Vol XXVI
No. 4

ISSN 0019-5014

CONFERENC
NIMBER

OCTOBER-
DECEMBER
1971

INDIAN JOURNAL OF AGRICULTURAL ECONOMICS

INDIAN SOCIETY OF
AGRICULTURAL ECONOMICS,
BOMBAY

Thus the condition: $1 - \frac{2}{\beta} < \frac{d}{b} < 1$: for convergence is satisfied in this case also.

Thus, both the models show that firstly, there is evidence for cobweb and secondly, it is of a convergent type. It must be mentioned that both the estimated equations contain a number of variables other than own price. This makes the determination of the precise time path rather complicated, even though it could be shown that so long as $\left|\frac{d}{b}\right|$ satisfies the condition for convergence of price to the equilibrium level, the series generated for other variables is also of a convergent type. The traditional model suggests a two-year periodicity of the price cycle which is not in conformity with observed behaviour. The second model implies a period of 2.3 years for nearly full adjustment. This gives cycles of 4—5 years' duration, assuming a static demand. This is much closer to the observed duration of the cycles. This supports McClements argument[13] that incorporation of the adjustment hypotheses in the supply relation improves the applicability of the cobweb theorem.

However, the inability to incorporate the influence of price intervention on both demand and supply sides, restricts the validity of general conclusions. It can only be said that the nature of supply and demand relations suggest a generally stable equilibrium.

PRICE ELASTICITIES—METHODOLOGICAL ISSUES WITH REFERENCE TO PERENNIAL CROPS

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Output decisions are generally claimed to have been influenced by prices and when products are at the end of their production process factor price is assumed to be given and product price becomes the relevant variable. As regards perennial crop with heavy initial investment plus varying annual costs, current product price seems to influence current output marginally and prices of previous periods would have greater relevance for current production. Related to this assumption is the expectation calculus of price for a given period and decision.

13. L. D. McClements, *op. cit.*

Recent developments in the use of expectation hypotheses on price discovery and process of output adjustment suggest that a 'naive' model of price expectation, *viz.*, output response to price lagged by one period could be an efficient model to explain output behaviour in developing agriculture.

More often acreage under a given crop, instead of its output, has been taken to indicate the farmer's decision behaviour in respect to market stimuli, especially of product prices. While this may plausibly be so regarding output decisions for annual crops (3, 4, 7, 9, 10, 11),* the case of perennial crops appears to be complex involving methodological questions which require great deal of conceptual scrutiny and empirical verification (1, 2). The present paper has two objectives: first, to identify relevant problems in specifying price variables for estimating price elasticities, and second, to present empirical support for various hypotheses on output response to prices. The reference crop is tea, an important crop component of India's international trade with its peculiar market structure and channels, and specialized production organization. The reference period is from 1921 to 1968 with the exception of the years 1943 to 1946, 1952 and 1954 which are excluded for the reasons that they are not normal years and no relevant data are available.

I

METHODOLOGICAL ISSUES

In an earlier paper (11) it was reported that changes in output of tea could be explained by changes in yield per unit of area and trend over years; and 'the disturbing information is that neither the prices of products nor the planted area could explain much of the variations in production.' That area planted lagged by six years, could not explain variations in production could possibly be reasoned in terms of uncertain market situation both domestic and foreign. However, it is not clear whether acreage decisions are influenced by prices. If prices have a bearing on acreage decisions what are the relevant prices ?

Obviously, one would look for prices received recently and/or during preceding periods. Perhaps the adaptive expectation hypothesis may also be considered. As a perennial crop with a production lag of six years from planting, prices of tea lagged by six years and its linkage backward may have to be examined. Furthermore, it is also necessary to analyse the relationship between modal price received before and/or between the intervening six years and acreage planted.

Conceptually, the area planted in a given period can be construed as a stock and new planting as new 'investment' while replanting as depreciation 'allowance' to maintain the existing stock. Viewed in this manner, maximum planted area during the period of preceding six years may be specified as relevant information for deciding on current planted area. This becomes

* Figures in brackets denote references cited at the end of this paper.

useful as a proxy variable when reliable estimates of new planting and replanting areas are not readily available.

Alternatively, output response models can be specified. Current prices, and past prices do form important elements of output decisions. Current prices change input-output relations and influence output through changes in yield per unit of planted area. The concept of current prices needs careful definition. Functionally they are 'expected' prices and they vary, depending on various hypotheses, from prices received during the preceding year to an average of prices received during the past years.

Another plausible hypothesis relates to consumption hypothesis of Duesenberry (5) which can be stated as, that prices received during the preceding year in relation to the maximum price received over previous years would perhaps explain partly output changes.

A related hypothesis is that output changes tend to be flexible to positive changes in price and 'sticky' to negative changes in price. The traditional analysis shows an average response of a variable over years and the present hypothesis could explain the differential response of output to direction of changes in prices.

The data on area, production and prices of tea were taken from the Tea Statistics (12) and additional information was obtained from the Tea Board by correspondence.

II

EMPIRICAL RESULTS

The results of analysis are presented below :

Notations

A_t = Area of tea in thousand hectares in the year, t

A_{max_t} = Maximum area of tea in thousand hectares prior to year, t

$A_{t-6\ max.}$ = Maximum area of tea in thousand hectares during the year t—6 and prior

P_{t-1} = Price of tea in Rs./lb. in the year t—1

P_{t-6} = Price of tea in Rs./lb. in the year, t—6

$P_{t-1\ max.}$ = Maximum price in Rs./lb. in the year t—1 and prior

$P_r = \frac{P_{t-1}}{P_{t-1\ max.}}$ (relative price)

Y_t = Production in thousnad tonnes in the year, t

$X_t = 1$ if $\Delta P_{t-1} > 0$

$\quad\; 0$ if $\Delta P_{t-1} < 0$

$Z_t = X_t . P_{t-1}$

T = Time (1921 = 1)

I. *Acreage Models*

(*a*) $A_t = 111.218 + 25.00606^{**} P_{t-6} + 0.6510^{*} A_{t\,max.} - 1.4775^{*}T$
$\quad\quad (61.42) \quad (5.775) \quad (0.2031) \quad (0.514)$

$R^2 = 0.64$

(*b*) $A_t = 294.911^{**} - 24.1902^{**} P_{t-6} + 40.10126^{**} P_{t-1\,max.}$
$\quad\quad (4.4) \quad (7.83) \quad (11.005)$
$\quad\quad + 0.16721\ T$
$\quad\quad (0.3768)$

$R^2 = 0.5437$

(*c*) $A_t = 369^{**} + 0.2002\ T + 0.0083\ T^2 + 14.3662^{**} P_{t-1}$
$\quad\quad (1.28) \quad (0.237) \quad (0.0104) \quad (2.863)$
$\quad\quad - 8.9562^{**} P_r$
$\quad\quad (1.0639)$

$R^2 = 0.83$

II. *Production Models*

(*a*) $Y_t = 113.80^{**} + 48.0579^{**} P_{t-1} - 0.9986\ Z_t - 9.327\ X_t$
$\quad\quad (26.5) \quad (6.47) \quad (5.03) \quad (7.47)$
$\quad\quad + 3.56024^{**}\ T$
$\quad\quad (0.339)$

$R^2 = 0.98$

(*b*) $Y_t = 110.27^{**} + 38.5424^{**} P_{t-1} + 3.7284^{**}\ T$
$\quad\quad (5.00) \quad (7.02) \quad (0.428)$

$R^2 = 0.96$

(*c*) $Y_t = 137.28^{**} + 63.7777^{**} P_{t-1} - 41.355^{**} P_r + 2.7786\ YT$
$\quad\quad (8.36) \quad (6.15) \quad (12.41) \quad (0.3217)$

$R^2 = 0.99$

In the three acreage models, the coefficients of lagged prices are significant at one per cent probability level; and that of maximum acreage was significant at 5 per cent level. However, trend was significant only in model I(a) at 5 per cent level but the level coefficient was not significant. Reverse relations exist in models I(b) and (c).

Though the coefficients of determination (R^2) are significantly different from zero in all the three models, specification bias appears to be very high in models I(a) and (b) and relatively less in model I(c). The negative relationship between acreage planted and the relative price is worth noting. The ratio, by specification, is equal to or less than unity. P_{t-1} has positive sign and $P_{t-1}/P_{t-1\,max.}$ has negative sign and one can perhaps conclude that $P_{t-1\,max.}$ has negative relation with acreage which would seem plausible. The higher the $P_{t-1\,max.}$ the lower the ratio and larger A_t. This positive relation between A_t and $P_{t-1\ max.}$ explains the 'hump' concept which perhaps bound the changes in A_t. Incidentally, it may also be noted that $A_{t\ max.}$ and $P_{t-6\ max.}$ have positive slopes which are similar to consumption hypothesis proposed by Duesenberry and Modigliani (13).

In the three production models, the hypothesis of differential response of output to different directions in changes in prices is estimated in model I(a). The coefficients of prices lagged by one year and time are significant at 1 per cent level and the same is for level coefficient. On the other hand, the coefficient of dummy variables are not significant indicating lack of differential response of output to positive and negative changes in prices. It seems that a simple price variable representing prices received in the preceding year (P_{t-1}) can explain adequately the variations in output. The dummy variables are therefore deleted. Model II(b) gives the relationship between output and price lagged by one period and time. As compared with model II(a) there is a marginal reduction in R^2 and magnitude of other coefficients.

Model II(c) uses relative price hypothesis which assumes that in addition to price lagged by one period, the ratio of current price to maximum price received earlier would help to explain the variations in output better. The fitted function is also better than other functions with R^2 being 0.99 and all the slope coefficients and level coefficients are highly significant at 1 per cent level. The signs of coefficients are also as expected. The coefficient of P_r and its sign has to be interpreted as noted earlier for acreage models. The relative price has inverse relation with output. An increase in peak price tends to decrease the relative price and increase the output.

The coefficients of elasticity of output in respect of various independent variables have been computed around mean levels and they are presented in Table I.

TABLE I—PRICE ELASTICITIES OBTAINED IN THE MODELS SPECIFIED

Equation	Variable	Elasticity
I (*a*)	Pt—6	0·0878
I (*b*)	Pt—6	0·0849
I (*b*)	Pt—6 max.	0·1573
I (*c*)	Pt—1	0·0612
I (*c*)	Pr	0·0238
II (*a*)	Pt—1	0·264
II (*b*)	Pt—1	0·212
II (*c*)	Pt—1	0·351
II (*c*)	Pr	0·142

An examination of the magnitudes of coefficients of elasticity shows a better relationship in production models than that in acreage models. Further more estimated R^2's are also consistently higher in the former models adding to their prediction power.

In sum, output decisions are influenced by prices, more specifically, price lagged by one year. Moreover, output does not seem to respond differently to different directions of price changes. Perhaps this insensitivity is the cause for frequent surpluses in markets depressing profitability of the industry.

With relatively less efficient acreage models to explain and predict output behaviour one would prefer output models where output is a product of acreage and yield. It follows by deduction that yield per unit of planted area matters most—a conclusion reported in an earlier paper.

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