Dynamic Supply Response Analysis of Pakistani Rice Growers

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Abstract

Alternative specifications of model of supply response of Pakistani rice growers and their economic implications are considered in terms of the existences and nature of production lags, and the choice between expected price and gross returns as the preferred explanatory of producer's response to changing economic condition. The analysis indicates that there are lags which are due primarily to the difficulties and cost of rapid adjustment rather than to the time required to revise expectations. The statistical results were similar for the alternative specification of gross margins and prices as the economic decision available. However, the price elasticities derived using the gross margins specification were about a third of those using the prices specification. The gross margin specification yielded additional information in the form of yield and input cost elasticities.

Keywords: Supply response analysis, Rice growers, Pakistan.

1. Introduction

Agriculture is the largest sector of Pakistan's economy. The agriculture sector contributes around 24.1 percent in GDP, and engaged half of the total employed labor force. It is largest source of foreign exchange earnings and meets raw material needs' of country's major industries such as textile and sugar production.(Economic Survey of Pakistan (2005-06).

The growth in the agriculture sector increased from 4.6 percent to 7.8 percent in the current year. This increase attributes to 9 percent expansion in major crops, 4.9 in minor crops, 5.6 percent in livestock, and 8.3 in fisheries sector. A feature of improved growth in the agriculture sector is record production of wheat and rice and recovery in cotton (Economic Survey of Pakistan 2005-06). Improved growth in a agriculture sector is attributed to the government's agricultural policy reforms such as waiving of interest on loans, introduction of Khushali bank, support price policy and introduction of micro credit facility. The growth is also attributed to timely measures to get cotton out of deep-seated crisis (Nasir et al 2005)

Rice is the second principal food and commercial crop and occupies about 10% of the total cropped area. The total cropped under the rice during the year 2005 production was 2503, Hectare, and Production 4991 tones.

Thailand, India, Chad are the main competitors of Pakistan (*Shaikh et al. 2006*) The government of Pakistan is taking effective measures to increase the yield, production and quality of export rice. Research efforts are continuing on developing high yielding basmati and IRRI varieties. Emphases are also being laid on agronomic research as well as on improved extension services, fertilizer use, direct seedling etc. The flow of input and credits is also being substantially increased. The research was investigated with the objectives to determine the factors that affect the supply of rice in Pakistan, and to estimate the short run price elasticities of rice in Pakistan.

2. Theoretical model and Dynamic Supply Analysis.

An agriculture supply function describes how the quantity of the product offered for sale varies as its price varies to relative to other product prices (Cochrane, 1995). Cochrane distinguishes between supply function response. The supply function describes the quantity which would be supplied at different prices with all other things constant, while the supply response relationship describes what will happen to the quantity supplied when all other things are not held constant. Nerlove (1958) provided much of the theoretical frame work in the supply response studies.

Let the supply equation be

$Qt = \quad a_o + a_1 P_t + a_2 Z_t$ \hspace{2cm} (1)

Qt = \quad Actual quantity produced

Pt = \quad Actual price of rice produced.

Zt = \quad Supply Shifters

$Q_t = \quad a_o + a_1 P^*_t + a_2 Z^*_t$ ……… (2)

Where Q_t = Quantity produced in time t

P^* = Expected price

Z^*_t = Supply shifters expected

The expected price is not observable and is explained as expected 'normal' price, i.e., the level about which the future price is expected to fluctuate. This can be expected as:

Actual $P - p_{t-1}$

$P^* - P^*_{t-1} - \beta(P_{t-1} - P^*_{t-1})$, \hspace{2cm} $0 \le \beta \le 1$ ………………. (3)

We assume the expected price is actual price. $P = P^*$

We can get the following equation by getting the value of P^* from equation (2) and substituting in into equation (1) and rearranging it,

$Q_t = \quad b_o + b_1 P_{t-1} + b_2 Q_{t-1} b_3 Z_{t-1} + b_4 Z_{t-1}$ ……. ……… (4)

The equation (3) can be estimated economically.

To estimate elasticities the formula used was $\partial Q/\partial P$. P/Q the first term for short and long run will be

Short run $\partial Q_t/\partial P_{t-1}$ and Long run: $b_1/_1 - b_2$

2.1 Model and Method of Estimation

The main interest of this study is the response of total planned output to a number of variables, because the planned output is an unobserved variable so time series data on planned output are not available. Hence a proxy of actual output has to be used in analyzing the response of planned output of rice to variation in its prices. The second analysis in this paper is done by taking the acreage under rice a dependent variable. Area is concerned to be a reasonably good proxy for production so long as it is a major input. The main objective of supply response studies is to analyze the movements in the intended acreage to price changes. The actual acreage may not reflect the intended acreage due to certain constraints (Lim, 1975). Necessary time series data over the years 1975-2005 were collected from the secondary sources.

2.2 Variables included in Econometric Model.

1. Production of Rice (QR_t)

Depended variable was total production of rice in Pakistan. The time series data of rice production were collected from different sources.

2. Actual Price of Rice (P)

The data on price of rice were collected from 1961-2005. The actual value of price of rice has direct relationship with production and acreage of rice.

3. Acreage under Rice (Ar_t)

Acreage under rice in Pakistan was taken as a dependent variable in the acreage response model. Time series data were collected from government publications.

4. Lagged price of Rice (PR_{t-1})

The data on price of rice were collected from 1961-2005. The lagged value of price of rice has direct relationship with production and acreage under rice t. Therefore, the coefficient of this variable should have a positive sign.

5. Lagged production of Rice (QR_{t-1})

This variable is expected to have a significant impact on production of rice in year t. This variable was expected to have a positive sign.

6. **Lagged acreage under of Rice (AR $_{t-1}$)**

The lagged acreage under rice also has a positive impact on the acreage under rice in year t. The variable has a positive sign.

7. **Lagged production of Cotton (ZC $_{t-1}$)**

The lagged price of cotton has an inverse relationship with production and acreage under rice because the cotton is competitive crop. Therefore the coefficient of this variable was expected to have a negative sign.

7. **Dummy Variable (D$_t$)**

Due to war with India, a dummy variable for the year 1961, 1966, 1971, agriculture production. The coefficient of this variable was expected to have a negative sign for production and acreage under rice.

2.3 Mathematical form of the Model

The following models were chosen among the various mathematical forms on the basis of economic, statistical and econometric criteria.

A.   Production Response

$QR_t = f (P_t, R_{-1}, PR_{t-1}, D_t, e_t)$

B. Acreage Response

$AR_t = f (PR_{t-1}, AR_{t-1}, PC_{t-1}, D_t, e_t)$ where,

QR_t is the total rice production (000tonnes) in year t.

AR_t is the total acreage under rice (000 hec) in year t

PR_{t-1} is the wholesale price of Rice (Rs/mounds) in year Legged $_{t-1}$

QR_{t-1} is the total rice production (000 tones) in year legged $_{t-1}$

AR_{t-1} is the total acreage under Rice (000 hec.) in year Legged$_{t-1}$

ZC_{t-1} is the wholesale price of Cotton (Rs/mounds) in year Legged$_{t-1}$

D_t is the dummy variable for war 1961, 1966, 1971.

e_t is the random disturbance term.

3. Results and Discussion

The time series for the present study was from 1961 to 2005 and secondary data will be collected for the analyses (Source Economic Survey of Pakistan Various). The results were obtained by using SHAZAM and presented in Table1, and 2.

  (A) Production Response

Ln QR_t = 2.56 + 0.192 Ln PR_{t-1}+ LnQR_{t-1}- 0.019 Ln ZC_{t-1} − 0.258Ln D_t

Table.1.Structural co-efficient, their significance and value of R2 for rice production response
in Pakistan (1961-2005)

Variable	Co-efficient	Standard Error	t-Ratio	Significance
Constant	2.75	0.867	2.948	***
PR$_{t-1}$	0.192	0.077	2.468	**
QR$_{t-1}$	0.653	0.1236	5.282	***
ZC$_{t-1}$	- 0.019	0.083	0.23	
D$_t$	- 0.258	0.103	2.489	**
R^2	0.9674			
R^2 (Adjusted)	0.9629			

*** = Significant at 1 percent level of Significance.

** = Significant at 5 percent level of Significance.

4. Interpretation of results

The examination of the co-efficient of determination for production response equation indicated that 96% variation in the production of rice in Pakistan was explained by the explanatory variable included in the model.

(a)   Lagged price of Rice (PR $_{t-1}$)

The Coefficient of lagged price of rice had a positive sign with a value of 0.192. The coefficient is significant at 5% confidence level which indicated that with one unit increase in the price of the rice in the last year, the production increased by 0.192 units. The sign and magnitude of co-efficient was according to expectations.

(b) Lagged production of Rice (QR $_{t-1}$)

The co-efficient of this variable had a positive sign with a value of 0.653 and was significant at 0.1 confidence level, which showed that lagged production of rice had a significant influence on the production of the rice. The size and sign of c0-efficient was according to the expectations based on theory.

(C) Lagged price of Cotton (PC $_{t-1}$)

The lagged price of cotton hah a negative sign with a value of 0.019 and non significant. The sign of co-efficient indicated that lagged price of cotton and rice production had an inverse relationship, as both are competitive crops. The co-efficient is non-significant because cotton is mainly grown on marginal land and has little influence on production of rice.

(d) War Dummy (D$_t$)

The dummy variable represented the war India in 1965. The co-efficient was negative, as was expected with a value of 0.258 and a significant at 5 percent confidence level. The negative influence of war on production might be due to non-availability of inputs at crucial stages in the production.

(B) Acreage Response

$$Ln\ AR_t = 6.8 + 0.096\ Ln\ PR_{t-1} + 0.158\ Ln\ PC_{t-1} - 0.0936 LnD_t$$

Table.2.Structural co-efficient, their significance and value of R^2 for rice production response in Pakistan (1961-2005)

Variable	Co-efficient	Standard Error	t-Ratio	Significance
Constant	6.8	1.043	6.518	***
PR$_{t-1}$	0.0965	0.0389	2.478	**
AR$_{t-1}$	0.158	0.128	1.235	
PC$_{t-1}$	0.0599	0.035	1.67	
D$_t$	- 0.094	0.0486	1.924	**
R^2	0.9604			
R^2 (Adjusted)	0.9564			

 *** = Significant at 1 percent level of Significance.

** = Significant at 5 percent level of Significance.

4.1 Interpretation of results

The examination of the co-efficient of determination was 0.9564, which indicated that 95% percent variation in the acreage under rice in Pakistan was being explained by the independent variable included in the model

(a)   Lagged price of Rice (PR $_{t-1}$)

The Coefficient of lagged price of rice had a positive sign with a value of 0.0965. The coefficient is significant at 5% confidence level which indicated that lagged price of rice had significant influence on acreage under rice.

(b)   Lagged production of Rice (AR $_{t-1}$)

The lagged acreage under Rice had a positive sign, according to expectations, with a value of 0.158 and was non-significant. This indicated that scope of horizontal expansion in Pakistan was limited.

(C).   Lagged price of Cotton (PC $_{t-1}$)

The co-efficient of this variable had a positive sign with a value of 0.059 and was non significant. The unexpected sign of co-efficient showed that price of cotton had no influence on the acreage of the rice as the cotton are sown on marginal lands.

(d)   War Dummy (D$_t$)

The dummy variable represented the war India in 1965-71, the co-efficient was negative, as was expected with a value of 0.094 and a significant at 5 percent confidence level. This indicated that war had a negative impact on the acreage under rice, which might be due to destruction of irrigation and other infrastructure and non-availability of inputs and other services.

4.2 Elasticities

The estimated short-run and long run elasticities for production and acreage response under rice are summarized in Table.3.

Table3.Own Price Elasticities for production and acreage under rice in Pakistan (1961-2005).

	Production Response	Acreage Response
Short Run	0.192	0.0965
Long Run	0.553	0.115

The own price elasticity for production shows that with the increase in the price of Wheat by 1 percent during the period of analysis, the quantity of rice production increased by 0.192 percent in the short run and 0.55 percent in the long run. In case of acreage response, with the increase in the price of rice by 1 percent during the period of analysis, the acreage under rice increased by 0.096 percent in the short run and 0.115 percent in the long run.

Conclusion: The "best" model was a long linear form, many variables were not including in the model due to non-availability of data, and important variables are included. The results of the analysis indicate that rice growers are response to changes in the prices of rice in the case of production and acreage under rice response. The lagged price of cotton has no significant impact on the production of rice and acreage under rice. This may attributed to the reason that cotton is grown on marginal lands and usually in the western areas of Pakistan. The cultivation of cotton is also risky due to the attack of pests. The dummy variable for the war period had a negative impact both on production and acreage under rice in the years 1961-2005. The co-efficient of lagged acreage was non significant, which indicated that horizontal expansion in area is limited in Pakistan, any increase in production will come through vertical expansion in future. This is a policy implication for government policy makers and researchers. With regards to elasticities. The own price elasticity of rice is 0.192 and 0.553 for short-run and long run production response and were acceptable on economic and statistical criteria.

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Appendix

Years	Acreage under Rice(000)Hec	Production under Rice(000)Tones	Price of Rice Rs/Mons.	Price of Cotton/mons
1961	1179	1006	13.62	16.46
1962	1200	1051	14.49	16.88
63	1194	1084	13.78	16.85
64	1229	1138	15.25	15.27
65	1276	1212	16.65	33.34
66	1345	1286	15.18	14.84
67	1386	1344	2290	19.32
68	1408	1394	2026	23.22
69	1462	1632	17.37	24.50
70	1532	1977	17.53	32.42
71	1560	2211	18.27	22.51
72	1527	2288	20.77	24.19
73	1480	2264	21.36	33.33
74	1483	2349	27.54	39.34
75	1532	2366	40.71	49.5
76	1609	2462	39.65	46.36
77	1688	2556	42.37	48.59
78	1786	2768	46.31	79.64
79	1891	2986	51.45	68.12

80	1987	3164	51.88	74.62
81	1998	3204	58.00	100.00
82	1981	3253	68.05	139.75
83	1962	3329	71.08	121.23
84	1984	3402	74.66	93.06
85	1992	3367	81.80	100.10
86	1954	3191	86.76	106.08
87	1976	3240	85.89	82.38
88	1964	3215	86.10	105.36
89	2024	3309	94.43	174.52
90	2037	3220	104.52	134.83
91	2087	3227	119.03	107.51
92	2106	3241	139.99	133.26
93	2061	3207	147.53	178.74
94	2086	3451	160.00	257.37
95	2095	3519	188.71	344.62
96	2158	3803	190	400
97	2179	3906	200	455
98	2243	4201	205	544
99	2331	4437	220	600
2000	2419	4721	240	700
2001	2439	4877	250	650
2002	2335	4614	255	900
2003	2225	4478	260	850
2004	2461	4848	250	1000
2005	2503	4991	260	900

X Variable 1 Residual Plot

X Variable 2 Residual Plot

X Variable 3 Residual Plot

X Variable 1 Line Fit Plot

X Variable 2 Line Fit Plot

X Variable 3 Line Fit Plot

Normal Probability Plot