RESEARCH NOTES

AN ECONOMETRIC ANALYSIS OF PRICE VARIATIONS
IN CATTLE MARKET

There are various issues which need research efforts in the area of cattle marketing in India. These issues centre around the trade 'tricks' adopted by the sellers and buyers either independently or in collusion with brokers, price-age relationships, factors accounting for price variations, transaction cost, and the physical and institutional infrastructure required for an efficient functioning of cattle markets. This paper is concerned with an analysis of price variations in cattle market. What factors govern price variations in cattle marketing? What attributes of cattle give rise to a price premium and what attributes cause price discounts? What are the directions and the magnitudes of the net effects of age, breed, colour, seasons and years on cattle pricing? These issues are quantitatively evaluated with data from the bullock market of Mudalagi, Belgaum district, Karnataka State.

DATA BASE OF THE STUDY

Agricultural Produce Market Committee (APMC), town/city municipal councils and religious institutions are the three agencies which organize and control cattle markets in Karnataka. Through informal discussions with several APMC Secretaries, District Marketing Officers and Senior Marketing Inspectors of North Karnataka, it was learnt that hardly any cattle market in the State excepting the Mudalagi cattle market had maintained records of data on cattle arrivals, sales, prices, age, colour and other dairy attributes of cattle. Keeping in view the data availability, Mudalagi cattle market is chosen for the present research study.

The Mudalagi cattle market is organized and controlled by the Town Municipal Council. In this market, the transactions take place in respect of bullocks, cows and buffaloes. However, it is a bullock dominant market, since more than 73 per cent of the annual arrivals of animals at this market comprise bullocks. So the present study is focused on bullock marketing. The sale records on bullocks have provided data on price, age, colour and breed of the bullock sold in the market. No data are recorded on other attributes of the animals such as weight, height, grade and index of health. The data in the appropriate form were available for a period of three years 1973-1975. The total number of bullocks sold during the three years was 49,710. Every fifth observation from this total number of observations available is selected for the present study. This provides a sample of 9,942 bullocks sold during these three years of study.

2. For a detailed description of this market, see Rathod, ibid, Chapter III.
3. ibid, p. 28.
ECONOMETRIC MODELS OF BULLOCK PRICE VARIATION

For a quantitative evaluation of the objectives outlined for this study, the relevant econometric model is proposed in this section. The variables such as age, colour, breed, season, year, weight, height, work efficiency and index of general health are usually postulated to account for the variations in bullock mean prices. Given the nature of the data available, only variables such as age, breed, colour and seasons are considered as explanatory variables in this paper. In addition to these, yearly effects on bullock price variations are also determined.

To determine the net effects of breeds, colours, seasons and years on the price variations, the relevant econometric device would be the Dummy Variable Technique. The analytical technique used in the present study is the general linear regression model with dummy variables incorporated into the regression equations. In coding the data, white colour, local breed, rainy season and the year 1973 are treated as the base. The following quadratic econometric model with the dummy variables for breeds, colours, seasons and years as explanatory variables in addition to age is proposed for a quantitative evaluation of the objectives of the study.

1. Model I: Bullock Pricing Model

\[ P_B = a + b_1x_1 + b_2x_2^2 + b_3x_3 + b_4x_4 + b_5x_5 + b_6x_6 + b_7x_7 + b_8x_8 + e_i \]

where

- \( P_B \) = unit price of bullocks measured in rupees;
- \( a \) = constant term;
- \( b_i \) = regression coefficients;
- \( x_1 \) = age of the bullocks measured in years;
- \( x_2 \) = breed intercept dummy variable with a value of one for Khillar and zero for local. (Khillar and local breeds are the two distinct breeds transacted in the Mudalagi market);
- \( x_3 \) = colour intercept dummy variable with a value of one for red colour bullock and zero otherwise;
- \( x_4 \) = colour intercept dummy variable with a value of one for black colour bullock and zero otherwise;
- \( x_5 \) = colour intercept dummy variable with a value of one for mixed colour bullock and zero otherwise;


C. E. McIntosh and M. H. Hawkins, “Dummy Variables: An Application in Cattle Price Analysis”, Canadian Journal of Agricultural Economics, Vol. 19, No. 1, February 1971, have used the Dummy Variable Technique for determining the net effects of types, classes, geographical area and condition of the animal on cattle prices.
\[ x_i = \text{season intercept dummy variable with a value of one for winter season and zero otherwise;} \]
\[ x_s = \text{season intercept dummy variable with a value of one for summer season and zero otherwise;} \]
\[ x_y = \text{year intercept dummy variable with a value of one for the year 1974 and zero otherwise;} \]
\[ e_i = \text{random error independently distributed with zero mean and finite variance.} \]

From econometric model I, the following equations are derived.

2. **Equation for Local Bullock Pricing Model**

\[ P_B = a + b_1 x_1 + b_2 x_1^2 + b_3 x_2 + b_4 x_3 + b_5 x_4 + b_6 x_5 + b_7 x_s + b_8 x_y + b_9 x_{10} + e_i \]

3. **Equation for Khiller Bullock Pricing Model**

\[ P_B = (a + b_1) + b_2 x_1 + b_3 x_1^2 + b_4 x_2 + b_5 x_3 + b_6 x_4 + b_7 x_5 + b_8 x_s + b_9 x_y \]

The intercept term in the local bullock pricing equation is ‘a’, whereas the intercept term in Khiller bullock pricing equation is (a+b_1). The difference between ‘a’ and (a+b_1) would account for the price variation due to the difference in breed. Similar results could be derived from econometric model I for determining colour, season and year effects on price variations. This point will be made much more concrete at a later stage in this paper while analysing the empirical results.

**EMPIRICAL ECONOMETRIC RESULTS**

Confronting econometric model I with data from the Mudalagi cattle market, we have obtained the empirical results as presented in Table I. It may be recalled that local breed, white colour, rainy season and the year 1973 form the base in the estimation of these empirical results.

The results derived from Table I on the equations for the two breeds are shown in Tables II and III respectively.

As evidenced in Tables I, II and III, all the regression coefficients are statistically significant at one per cent level, excepting that for the winter season dummy variable \((x_i)\). Five important results are abstracted from these tables for a detailed discussion.
### Table I—Estimates of Bullock Pricing Function

<table>
<thead>
<tr>
<th>Variables</th>
<th>Regression coefficients</th>
<th>Standard error</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pure constant intercept</td>
<td>242.62</td>
<td>5.80</td>
</tr>
<tr>
<td>$x_1$</td>
<td>143.97**</td>
<td>0.53</td>
</tr>
<tr>
<td>$x_2$</td>
<td>162.26**</td>
<td>12.33</td>
</tr>
<tr>
<td>$x_3$</td>
<td>-212.16**</td>
<td>16.55</td>
</tr>
<tr>
<td>$x_4$</td>
<td>-159.48**</td>
<td>15.35</td>
</tr>
<tr>
<td>$x_5$</td>
<td>34.58**</td>
<td>10.63</td>
</tr>
<tr>
<td>$x_6$</td>
<td>15.80</td>
<td>13.16</td>
</tr>
<tr>
<td>$x_7$</td>
<td>-79.80**</td>
<td>14.44</td>
</tr>
<tr>
<td>$x_8$</td>
<td>165.56**</td>
<td>11.85</td>
</tr>
<tr>
<td>$x_9$</td>
<td>354.72**</td>
<td>12.45</td>
</tr>
</tbody>
</table>

$R^2 = 22$ per cent

** Significant at 1 per cent level.

F-computed = 280.00
Significant at 1 per cent level.

### Table II—Estimates of Local Bullock Pricing Function

<table>
<thead>
<tr>
<th>Variables</th>
<th>Regression coefficients</th>
<th>Standard error</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pure constant intercept ($a$)</td>
<td>242.62</td>
<td>5.80</td>
</tr>
<tr>
<td>$x_1$</td>
<td>143.97**</td>
<td>0.53</td>
</tr>
<tr>
<td>$x_2$</td>
<td>-212.16**</td>
<td>16.55</td>
</tr>
<tr>
<td>$x_3$</td>
<td>-159.48**</td>
<td>15.35</td>
</tr>
<tr>
<td>$x_4$</td>
<td>34.58**</td>
<td>10.63</td>
</tr>
<tr>
<td>$x_5$</td>
<td>15.80</td>
<td>13.16</td>
</tr>
<tr>
<td>$x_6$</td>
<td>-79.80**</td>
<td>14.44</td>
</tr>
<tr>
<td>$x_7$</td>
<td>165.56**</td>
<td>11.85</td>
</tr>
<tr>
<td>$x_8$</td>
<td>354.72**</td>
<td>12.45</td>
</tr>
</tbody>
</table>

$R^2 = 22$ per cent

** Significant at 1 per cent level.

### Table III—Estimates of Khilal Bullock Pricing Function

<table>
<thead>
<tr>
<th>Variables</th>
<th>Regression coefficients</th>
<th>Standard error</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pure constant intercept ($a + b_2$)</td>
<td>404.88</td>
<td>5.80</td>
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<tr>
<td>$x_1$</td>
<td>143.97**</td>
<td>0.53</td>
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<tr>
<td>$x_2$</td>
<td>-212.16**</td>
<td>16.55</td>
</tr>
<tr>
<td>$x_3$</td>
<td>-159.48**</td>
<td>15.35</td>
</tr>
<tr>
<td>$x_4$</td>
<td>34.58**</td>
<td>10.63</td>
</tr>
<tr>
<td>$x_5$</td>
<td>15.80</td>
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<tr>
<td>$x_6$</td>
<td>-79.80**</td>
<td>14.44</td>
</tr>
<tr>
<td>$x_7$</td>
<td>165.56**</td>
<td>11.85</td>
</tr>
<tr>
<td>$x_8$</td>
<td>354.72**</td>
<td>12.45</td>
</tr>
</tbody>
</table>

$R^2 = 22$ per cent

** Significant at 1 per cent level.
1. Age Effect on Price Variations

Since the regression coefficients of $x_1$ and $x_1^2$ are statistically significant at one per cent level, the evidence on a significant non-linear relationship between price and age of the animal is provided. The positive sign of regression coefficient of $x_1$ and the negative sign of regression coefficient of $x_1^2$ suggest that the price of bullock increases up to a certain age, reaches its maximum and thereafter the price starts decreasing. The quadratic curve concave downward (to the origin) would seem to be a rational explanation of price-age relationship.

From the results given in Table I, it is estimated that fifth year is the age at which the bullock commands the maximum market value; until fifth year, the market value goes on increasing and beyond fifth year of age the market value goes on decreasing.  

2. Breed Effect on Price Variations

The coefficient of the breed intercept dummy variable ($x_4$) is statistically significant. Since the value of one is assigned for the Khilar breed and zero for the local breed in our dummy variable set up, and the regression coefficient of $x_4$ is positive, the net effect of Khilar breed on price has turned out to be positive. The white bullocks of local breed fetched average prices, whereas the white Khilar bullocks received a price premium of Rs. 162.26 during the rainy season of 1973. The effect of this is to shift the value of the pure constant intercept for Khilar breed upward, i.e., $(a + b_4) > a$, since $a > 0$ and $b_4 > 0$.

The price premium on Khilar breed may be attributed to a couple of factors. The Khilar breed of the study area is known for its draft work efficiency and also for its endurance power. This breed has some attractive features in height, muscular structure, well developed hump, straight horns and fierce looking eyes.

3. Colour Effect on Price Variations

The third important result pertains to the net effects of different colours on price variations. Since the white colour has been used as the base in the dummy variable set up, the net effects of red, black and mixed colours on prices have been captured in the empirical results. The regression coefficients of red colour dummy variable ($x_5$) and black colour dummy variable ($x_6$) are negative and statistically significant. This implies a price discount on red and black colour bullocks. Everything else being the same, when compared to a white bullock, there is a price discount of Rs. 212.16 on a red bullock and a price discount of Rs. 159.48 on a black bullock. These price discounts may be attributed to the fact that red and black colour bullocks

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6. For details, see Rathod, op. cit.
get exhausted soon in field work, because these two colours absorb sunrays (heat) rather quickly. This in turn would increase the body temperature and pulse rate and thereby make the animals feel uncomfortable and tired. These are only suggestive explanations without any empirical evidence.

The regression coefficient of the mixed colour dummy variable \((x_1)\) is positive and statistically significant. This positive sign implies that mixed colour bullocks carry a higher price than a white bullock sold during the same time. This price premium on mixed colour bullocks could not be substantiated with any rationale.

4. Seasonal Effect on Price Variations

To determine the net effects of seasons on price variations, two dummy variables for the three seasons are introduced with rainy season as the base. The regression coefficient of winter season dummy variable \((x_2)\) is positive, but statistically insignificant. The positive sign implies a price premium during the winter season. During the winter season, the bullocks are generally stall-fed with green fodder giving rise to their attractive appearance. Moreover, the agricultural region around Mudalagi cattle market is a rabi-dominant area. So during the winter season there is a heavy demand for draft cattle to undertake rabi field operations. These two factors may possibly account for the positive price effects during the winter season.

The regression coefficient of summer season dummy variable \((x_3)\) is negative and statistically significant. Bullocks sold during the summer season brings Rs. 79.80 less than the average prices fetched during the rainy season. Two possible reasons may be advanced for this statistically significant price discount. First, the study area is not a kharif tract to generate more demand for bullocks during summer in order to meet bullock power requirements for kharif field operations. Second, the non-availability of green fodder during summer may lead to a weak appearance of bullocks. Low feed intake by bullocks during summer may also contribute to this weak appearance.

5. Yearly Effect on Price Variations

With 1973 as the base, the two intercept dummy variables \((x_{1974})\) and \((x_{1975})\) are introduced to determine the net price effects of the years 1974 and 1975. The regression coefficients for both the year intercept dummy variables are positive and statistically significant. A white bullock sold during the rainy season of either 1974 or 1975 is indicated to have fetched a price premium compared to its price during the same season of 1973. The year 1973 was a drought period in this region. This had given rise to heavy arrivals of bullocks in the market and created a sort of glut in the cattle market. In fact, the total number of arrivals of bullocks during 1973 was 78,523, whereas the corresponding number was 70,544 and 64,596 in 1974 and 1975 respectively.

The value of \(R^2\) is found to be 22 per cent. The variables included in the model could explain 22 per cent of the variations in prices. The value of
F-computed comes to 280.00. Since this computed value is greater than F-critical (2.32) at one per cent level for 10 and 9931 degrees of freedom, statistically significant explanatory power of the model is established. This low $R^2$ could perhaps be attributed to the omission of some variable such as weight and height of bullocks, working efficiency, health conditions and auspicious and inauspicious marks from the specification of the bullock pricing model. Due to lack of data, these variables could not be incorporated into the model.

**SUMMARY AND CONCLUSION**

The main objective of the study was to account for price discount and price premiums in bullock marketing. In order to determine the net effects of age, colours, breeds, seasons and years on bullock price variations, a quadratic econometric model has been formulated and empirically verified with data from the Mudalagai cattle market. Four major results have been obtained.

First, while the local bullocks fetch average prices, Khillar bullocks are indicated to have fetched a price premium. Second, when the white bullocks carry average prices, the red and black colour bullocks depress the prices below the average, and the mixed colour bullocks bring price premium. Third, the bullocks sold during the rainy season receive the average prices, whereas the winter season provides a price premium and the summer season gives rise to a price discount. Fourth, compared to the base year 1973, price premiums are recorded for the years 1974 and 1975.

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**PRICE RESPONSE OF A PERENNIAL CROP—A CASE STUDY OF INDIAN TEA‡**

Indian tea has a chequered history. It has periods of rise and fall. The lack of stability in the industry has retarded the pace of its development. Thus the performance of tea industry, although impressive occasionally in absolute terms, has been found inconsistent and disheartening in contrast to other tea growing countries. The last experience on price slump was during the late sixties and the early seventies. Though recently it has been able to stage some recovery from depression, nothing can be said in unequivocal terms about the longevity of the situation. Problems like excessively high cost of production, lower yields, employment fixities, export slackness, climatic specificities, etc., are some of the ills plaguing the industry.

A thorough probe into all aspects of the tea economy at this juncture would, therefore, be necessary. The present study was, however, confined

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‡ This paper is a part of the first author's M.Sc. Thesis entitled "The Impact of Price Changes on Area, Production, Yield and Employment in the Indian Tea Industry", Indian Agricultural Research Institute, New Delhi-12, 1975.