PRICE OF MILK AND FEED COST AS FACTORS INFLUENCING INCREASED MILK PRODUCTION

K. C. RAUT and T. JACOB
Institute of Agricultural Research Statistics, New Delhi

Introduction

India possesses about a quarter of the world's cattle and buffalo population but the milk productivity of animals is extremely low. One of the important pre-requisites for increasing milk production is provision of incentive by way of a remunerative price for the commercial producers of milk. The pricing of milk may have both short-run and long-run effects on production and marketed surplus of milk. Hardly any work has been carried out in the country to study the response of milk production to price, perhaps mainly due to non-availability of adequate data. With limited data available, an attempt has been made in this paper to study the effect of price of milk and feed cost on milk production.

2. Material for Study

The Institute of Agricultural Research Statistics (I.C.A.R.) has carried out large-scale sample surveys to study the economics of livestock and livestock products in different parts of the country. The data utilised in the present study pertain to the surveys — (i) to study the economics of raising cattle and buffaloes in Hissar district of Haryana State (1963-67) and (ii) to estimate the availability and cost of production of milk in Krishna delta areas of Andhra Pradesh (1967-69). In each of these surveys, a suitable sampling design was employed to obtain the estimates with a reasonable degree of precision. For collection of data, the cost accounting approach (Panse et al, 1964) was adopted by stationing trained investigators working on whole-time basis in the villages or towns selected for the purpose. Data on milk yield of individual animals and feed given to them were recorded by actual weighment and other relevant information such as breed and age of animals, procurement and prices of feed stuffs, sale and purchase price of animals, utilisation of milk, market rates of milk and milk products, etc., was collected through careful observation and enquiry. Thus the surveys provided objective and reliable estimates of milk production and various components of cost of production. The items of study in the paper are on response of milk production to price of milk and feed cost.

3. Market Price of Milk

As one of the objects of the study is to examine the effect of price on the production of milk, it is of interest to know the fluctuations of the market rates of cow milk and buffalo milk. The frequency distributions of producers according to sale price of milk based on the data obtained in the course of the surveys carried out by I.A.R.S. in Hissar district of Haryana State and in Krishna delta area in Andhra Pradesh are given in Table 1. The market price of cow milk in Hissar district ranged from 45 paise to 90 paise per kg. during the year 1965-66 while the price of buffalo milk ranged from 66 to 105 paise per kg. In Krishna delta area the market price of buffalo milk ranged from 45 paise to one rupee per kg. during 1967-68. There was a good deal of fluctuation in price of milk not only between seasons but also within seasons.

4. Response of Production to Milk-feed Price Ratio

It is logical to assume that as the margin of return increases the producer is likely to take more interest in his milch stock and thereby help to increase milk production. From the surveys carried out by the I.A.R.S. to estimate the cost of production of milk, it was observed that feed accounted for the largest part broadly amounting to 65 to 70 per cent of the total cost. Also, in an investigation (Jacob et al, 1971) where production functions were fitted relating milk yield to inputs like feed cost, value of paid labour, etc., it was observed that regression co-efficients of feed were all positive and were significant in almost all the cases studied while the co-efficients of other factors did not show any consistent trend. Thus in the present study, along with the price of milk the feed input alone was considered. Functions were fitted considering the factors milk yield per animal in milk per day and ratio of the price of milk to feed cost per kg of milk. This ratio is the indicator of the margin of profit a producer will receive (Halvorson 1955, 1958, King 1958). The feeding practices may change according to the change in price of milk. The relationship attempted will indicate short-run effect.

From the data pertaining to Hissar, the relationship has been worked out for cows and buffaloes and from those of the Krishna Delta area it has been worked out for buffaloes which are predominant in the selected areas. The Cobb-Douglas function explained more variation than the linear and was taken for the estimation of elasticity coefficients. The estimated elasticity co-efficients are given in Table 2. All the coefficients are positive and excepting two, all are found to be significant. This indicates that the milk production per animal in milk would increase as the milk-feed price ratio increases. For example, in the case of buffaloes in Hissar during winter season, the elasticity coefficient is 0.64 indicating that for one per cent increase in the price ratio, the milk yield would increase by 0.64 per cent. Consider a specific case where the price of milk is Re. 1/-per kg. and the milk-feed price ratio is 'one.' An increase in the price of milk by 10 paise would mean the price ratio to be equal to 1.1 if the feed price remains constant, and with this change, one would expect the average milk yield of a buffalo in milk to increase from 5 kg. (say) to 5.320 kg. This ratio (1.1) can also be attained by keeping the price of milk constant and reducing the feed cost. The average milk yield in that case is expected to be enhanced by 0.32 kg. as in the first case.

For a detailed study of the above nature, both short-run and long-run production elasticities will have to be worked out. These studies would require data on various factors for a number of years. Once such data become avilable, regression models using lagged price, cost of production, etc., as independent variates and milk production as dependent variate can be worked out in studying producers responsiveness to price and other factors relating to the production of milk.

5 Summary

An attempt has been made to study the influence of pricing and feed cost on milk production utilising data collected in the large-scale sample surveys carried out by I.A.R.S. The relationship between changes in milk production per animal and changes in milk feed price ratio was worked out to know the short-run production elasticity. From the study, it was observed that the milk yield would increase as the milk-feed price ratio increases. The type of studies required for estimation of both short-run and long-run effects has also been indicated.

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TABLE 1

Frequency distribution of producers (in percentage) according to sale price of milk :

Rates (P/kg.)	*Hissar (1965-66)*						*Krishna delta area (1967-68)*		
	Cow			*Buffalo*			*Buffalo*		
	Winter	*Summer*	*Rainy*	*Winter*	*Summer*	*Rainy*	*Rainy*	*Winter*	*Summer*
⩽ 50	22.6	—	2.9				2.1		
51- 55	9.7	14.7	5.9				4.2		
56- 60	16.1	14 7	5 9				2.1	4.2	
61- 65	12.9	17.7	29.4				2.1	8.3	
66- 70	9.7	17.6	20.6	9.4	6.1	—	10.4	10.4	
71- 75	12.9	11.8	5.9	31.2	24.2	21.2	20.8	18.8	2.1
76- 80	12 9	8.8	11.8	31.2	24.2	24.2	14.6	33.3	27.1
81- 85	3.2	5.9	8.8	9.4	18.2	12.1	18.8	6.3	16.7
86- 90	—	8.8	8.8	15 6	9.1	6 1	4 2	8.3	16.7
91- 95	—	—	—	3.1	12.1	18.2	6.3	4.2	25.0
96-100					6.1	12.1	14.4	6.3	12.5
101-105						6.1			

TABLE 2

Elasticity of milk yield to milk-feed price ratio :

Area	*Species*	*Season*	*Average milk yield per day (kg.)*	*Elasticity coefficient*
Hissar	Cow	Winter	2.65	0.68* (0.281)
,,	,,	Summer	2.77	0.71** (0.243)
,,	,,	Rainy	2.52	0.70** (0.224)
,,	Buffalo	Winter	6.20	0.64** (0.202)
,,	,,	Summer	5.02	0.67* (0.291)
,,	,,	Rainy	4.32	0.48 (0.252)
Krishna Delta	,,	Rainy	1.92	0.34 (0.233)
,,	,,	Winter	2.07	0.43* (0.167)
,,	,,	Summer	2.10	0.56* (0.190)

(Figures in bracket show the standard errors)

* Significant at 5% level.

** Significant at 1% level.

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A NOTE ON AN APPROXIMATION OF THE F DISTRIBUTION

C. G. KHATRI

Gujarat University, Ahmedabad-9

Introduction

Scott and Smith (1970) justified Moran's approximation to the Student's t with n degrees of freedom (d.f.) using Fisher's general expansion of t, and they showed by a numerical table that the approximation $P(\mid t \mid \leqslant t_\alpha^*)$ is very close to α even for small values of n, if

$$t_\alpha^* = z_\alpha \,[1 - (z_\alpha^2 + 1)/4n]^{-1} \text{ and } P(\mid x \mid \leqslant z_\alpha) = \alpha,$$

where x is a standard normal variate. In this note, we give a different type of approximation to an F distribution with m and n d.f. by a Chi-square one with m d.f. and it can be applied for $n>m$ and the result for $n<m$ can be obtained by noting that $1/F_{n,m}$ is distributed as $F_{m,n}$ where $F_{m,n}$ is a F statistic with m and n d.f. If X^2_m is a Chi-square statistic with m d.f. and if

$$P(X^2_m \leqslant mz) = \alpha, \text{ and } P(F_{m,n} \leqslant F_\alpha) = \alpha, \qquad \text{.. (1)}$$

then it is shown that $F_\alpha = F + 0(n^{-4})$ where

$$F = z \exp\,[n^{-1} h(z) + n^{-2} g(z) + n^{-3} f(z)] \qquad \text{...(2)}$$

with

$$h(z) = \{mz - (m-2)\}/2, \qquad \text{...(3)}$$

$$g(z) = \{m^2z^2 - 5m(m-2)z + 4(m-1)(m-2)\}/24 \qquad \text{...(4)}$$

and

$$f(z) = -(m-2)\{m^2z^2 - m(5m-6)z + 4m(m-2)\}/48. \qquad \text{...(5)}$$

This approximation is justified by some numerical calculations even for small values of $n>m$. Tables 1 and 2 give the values of $P = P(F_{m,n} \leqslant F)$ for $m=1$, 2, 4 and 6 and $\alpha = .005$, .01, .25, .5, .75, .9, .95, .99 and .995.

2. Proof of the Approximation

In (2), we assume that $h(z)$, $g(z)$ and $f(z)$ are differentiable functions with respect to z. Using (2) in (1) and differentiating

$$P(F_{m,n} \leqslant F_\alpha) = P(x^2_m \leqslant mz)$$

with respect to z, we get

$$\left\{\Gamma(m+n)/2)/(n/2)^{m/2}\Gamma(n/2)\right\}F^{(m/2)-1}\frac{dF_\alpha}{dz}$$

$$=z^{(m/2)-1}(1+mF_\alpha/n)^{(m+n)/2}\exp(-mz/2) \qquad \ldots(6)$$

Using an approximate result

$$\log\Gamma(p)=(p-1/2)\log p-p+(1/12p)-(1/360p^3)+(1/2)\log 2\pi+o(p^{-4})$$

given in Cramer (1946 p. 130), we have

$$\log\{\Gamma(m+n)/2/(n/2)^{m/2}\Gamma(n/2)\}$$

$$=(1/4n)m(m-2)-(1/12n^2)m(m-1)(m-2)+(1/24n^3)m^2(m-2)^2+0(n^{-4}). \qquad \ldots(7)$$

Using (7) and the approximation (2) in (6), after some simplifications, we get for all n

$$\begin{aligned}&(1/4n)m(m-2)-(1/12n^2)m(m-1)(m-2)+(1/24n^3)m^2(m-2)^2\\ &+(1/2n)\{m\,h(z)+2z\,h'(z)\}+(1/2n^2)\{m\,g(z)+2z\,g'(z)-(z\,h'(z)^2)\}\\ &+(1/6n^3)\{3m\,f(z)+6z\,f'(z)+2(z\,h'(z)^3-6z^2h'(z)g'(z)\}+0(n^{-4})\\ &=(1/4n)\{2mz\,h(z)+2m^2z-m^2z^2\}+(1/12n^2)\{6mz\,g(z)+3mz\,h^2(z)\\ &+6m^2z(1-z)\,h(z)-3m^3z^2+2m^3z^2\}+(1/24n^3)\{12mz\,f(z)+12m\,h(z)g(z)\\ &+2mz\,h^3(z)+12m^2z(1-z)g(z)+6m^2z(1-2z)\,h^2(z)-12m^3z^2(1-z)\,h(z)\\ &+4m^4z^3-3m^4z^4\}+0(n^{-4}),\end{aligned}$$

where $p'(z)$=the first derivative of $p(z)$ with respect to z.

Now, comparing the coefficients of $(1/n)$, $(1/n^2)$ and $(1/n^3)$ and using the polynomial expressions of $h(z)$, $g(z)$ and $f(z)$, we get the final results as mentioned in (3), (4) and (5) respectively. Thus, the approximate result is established.

The table 1 gives the comparisons of this approximation to that of Scott and Smith (1970) for $m=1$, and we notice that for small values of n the approximation given in this note is better than that of Scott and Smith (1970). From the table 2, we notice that the approximation becomes weaker for small values of n ($>m$), but it can be used safely for $n>2m$.

3. Summary

An approximation of the F distribution is proposed in this paper. This approximation is justified by some numerical calculations even for small values of $n>m$ where n and m stand for the parameters of the F distribution.

TABLE 1

Values of $P=P(F_{1,n} \leqslant F)$: upper values are based on (2), values with ** are based on (2) without g(z) and f(z) terms, values with * are based on (2) without f(z) term and the last vaules are given by Scott and Smith (1970)

	·005	·01	·05	·1	·25	·5	·75	·9	·95	·99	·995
1.	·00512**	·01024**	·05103**	·10224**	·25295**	·49582	·75094	·90743	·95907	·99549	·99850
			·04914	·09831	·24627						
	—	—	—	—	—	—	—	—	—	—	—
2.	·00502**	·01004**	·05021**	·10036**	·25034**	·49977	·75021	·90097	·95135	·99126	·99599
			·04995	·09990	·24978						
	—	—	—	—	—	—	—	—	—	—	—
3.	·00501**	·01001**	·05005**	·09998	·24997	·49997	·75007	·90025	·95036	·99038	·99532
	—	—	—	—	—	·5014	·75102	·9080	·9617	·9942	·9983
4.	·00500**	·01001**	·05003**	·10000	·24999	·49999	·75003	·90009	·95013	·99016	·99514
	—	—	—	—	—	·5007	·75040	·9010	·9537	·9921	·9968
5.	·00500**	·01000**	·05002**	·10000	·25000	·50011*	·75004*	·89991*	·94987*	·98992*	·99495*
						·50000	·75001	·90003	·95006	·99007	·99506
	—	—	—	—	—	·5004	·75019	·9005	·9509	·9912	·9961

TABLE 2

Values of $P=P\ (F_{m,n} \leqslant F)$ where F is defined by (2)

	·005	·01	·05	·1	·25	·5	·75	·9	·95	·99	·995
1.	·005	·01	·05	·1	·25001	·50026	·75214	·90569	·95680	·99437	·99791
2.	·005	·01	·05	·1	·25000	·50003	·75023	·90081	·95115	·99111	·99587
3.	·005	·01	·05	·1	·25000	·50001	·75006	·90022	·95034	·99038	·99532
4.	·005	·01	·05	·1	·25000	·50001	·75002	·90008	·95013	·99016	·99514
5.	·005	·01	·05	·1	·25000	·50001	·75001	·90004	·95006	·99008	·99507
6.	·005	·01	·05	·1	·25000	·50000	·75000	·90002	·95003	·99004	·99504
4.	·00495	·00991	·04968	·09955	·24964	·50041	·75086	·90045	·95017	·98999	·99499
5.	·00498	·00996	·04986	·09980	·24984	·50020	·75041	·90022	·95008	·98999	·99499
6.	·00499	·00998	·04993	·09990	·24992	·50010	·75022	·90011	·95004	·98999	·99499
7.	·00499	·00999	·04996	·09994	·24995	·50006	·75013	·90007	·95002	·98999	·99500
8.	·00500	·00999	·04998	·09997	·24997	·50004	·75008	·90004	·95001	·99000	·99500
6.	·00487	·00977	·04923	·09890	·24759	·50032	·75144	·90106	·95058	·99005	·99500
7.	·00493	·00987	·04956	·09936	·24851	·50019	·75086	·90064	·95036	·99003	·99500
8.	·00496	·00992	·04973	·09961	·24902	·50012	·75055	·90041	·95023	·99002	·99500
9.	·00497	·00995	·04982	·09974	·24932	·50008	·75037	·90028	·95016	·99001	·99500
10.	·00498	·00996	·04988	·09983	·24951	·50006	·75025	·90019	·95011	·99001	·99500

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