Vol XXVI
No. 4

ISSN 0019-5014

CONFERENC
NIMBER

OCTOBER-
DECEMBER
1971

INDIAN JOURNAL OF AGRICULTURAL ECONOMICS

INDIAN SOCIETY OF
AGRICULTURAL ECONOMICS,
BOMBAY

ACREAGE RESPONSE TO PRICES FOR MAJOR CROPS IN PUNJAB—AN ECONOMETRIC STUDY

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INTRODUCTION

A number of researches have been conducted to study the farmers' response to prices in so far as the allocation of available acreages to different crops are concerned. In most of these studies Nerlovian model has been used either as such or with minor modifications. There prevails no conscienable agreement as to which price do the farmers respond. Is it absolute price of the commodity or its relative price? Do the farmers look to harvest prices or wholesale prices for such decisions? Some studies have brought out that while certain crops respond significantly to absolute prices there are others that respond to relative prices. The answer to the question (as to which prices should be taken for analysis) should not be left to the computor but there should be sufficient economic justification for such a selection.

Yet another similar problem is to get an unbiased estimate of the response of the farmers to the risk elements (both price and yield) involved in different crop enterprises. So far, most of the supply functions obtained either ignored the risk variable or did not specify it properly. A recent study[1] incorporated moving standard deviation of the prices—both relative and absolute, together and alternatively as a variable to measure the risk. The two basic assumptions of the multiple regression analysis are that the explanatory variables are independent and normally distributed. The distribution of standard deviation is not normal[2] and hence the estimates obtained through a model with standard deviation as a variable may not be 'blue' estimates.

Keeping in view the limitations of the previous investigations, this study is an attempt to obtain the best estimates of the response of Punjab farmers

1. C. C. Maji, D. Jha and L. S. Venkataramanan, "Dynamic Supply and Demand Models for Better Estimations and Projections: An Econometric Study for Major Foodgrains in the Punjab Region," *Indian Journal of Agricultural Economics*, Vol. XXVI, No 1, January-March, 1971, pp. 21-27.
2. M. G. Kendall and Allen Stuart: The Advance Mathematical Statistics, Vol. II, Charles Griffins and Co., London, 1961, p. 375.

to prices while making a decision about acreage allocation to major crops, *viz.*, wheat, paddy, maize, groundnut and *desi* cotton.

MATERIAL AND METHODS

Specification of Variables

The main postulation of this study is that for decision-making in regard to the allocation of acreage, farmers look to harvest prices of the crops and not to the wholesale prices or any other price. The logic underlying this assumption is that about 70 to 95[3] per cent of the produce in Punjab is sold in the market within two months after harvest except maize where the percentage arrivals during these months are a little lower. As such harvest prices exercise exceedingly more influence on the decisions of the farmers than wholesale prices. The farmers base their expectations of future prices on harvest prices. The second postulation of the current analysis is that the decision of allocating the acreage does not depend upon past prices alone but the extent of variation in these prices count much in building these price expectations to the farmer.

As yet it remains to be elaborated that the prices of the crops have not been taken as such but a measure of relative profitability has been used instead. The index of value productivity (yield × price) of the crop has been deflated by the value productivity index of the competing crops and this has been used as a variable instead of price. The competing crops for wheat, paddy, maize, groundnut and *desi* cotton were as follows. Gram and barley for wheat; maize for paddy; bajra, cotton American, cotton *desi* and sugarcane for maize; cotton American, sugarcane, maize and wheat for cotton *desi* and bajra for groundnut. The risk variable was the coefficient of variation of the relative profitability, for the three preceding years when the decision is taken. The distribution of the coefficient of variation is normal.[4] However, both the coefficient of variation and the standard deviation alternatively have been used as variables in order to observe the difference in their relative performance.

Specification of the Model

The model used was essentially of the Nerlovian type, *i.e.*,

$$Y_t^* = a_o + a_1 P_{t-1} + a_2 \sigma P_{t-1} + a_3 U_t$$
$$(Y_t - Y_{t-1}) = \beta (Y_t^* - Y_{t-1})$$

The reduced form of this function is

$$Y_t = a_o \beta + a_1 \beta P_{t-1} + (1-\beta) Y_{t-1} + a_2 \beta \sigma P_{t-1} + a_3 \beta U_t$$

3. Balwinder Singh and D. S. Sidhu: Pattern of Market Arrivals and Prices for Foodgrains in the Punjab, Department of Economics and Sociology, Punjab Agricultural University, Ludhiana (unpublished paper).

4. M. G. Kendall and Allen Stuart: *op. cit.*, p. 375.

where Y_t = acreage under crop for the year t,
Y_{t-1} = lagged acreages,
P_{t-1} = relative profitability[5] of the crop for t—1
σP_{t-1} = standard deviation of P_{t-1},
CVP_{t-1} = coefficient of variation of P_{t-1},
U_t = residual.

The analysis was restricted to the recent decade, *i.e.*, 1960-61 through 1969-70.

RESULTS AND DISCUSSIONS

The cropwise discussion is presented below :

Wheat

The results of the three response equations are summarized in Table I. From the table it was observed that in all the three equations the coefficient of lagged acreages turned out to be significant. It was significant at 5 per cent

TABLE I—REGRESSION COEFFICIENTS, THEIR STANDARD ERRORS (SE), t-VALUES AND VALUE OF R^2 FOR THREE DIFFERENT EQUATIONS FOR WHEAT (1960-61 TO 1969-70)

Equations	Variable	bi	SE(bi)	t-values	R^2
	Y_{t-1}	0·8617	0·02845	3·028**	
I	P_{t-1}	1·2780	1·7821	< 1	0·9102
	Y_{t-1}	0·8345	0·1615	5·167*	
II	σP_{t-1}	1·1610	3·4990	< 1	0·9144
		—10·2130	15·3530	< 1	
	Y_{t-1}	0·8449	0·1754	4·817*	
III	P_{t-1}	0·3780	3·2990	< 1	0·9203
	CVP_{t-1}	—5·5280	14·9840	< 1	

* = Significant at 1 per cent level.
** = Significant at 5 per cent level.

probability level in equation I and at 1 per cent level in equations II and III. The rest of the coefficients did not turn out to be significant. The coefficient of the relative profitability bore a desired sign (positive) in all the three equations and the same held true for the third variable in equations II and III. This might be due to the fact that wheat was relatively a low risk crop probably because of assured irrigation facilities and fixed prices of the product. It was further observed that the risk measured by the coefficient of variation increased the value of R^2 from 0.9144 in equation II to 0.9203

5. Relative profitability = $\frac{\text{(Price) (Yield)}}{\text{(Price) (Yield) of competing crops.}}$

in equation III. At the same time its inclusion reduced the coefficient of profitability which in turn affected the short run and long run elasticities (Table II). In the last two equations the estimates of the coefficient of adjustment did not show a marked change but they were different from the one obtained from the first. The long run elasticity was higher than the short run elasticity in each case.

TABLE II—COEFFICIENT OF ADJUSTMENT, SHORT RUN AND LONG RUN ELASTICITIES BASED ON THREE DIFFERENT EQUATIONS FOR WHEAT

Equation	Coefficient of adjustment	Elasticity	
		Short run	Long run
I	·1385	·0808	·5842
II	·1655	·0734	·4435
III	·1551	·0239	·1514

Maize

In the case of maize crop, the coefficient of profitability worked out to be significant at one per cent level in all the equations (Table III). The coefficient attached to the risk variable characterized by the standard deviation (equation II) and the coefficient of variation (equation III) were also highly significant with appropriate (negative) sign since maize is relatively a high risk (yield) crop. It implied that the farmers do take into consideration the relative profitability along with its variation for making a decision about the allocation of acreages to this crop. The inclusion of the coefficient of variation as a variable, in place of the standard deviation, improved the coefficient of determination.

TABLE III—REGRESSION COEFFICIENTS, THEIR STANDARD ERRORS (SE), t—VALUES AND VALUE OF R^2 FOR THREE DIFFERENT EQUATIONS FOR MAIZE (1960-61 TO 1969-70)

Equation	Variable	b_i	SE(b_i)	t—values	R^2
	Y_{t-1}	·1834	·1499	1·223	0·9827
I	P_{t-1}	·4940	·1130	4·377*	
	Y_{t-1}	·2088	·1349	1·548	
II	P_{t-1}	·5491	·0671	8·183*	0·9950
	σP_{t-1}	—·8871	·2291	3·872*	
	Y_{t-1}	·1509	·1257	1·200	
III	P_{t-1}	·4581	·0603	7·597*	0·9958
	$CV_{P_{t-1}}$	—1·2350	·2896	4·264*	

* = Significant at 1 per cent level.

In all the three equations the coefficient of adjustment did not differ markedly. The short run elasticity with respect to the variable measuring

relative profitability (P_{t-1}) did not differ much. The long run elasticity estimates were higher than the short run estimates (Table IV).

TABLE IV—COEFFICIENT OF ADJUSTMENT, SHORT RUN AND LONG RUN ELASTICITIES BASED ON THREE DIFFERENT EQUATIONS FOR MAIZE

Equations	Coefficient of adjustment	Elasticity	
		Short run	Long run
I	·8166	·1142	·1398
II	·7912	·1269	·1604
III	·8491	·1267	·1492

Paddy

The coefficient of lagged acreages in the case of paddy crop turned out to be significant at 1 per cent level in the case of equations I and II but the level of significance dropped to 5 per cent in the case of equation III.

The coefficient attached to the relative profitability variable did not work out to be significant but was accompanied by a correct (positive) sign. In equation III the coefficient of the variable measuring risk ($CV_{P_{t-1}}$) turned out to be significant at 5 per cent level and also increased the value of R^2 from 0.9094 to 0.9382 (Table V).

TABLE V.—REGRESSION COEFFICIENTS, STANDARD ERRORS, t—VALUES AND R2 FOR THREE DIFFERENT EQUATIONS FOR PADDY (1960-61 TO 1969-70)

Equations	Variable	b_i	SE(b_i)	t-values	R^2
I	Y_{t-1}	·1361	·0279	4·878*	0·9065
	P_{t-1}	·1439	·8786	< 1	
II	Y_{t-1}	·6428	·1634	3·933*	0·9094
	P_{t-1}	·7562	·4258	1·77	
	σP_{t-1}	—2·9632	1·6886	1·75	
III	Y_{t-1}	·7005	·2850	2·457**	0·9382
	P_{t-}	·5911	·5575	1·060	
	$CV_{P_{t-1}}$	—2·5597	1·0021	2·554**	

* = Significant at 1 per cent level.
** = Significant at 5 per cent level.

Inclusion of variable σP_{t-1} and $CV_{P_{t-1}}$ in equations II and III respectively changed the coefficient of adjustment which affected the short run elasticity and the long run elasticity significantly (Table VI).

TABLE VI—COEFFICIENT OF ADJUSTMENT, SHORT RUN AND LONG RUN ELASTICITIES BASED ON THREE DIFFERENT EQUATIONS FOR PADDY

Equation	Coefficient of adjustment	Elasticity	
		Short run	Long run
I	·8639	·0463	·0536
II	·2572	·2434	·6814
III	·2995	·1903	·6354

The coefficient of adjustment did not vary much when calculated from equation II and equation III, but the estimates differed markedly when compared to the coefficient of adjustment derived from equation I. The same was true for short run and long run elasticities.

Groundnut

In the case of groundnut the coefficient attached to the lagged acreage worked out to be significant at 1 per cent level in all the three cases (Table VII). The relative profitability did not work out to be significant in equation I. But the same turned out to be significant at 10 per cent when σP_{t-1} and CVP_{t-1} were included as a measure of risk in equations II and III respectively. The coefficient of the variable σP_{t-1} was also significant at 10 per cent in equation II. But when σP_{t-1} was replaced by CVP_{t-1} in equation III the coefficient attached with CVP_{t-1} worked out to be significant at 5 per cent level. There was not much of a difference in so far as the value of R^2 was concerned.

TABLE VII—REGRESSION COEFFICIENTS, STANDARD ERRORS (SE), t-VALUES AND R^2 OF THREE DIFFERENT EQUATIONS FOR GROUNDNUT (1960-61 TO 1969-70)

Equation	Variable	b_i	SE(b_i)	t-values	R^2
I	Y_{t-1}	·8326	·1383	6·020*	0·8503
	P_{t-1}	·8630	·8110	1·664	
II	Y_{t-1}	·7657	·0958	7·992*	0·9416
	P_{t-1}	1·2690	·5630	2·254***	
	σP_{t-1}	—2·2850	·7460	2·285***	
III	Y_{t-1}	·7615	·0937	8·127*	0·9445
	P_{t-1}	1·3070	·5520	2·367***	
	CVP_{t-1}	—2·2370	·7020	3·186**	

* Significant at 1 per cent level.
** Significant at 5 per cent level.
*** Significant at 10 per cent level.

Inclusion of variable σP_{t-1} and CVP_{t-1} increased the value of the coefficient of adjustment from .1674 to .2343 and .2384 in equations II and III respectively. The coefficients of adjustment based on equations II and III worked out closer to each other but these were higher as compared to that calculated from equation I. Similarly the short run and long run elasticities worked from equations II and III were also affected and were higher than the one worked out from equation I (Table VIII). The long run elasticities

TABLE VIII—COEFFICIENT OF ADJUSTMENT AND SHORT RUN AND LONG RUN ELASTICITIES BASED ON THREE DIFFERENT EQUATIONS FOR GROUNDNUT

Equations	Coefficient of adjustment	Elasticities	
		Short run	Long run
I	·1674	·5118	3·057
II	·2343	·7526	3·212
III	·2384	·7751	3·251

with respect to relative profitability worked out to be highly elastic for this commercial crop. It ranged from 3.057 in equation I to 3.251 in equation III. The reason for this high elasticity is that it is a cash crop and the marketable surplus in cash crops is higher than that in foodgrain crops.

Desi Cotton

In so far as *desi* cotton was concerned the coefficient of lagged acreages turned out to be significant in all the equations although the level of significance varied from 5 per cent in equations I and III to 1 per cent in equation II. The coefficient of relative profitability worked out to be significant at 1 per cent in the case of equations I and II but the level of significance changed to 10 per cent when the coefficient of variation was used to measure risk in place of standard deviation. The coefficient of the variable CVP_{t-1} turned out to be significant at 5 per cent in equation III whereas in equation II the coefficient of σP_{t-1} was significant at 10 per cent. This variable (CVP_{t-1}) increased the R^2 value from 0.8756 and 0.9326 in equations I and II respectively to 0.9632 in equation III (Table IX). All the coefficients carried the expected signs.

The value of coefficient of adjustment and the short run elasticities are presented in Table X.

It was observed that in all the three equations the values of the coefficient of adjustment did not differ markedly although they were close to each other as derived from equations II and III and higher than the one derived from equation I. The long run elasticity with respect to relative profitability was higher than short run elasticity and was elastic. Again the reason being that *desi* cotton is a cash crop and the marketable surplus is very high.

TABLE IX—REGRESSION COEFFICIENT, THEIR STANDARD ERRORS (SE), t-VALUES AND VALUE OF R^2 FOR THREE DIFFERENT EQUATIONS FOR *Desi* COTTON (1960-61 TO 1969-70)

Equations	Variables	b_i	SE (b_i)	t-values	R^2
I	Y_{t-1}	·4689	·1418	3·306**	
	P_{t-1}	1·6367	·2997	5·461*	0·8756
II	Y_{t-1}	·4273	·1142	3·742*	
	P_{t-1}	1·3915	·2619	5·313*	0·9326
	σP_{t-1}	—1·8303	·8121	2·254***	
III	Y_{t-1}	·4178	·1393	2·999**	
	P_{t-1}	2·0907	·9769	2·140***	0·9632
	CVP_{t-1}	—8·8727	3·5191	2·521**	

* Significant at 1 per cent level.
** Significant at 5 per cent level.
*** Significant at 10 per cent level.

TABLE X—COEFFICIENTS OF ADJUSTMENT, SHORT RUN AND LONG RUN ELASTICITIES BASED ON THREE DIFFERENT EQUATIONS FOR *Desi* COTTON

Equation	Coefficient of adjustment	Elasticities	
		Short run	Long run
I	·5311	·5350	1·0072
II	·5727	·4549	0·7943
III	·5822	·6834	1·1738

CONCLUSIONS

From the foregoing results it is evident that the coefficient of variation as a variable in place of standard deviation has consistently given higher coefficient of determination. The improvements in results brought about by inclusion of CV as a variable is also reflected in the coefficient of adjustment and in short and long run elasticities. The long run elasticities were higher than the short run elasticities in each case. The elasticities were more than one in the case of cash crops, *viz.*, groundnut and *desi* cotton. It has also been demonstrated that maize, groundnut and *desi* cotton were relatively high risk crops whereas paddy and wheat were relatively low risk crops mentioned in the descending order of the risk.