestic milk production being a physiological process is available only in the medium to long term.

We begin our analysis by studying the movement of milk price over time.

2 Milk Price

The wholesale price index (WPI) of milk has risen at a compounded annual growth rate (CAGR) of 10.7% in the last 8 years from April 2006 to March 2014. This is more than twice the rise in the previous 8-year period from April 1988 to March 2006[xiv] of CAGR of 4.7% (Rajeshwaran, Naik and Dhas, 2014).

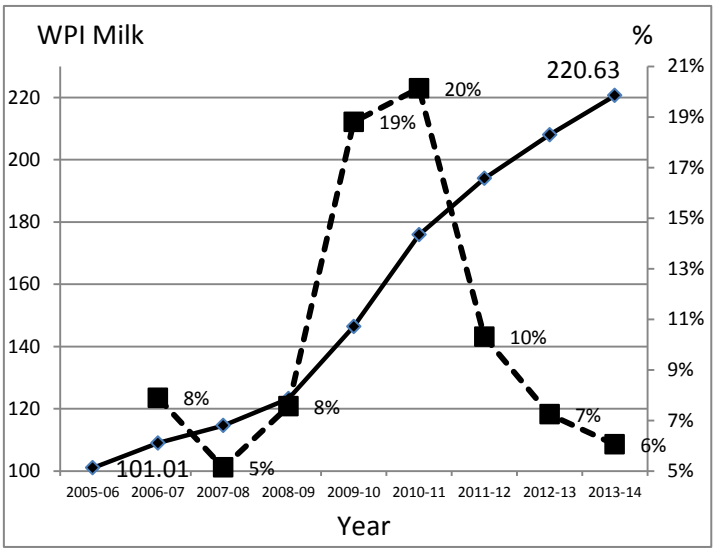

Figure 2 WPI Milk and Percentage growth rate

The nominal price of milk rose by 19% and 20% per annum in 2009-10 and 2010-11, respectively (Figure 2). While the rise has come down to 6% from the historically high level of 20%, its fall-out effect on consumer price continues. The consumer price of milk continued its upward rise even in 2014, the last two being effected in January 2014[xv] and May 2014[xvi]. Earlier studies reveal that a nominal rise in milk price is a necessary but insufficient incentive for farmers to rear more number of dairy animals and produce more milk (Rajeshwaran, Naik and Dhas, 2014), indicating that there may be other factors of production that are acting as constraints and need to be addressed.

This rise is ostensibly due to disparity between growth in domestic production and consumer demand combined with an insufficient stock of SMP in the domestic market. The stock may have been depleted due to either lower production in the previous season and/or lifting of ban on its export in previous years, resulting in a snowball effect.

We now examine the trend of milk consumption on the demand-side.

3 Milk Consumption

Total milk consumption is factor of per capita consumption and number of persons or households consuming milk. If any one or both grow over time, an increased demand for milk is expected. After 2004-05, we find that both have shown growth.

During the 11 year period from 1993-94 to 2004-05, per capita milk consumption was constant at around 143 grams per day[xvii] for rural people and 200 grams per day[xviii] for those living in urban areas[xix], showing little or no change especially in rural areas[xx]. Hence, past literature is based on little or no growth in milk consumption. However, in the 7-year period after 2005, the per capita milk consumption grew at a CAGR of 1.8% and 1.2% and by 2011-12, reaching 162 grams per day[xxi] in rural areas and to 218 grams per day[xxii] in urban region[xxiii] (Table 2). This indicates that the year 2004-05 was a turning point in demand growth. Accordingly, the milk

demand is expected grow in a non-linear and exponential manner. This change is due to the structural change in the diet of people in the developing world, urbanisation and increased income level(Delgado, 2003).

	1993-94	1999-2000	2004-05	2011-12	CAGR (2004-05 to 2011-12)
Rural	143	145	143	162	1.8%
Urban	186	208	200	218	1.2%
Source: 50th, 55th, 61st and 68th rounds of NSS					

Table 1 Per capita milk consumption (grams per day)

It is important to note here that there is a high variation in milk consumption, between states. In terms of value, the per capita expense on milk over a period of 30 days in 2011-12 was a mere Rs.13.84 (2.6% of total food expense) in Chattisgarh, whereas it was as high as Rs.474.57 (41.9% of total food expense) in Haryana. States with lower milk consumption levels are expected to grow at a faster rate on account of higher income elasticity of the lower income group.

According to FAO, India had a per capita consumption of milk of 188 grams per day excluding butter; whereas it was 585 grams per day for developed countries, in 2007. Even for a developing nation such as Brazil, it was 342 grams per day (Gerosa and Skoet, 2012). This indicates the enormous possibility for future growth of milk consumption in India. Sri Lanka stood in contrast with milk consumption of a mere 88 grams per day, being fully import dependent (Ranawana, 2008).

In addition to higher per capita consumption, more number of households have also started to consume milk. In 1993-94, one-third of rural households and one-fifth of urban households are reported to have not consumed milk[xxiv]. By 2011-12, their number decreased to 12 % and 15%[xxv], respectively (Table 3).

Year	Rural	Urban
1993-94	67	79
2004-05	71	85
2009-10	76	85
2011-12	78	85
Source: 50th & 68th Rounds of NSS		

Table 2 Percentage of households consuming milk

The importance of milk can be seen from the fact that milk is the second most important component of consumer expenditure, among food items after cereals (Table 4). While expenditure on cereals reduced by 50% between 1993-94 and 2011-12 for rural and urban areas, the money spent on milk and products has reduced on;y marginally from 9.5% to 9.1% for rural and from 9.8% to 7.8% in urban areas[xxvi]. The proportion of money spent on food items also reduced to 48.6% and 38.5% of total consumer expenditure for rural and urban areas, respectively by 2011-12.

Food Type	Rural			Urban		
	1993-94	2004-05	2011-12	1993-94	2004-05	2011-12
Cereals	24.2	18.0	12.0	14.0	10.1	7.3
Milk & Products	9.5	8.5	8.1	9.8	7.9	7.8
Food Total	63.2	55.0	48.6	54.7	42.5	38.5
Source: 68th Round of NSS						

Table 3 Percentage of consumer expenditure

We now analyse the growth pattern in milk production.

4 Milk Production

Total milk production in India increased from 75.4 million tonne in 1997-98[xxvii] to 139.7 million tonne in 2013-14[xxviii](Figure 3). In the 8-year period from 2006-07 to 2013-14, it grew at a CAGR of 3.93%, whereas in the previous 8-year period of 1998-99 to 2005-06, it grew at a CAGR of 3.21%.

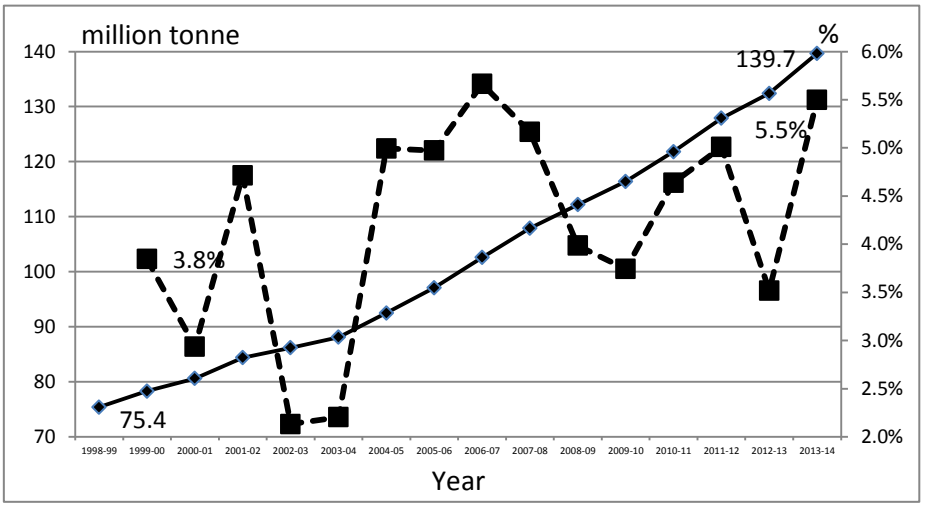

Figure 3 Milk production and annual growth rate

In 2007, the 11th 5-Year Plan Working Group of the Planning Commission, Government of India had expressed concern about the slowdown in growth in milk production cautioning that it would adversely affect the growth of the livestock and overall rural economy. Recently, the Global Agricultural Information Network (GAIN) Report of 2013 (Mani, 2013) and 2014 (Mani and Intodia, 2014) have repeatedly cautioned the need for enhancing growth in domestic milk production. The positive aspect is that India has a high unutilised and underutilised capacity to produce milk, in terms of number of animals in milk and productivity per animal (Nimbkar and Kandasamy, 2011).

Another way to study milk production in the country in terms of self-sufficiency or food security is to analyse the per capita availability and its growth trend. The per capita milk availability in India is said to have crossed the world average of 294 grams, reaching 296.5 grams in 2012-13[xxix]. The per capita milk availability in India increased at a CAGR of 2.62% during the 8-year period ending 2012-13, as against 1.49% in the previous 8-year period ending 2004-05[xxx] with an overall average CAGR of 2.27% over the 16-year period.

4.1 Adult dairy animal population

Growth rate in total adult female bovine population has reduced to a CAGR of 0.9%[xxxi] (2007 to 2012), from 2.4%[xxxii] (2003 to 2007) as per the Quinqennial animal census. These figures indicate setting in of attrition in asset growth of milk producing units, year 2007 being the turning point. In fact, the absolute increase of 58 lakh (4.8%) in the total number of female bovines in the 5-Year period from 2007 to 2012 is only half the number of 107 lakh (9.8%) added in the earlier 4-Year period between 2003 and 2007. Even in the earlier 6-year period from 1997 to 2003, there was a drop in total population by 36 lakh animals. Hence, the positive growth observed from 2003 to 2007 may be considered only as an aberration and not reflect the true long term negative growth. For the 5-year period from 2007 to 2012, the CAGR indicates a sharp fall for indigenous cows from 1.5% to -0.7% and for buffaloes from 1.9% from 1.0%, over the previous period. Only crossbred cows showed an increase in growth from 4.3% to 6.1% (Table 5). These figures indicate that we need to study each type of animal individually to understand the reasons behind their growth.

The proportion of adult animals in milk to total adult female population remained constant, at around 66% for buffaloes and crossbred cows and for indigenous cows around 53%, during all the last four Quinqennial livestock surveys.

Adult Females	Population (lakh)				Compounded Annual Growth Rate (CAGR)		
	1997	2003	2007	2012	2003 over 1997	2007 over 2003	2012 over 2007
Buffalo	467.7	475.7	513.8	538.6	0.3%	1.9%	1.0%
Indigenous cow	550.8	495.9	542.7	524.9	-1.7%	2.3%	-0.7%
Crossbred cow	112.1	123.0	145.7	196.4	1.6%	4.3%	6.1%
Total	1130.6	1094.7	1202.1	1259.8	-0.5%	2.4%	0.9%
Source: 16th, 17th, 18th and 19th Livestock Census, GoI							

Table 4 Compounded Annual Growth Rate of adult bovine animals

4.2 Productivity per animal

Productivity of milk per animal increased at a CAGR of 1.23%, 2.63% & 0.68% for buffaloes, indigenous cows and crossbred cows, respectively between 2004-05 and 2012-13. However, this is lower than the CAGR in the earlier 10-year period for buffaloes and crossbred cows when it was 1.64% and 1.41%, respectively. Interestingly, milk productivity of indigenous cows had increased from 1.36%, on a CAGR basis. This indicates that the growth rate in milk productivity of animals in the case of crossbred cows and buffaloes may have passed their peak rates in growth, given the existing factors of production, especially in the long-term. This is of importance since it is these two types of animals that are most productive, yielding the highest milk yield per day; 7.02 kg per day for crossbred cow and 4.8 kg per day for buffalo in 2012-13, whereas indigenous cows which showed high growth in milk productivity yielded only 2.36 kg per day.

In 2011-12, milk produced by buffalo, indigenous cattle and crossbred cattle, was in the ratio of 53:22:25 while the ratio of animals in milk was 46:38:15 in 2011-12 (Table 6). Thus, it can be seen that buffaloes continue to be the main stay of milk supply in India. Since the ratio of number of buffaloes (46%) and buffalo milk production (53%) is high, the proportion of buffaloes in the dairy animal population is an important determinant of milk price. Hence, any constraint to its growth is expected to have adverse consequence in total milk production aggravating the rise in domestic milk price. Therefore, the higher expected demand for carabeef (buffalo meat) arising from a ban on cow slaughter is expected to increase the milk price.

Dairy animal type	Animals in milk ('000)		Milk production ('000 MT)		Average milk yield per day (Kg)
	No	%	Quantity	%	
Buffalo	38638	46%	67675	53%	4.80
Indigenous cattle	31870	38%	27421	22%	2.36
Crossbred cattle	12642	15%	32384	25%	7.02
Total	83150		127480		

Table 5 Estimates of milch animals, milk production and milk yield in 2012-13

We now proceed to analyse the key short-term determinant of milk price, the stock of SMP and butter available in the domestic market for reconstitution.

5 Short-term Milk price stabilising mechanism

The domestic stock of SMP and butter is built by domestic production in the winter months when there is excess of milk production over consumption. The fat portion in milk is skimmed, churned and stored at –20 degree Celsius as butter with a shelf life of 12-14 months. The skimmed milk is spray dried to SMP for storage in bags under room temperature, away from moisture and sunlight. The milk powder so produced has shelf life of about 6–8 months. Both have a high production and storage cost.

The domestic stock levels are actively maintained by controlling its export and import (Jayakrishna e Rajasekaran, 2015). Earlier, both were banned to protect the Indian dairy farmers from price fluctuations in the world market to encourage milk production. Imports if allowed on ad hoc basis were carried out only by canalised agencies, while exports was freely allowed as and when ban was lifted.

We now detail a few of the past policy interventions on SMP export and import, to regulate or moderate the rise in price of milk, within the country. In May 2005, 10,000 MT of SMP was allowed to be imported at a concessional duty of 15%[xxxiii]. In October 2007, the ban on SMP export was lifted and Indian SMP manufacturers and traders were able to freely export till Feb 2011. In March 2010, 30,000 MT of SMP and 15,000 MT of butter was allowed to be imported at zero % duty[xxxiv] to augment domestic supplies. Between April 2006 and January 2007, ban on export of SMP was lifted, when 26,000 MT were exported. The ban was again lifted on 8 June 2012[xxxv] specifically to improve financial and cash position of dairy firms and help milk producers[xxxvi]. This resulted in a historically high quantity of SMP being exported; 1,24,000 MT in 2013-14 against 70,000 MT in 2012-13, a 77% increase. This phenomenal rise in export was also partly due to a 5% export incentive given under Vishesh Krishi and Gram Udyog Yojana[xxxvii], and higher international price. The export incentive was withdrawn in July 2014. The private sector in the milk trade was then of the opinion that exports constitutes only 0.6% of total milk production in 2013-14 and hence cannot be the cause for the rise in domestic milk price[xxxviii]. However, what is important is not the quantity of export but its incremental change in export which is expected to have an adverse effect on its availability in the domestic market and hence its adverse effect on milk price.

It can thus be observed that Government of India was aware of and concerned about the rise in milk price and were taking policy decisions to moderate it on a continual basis. However, the abnormal rate of rise continued unabated for the 8-year period up to March 2014. This indicates that either the policy decisions were insufficient or not timed well or simply insufficient.

6 Research Method and discussion

Since we are interested in the long-term and short-term relationship between the independent variables and milk price, we analyse secondary monthly panel data using the Engel and Granger Two-step Error Correction Model.

The generic model for demand and supply for milk conceptually shown in Figure 1 is as follows:

Q (Demand for milk) = f (milk price, human population, per capita consumption, per capita Income, export of skim milk powder) and

Q (Supply for milk) = f (milk price, production cost, skim milk powder price, butter price, beef price, import of skim milk powder)

Single equation error correction model is useful when theory dictates a causal relationship of interest and when there is a long-memoried stationary data. We find that the time-series data under study are integrated in the same order and their linear combination is stationary and thus they can be said to be co-integrated.

In the first step, we estimate the coefficients of the four independent variables by regressing Y_t on $X_{it.}$

$$Y_t = \boldsymbol{\alpha} X_{it} + \mu_t, \text{ where} \qquad \text{---------- (1)}$$

Y_t is milk price, α is the coefficient**,** X_{it} consists of SMP price, butter price, beef price and per capita income and μ_t is the error term with normal OLS assumption capturing effect of all unobserved variables.

In our case, this regression model is as follows:

$$\textbf{Milk Price}_t = \alpha_1\textbf{SMP price}_t + \alpha_2\textbf{butter price}_t + \alpha_3\textbf{beef price}_t + \alpha_4\textbf{per capita income}_t + \mu_t$$

The period of our analysis is 64 months from January 2010 to April 2015. For milk, SMP, butter and beef, we use monthly wholesale price index (WPI); while for income, we use the per capita GDP at constant prices as of 2000. On the supply side, major cost of milk production which is labour, apart from feeding cost, has been accounted for by taking real prices by deflating the nominal values of all indices with CPI (Agriculture labour), with base year as 2006. SMP and butter prices are expected to have a positive coefficient on milk price, as they are constituents of milk. Beef price is expected to have positive coefficient as any increase in beef price is expected to have a negative influence on the number of adult female animals in milk and thus adversely affecting milk supply. On the demand side, income is said to be an important factor (Nair, 2013) and is expected to have positive coefficient as it increases the demand for milk.

Variables	Coefficients	Std. error	t-statistics
SMPR	0.34*	0.04	7.46
BUTR	0.33*	0.05	6.62
BEFR	0.10**	0.05	2.11
PCPR	0.00*	0	18.34
R^2	0.80		
Adjusted R^2	0.79		
Durbin–Watson statistic	0.70		
No. of observations	64		

* and ** indicate significance at 1% and 5% respectively. SMPR = WPI of skim milk; BUTR = WPI of Butter; BEFR = WPI of beef; PCPR = Per capita income

Table 6 Long-term estimates of milk price determinants

The regression model shows that a 1 unit change in the price of SMP results in 0.34 unit change in the price of milk, while a 1 unit change in the price of butter results in 0.33 unit change in the price of milk and a 1 unit change in the beef price results in 0.1 unit change in milk price. All coefficients including per capita income show a positive and significant relationship as expected.

All independent and the dependent variables are non-stationary at level and stationary in first difference, as per Augmented Dicky Fuller Test. Regression at level indicates it could be a spurious relationship as R^2 value (0.80) > Durbin Watson Test (0.70)(Granger and Newbold, 1974). However, we find that the residual is stationary. Hence, the regression equation at level is not spurious and is in fact a long-run model. Stationarity of the residual of this regression combined with significant and expected sign of the coefficients also indicates that the variables are "co-integrated", i.e., they have long-term association. Therefore, the coefficients of SMP, butter, beef and per capita income obtained at level are long-run coefficients.

The residual (μ_t) of the above regression represents that portion of milk price not explained by the four variables under study. Hence, in the second step, we make use of the residual from this regression by incorporating its lagged value (μ_{t-1}) into the regression of first difference of all variables under study, to obtain the short-term coefficients of the four variables under study, where the generic single equation error correction model is

$$\Delta \boldsymbol{Y_t} = \boldsymbol{\beta} + \boldsymbol{\lambda_1}\Delta \boldsymbol{X_t} + \boldsymbol{\lambda_2}\mu_{t-1} + \boldsymbol{\varepsilon_t} \quad \text{--------- (2)}$$

Thus the error correction specification model we use to understand the short-term relationship of the variables is as follows:

ΔMilk Price$_t$ = β_0 + $\beta_1\Delta$SMP price$_t$ + $\beta_2\Delta$butter price$_t$ + $\beta_3\Delta$beef price$_t$ + $\beta_4\Delta$per capita income$_t$ + $\beta 5\ \mu_{t-1}$ + ε_t, where,

Δ denotes the first difference; μ_{t-1} is the one-period lagged value of the residual from first regression at level and $\boldsymbol{\varepsilon}_t$ is the error term with the usual OLS properties.

Variables	Co-efficients	Std. error	t-statistics
D(SMPR)	0.23*	0.09	2.51
D(BUTR)	0.20***	0.12	1.63
D(BEFR)	0.07^{ns}	0.11	0.67
D(PCPR)	0.00***	0.00	1.77
RESIDU(-1)	-0.46	0.09	-5.16
R^2	0.45		
Adj. R^2	0.41		
Durbin–Watson statistic	1.60		
No. of observations	63		

* and *** indicate significance at 1% and 10% respectively, while ns indicates not significant. D(SMPR) = 1^{ST} difference of WPI of skim milk; D(BUTR) = 1^{st} difference of WPI of Butter; D(BEFR) = 1^{st} difference of WPI of beef; D(PCPR) = 1^{st} difference of Per capita income & RESIDU(-1) = lag 1 of residual from regression at level

Table 7 Short-term estimates of milk price

We obtain short-run significant coefficients indicating that for every unit rise in price of SMP, there is a 0.23 unit rise in the price of milk; whereas for every unit rise in the price of butter, there is a 0.20 unit rise in the price of milk, in the short-term.

The error correction term, RESIDU has a negative sign (0.46) and is significant ($P < 0.01$) indicating that it is correcting the disequilibrium @ 46% every month. Its negative sign and significance provides validity to our earlier conclusion that the variables under study have long-run equilibrium association. Breusche Godfrey Serial Correlation LM Test of the residual of the error correction model shows that it is not serially correlated ($P > 0.05$). Checking for normality of the residual of the model using Jarque Bera test, we find that the residual is not normal ($P < 0.05$).

6 Conclusion

Analysis of monthly panel data of milk price with price of SMP, butter and beef and per capita income for the period from January 2010 to April 2014, reveal significant role of domestic price of milk, through direct effects in the short-term and indirect effects in the long-term.

We also find that during this period, Government of India policy interventions on domestic buffer stock of skim milk powder and butter did not curb rise in milk price. This indicates that decision regarding lifting of ban on export of SMP and butter needs to be taken more with a long-term perspective rather than the short-term of merely reducing stocks of SMP available with domestic players. In the long-term, beef prices are found to have be supporting attrition of adult female animal population.

Hence, policies regarding milk production and productivity enhancement programme need to be undertaken across the country under a new set of production factors keeping in view of the fact that there is attrition in the growth of animal population. Hence, these policies should facilitate and encourage farmers rear increased number of buffaloes and cows especially those with higher than average milk potential, breed-wise. The specific areas that need to be addressed afresh with renewed vigour are credit, insurance and market for livestock as well as cost of feeding along with preventive health cover and targeting the small-holder. Only then can India ensure food security for its citizens, with respect to milk.

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