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Supply Response of Rice in Khyber Pakhtunkhwa

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ABSTRACT

The present study is aimed at investigating the supply response of rice in Khyber Pakhtunkhwa using time series data from 1976-2010. The study used augmented dickey fuller test for stationarity with zero lag and one lag. The data showed stationarity at one lag. The vector auto regression is used for the analysis taking log production as dependent variable and lag-log production, lag-log rice price and lag-log competitive crop price as independent variable. The results are significant ($p<0.05$). The short and long run elasticity estimated are 0.597 and 1.481 for production, 0.037 and 0.091 for price and -0.066 and -0.163 for competitive crop (maize) showing inelastic relation of production with lag production, lag price and lag competitive crop price except lag production in long run. The study recommends that the prices should be kept stabilized by the government so that the farmers can easily take their decision regarding allocation of land to a specific crop. For the use of modern technology loans should be disbursed to the farmers with reasonable interest rate. The farmers should be properly educated through extension workers so that they are able to adopt new technology and increase productivity.

1. INTRODUCTION

Rice is one of the important crops in the world that supported more people for more years than any other cereal (Greenland, 1997). In Asia, it has become deeply entwined with the cultures of the region. The environmental and geographical factors also supported rice production in the region. High rainfall during monsoon and the nutrients and fertile sediments carried with the floodwaters created the favorable conditions for rice production. The rice industry is characterized by few large producing countries with many small producers. China, India, Indonesia, Bangladesh, Vietnam, Myanmar and Thailand produce 87 percent of the world rice.

For the small producing countries like Pakistan, the changes in global market conditions raise many challenges. Hence countries like Pakistan need to react more quickly to adjust its domestic policies. The importance of this reaction further increases in the wake of increase in global food prices. Supply elasticity, measuring the quantity response to changes in prices, is important tool in making the decisions about changes in policies. Supply elasticity is an important theme in production economics and is being used as a tool by Agricultural economists to evaluate the effectiveness of price policies in farmer's resource allocation. The objective of research on supply elasticity, according to Nerlove and Bachman 1960 is to improve the understanding of the price mechanism of supply response. The price policies have long been the basis of farm decision in many less developing countries.

Supply elasticity is estimated by specifying and estimating a supply model. Supply model specifies output as a function of a set of exogenous variables including lagged output, input prices and other supply shifters. Supply response models are estimated either using direct procedure or duality technique. The direct method consists of the adoptive expectation model of Nerlove (1958). Nerlove (1958) introduced the idea of partial adjustment suggesting that since it takes a while for equilibrium to occur, therefore, only a partial adjustment takes place within a unit time period. The delay occurring in the equilibrium could be due to many reasons including consumer preferences and resource fixity which takes a while to change while production already took place and needs to be disposed off. The technique has the major advantage of simple data requirements and the possibility of fewer specification errors.

Duality methods include the estimation of profit or cost functions. The profit function specifies maximum profit associated with a given level of output with input prices. The output supply and input demand are obtained by

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taking partial derivatives of the profit function with respect to prices of output and inputs. The indirect cost function is defined as the minimum cost required to produce a given level of output as given factor prices. The partial derivative of the indirect cost function with respect to output gives the marginal cost function. In perfect competition, marginal cost is equal to price of output. This relationship is solved to get output supply. The main advantage of this approach is that it uses economic theory and represents closer approximation of the reality. However, the approach requires more data especially it requires cost of production data over time. Further, short and long run elasticities are not directly estimable using these techniques unless profit or cost functions includes fixed cost of production than elasticities are short run.

The goal of this study is to estimate the supply response of rice in Khyber Pakhtunkhwa and to estimate short and long run supply elasticities for rice in Khyber Pakhtunkhwa.

2. METHODS AND MATERIALS

The study was conducted in whole Khyber Pakhtunkhwa. This section discusses the nature and sources of the data. The empirical analysis of this study used annual data from 1976 to 2010.Data regarding rice production, (kg/hectare) was obtained from Agriculture statistics of Pakistan, and that of prices (Rs/kg) was obtained from Provincial Federal Beareu of Statistics Peshawar for the years 1976 to 2010.
Nerlove (1958) introduced the idea of partial adjustment suggesting that since it takes a while for equilibrium to occur, therefore only a partial adjustment takes place within a unit time period. The delay occurring in the equilibrium could be due to many reasons including consumer preferences, which takes a while to change and production already took place and needs to be disposed off.

Conceptual Model

Nerlove (1958) assumed that quantity supplied in the current time period (Q_t^s) is determined by the price expected in the current time period (P_t^*) then

$$Q_t^s = a + bP_t^* + e_t \quad \ldots\ldots (3.1)$$

Where a and b are the parameters to be estimated and e_t is the error term and assumed to be distributed normally with zero mean and constant variance σ^2.

The Nerlove (1958) technique assumes that each year farmers revise the price they expect to prevail in the market in the coming year in proportion to the errors they make in predicting prices in the current time period. Mathematically

$$P_t^* - P_{t-1}^* = r[P_{t-1} - P_{t-1}^*] \qquad 0 \le r \le 1 \quad \ldots\ldots (3.2)$$

Where P_t^* and P_{t-1}^* are expected prices at time period t and $t-1$ while r is a constant called coefficient of adjustment and ranges between 0 and 1. If $r = 1$, then $P_t^* = P_{t-1}^*$ and equation (3.2) converges to a cobweb model while if $r = 0$ then $P_t^* = P_{t-1}^*$ indicating current expected price is the same as in previous year, the equation also shows that if r is high than expected price is obtained more quickly.

Equation (3.2) can also be written as

$$P_t^* = \gamma P_{t-1} + (1-\gamma)P_{t-1}^* \quad \ldots\ldots (3.3)$$

Indicating that the current expected price (P_{t-1}^*) is the weighted average of expected prices in the previous yearP_{t-1}^* and actual price in the previous yearP_{t-1}. However, expected prices (P_t^* & P_{t-1}^*) are unobservable and equation (3.2) cannot be directly estimated. to eliminate unobservable price from equation it is assumed that

$$P_t^* = rP_{t-1} + r(1-r)P_{t-2} + r(1-r)^2 P_{t-3} + \ldots\ldots \quad \ldots\ldots (3.4)$$

Substitute equation (3.3) into equation (3.1) yields equation (3.5)

$$Q_t^s = a + b(\gamma P_{t-1} + \gamma(1-\gamma)P_{t-2} + \gamma(1-\gamma)^2 P_{t-3}) + \cdots \ldots \ldots + e_t \ldots\ldots (3.5)$$

Apply the Koyck transformation to equation (3.5) .Koyck transformation entails multiplication of equation (3.5) by $(1-\gamma)$ and lagging it one time period.

$$(1-\gamma)Q_{t-1}^s = a(1-\gamma) + b[\gamma(1-\gamma)P_{t-2} + \gamma(1-\gamma)^2 P_{t-3} + \gamma(1-\gamma)^3 P_{t-4} + \cdots] + (1-\gamma)e_{t-1} \ldots\ldots (3.6)$$

Subtracting equation (3.6) from (3.5) yields equation (3.7).

$$Q_t^s - (1-\gamma)Q_{t-1}^s = a - a(1-\gamma) + b\gamma P_{t-1} + e_t - (1-\gamma)e_{t-1} \ldots\ldots (3.7)$$

$$Q_t^s = a\gamma + b\gamma P_{t-1} + (1-\gamma)Q_{t-1}^s + \epsilon_t \ldots\ldots (3.7')$$

Where $\epsilon_t = e_t - e_{t-1}(1-\gamma)$ .equation $(3.7')$ is more simply presented as equation (3.8).

$$Q_t^s = \pi_0 + \pi_1 P_{t-1} + \pi_2 Q_{t-1}^s + \epsilon_t \ldots\ldots (3.8)$$

From (3.8) and (3.7) , $\pi_2 = 1-\gamma$ *and hence* $\gamma = 1-\pi_2$, *and* $\pi_1 = b\gamma$ *and therefor* $b = \frac{\pi_1}{\gamma}$. short and long run supply elasticities can be derived using equation (3.8) The short run supply elasticity is given as fallows;

$$\epsilon_s = \frac{\partial Q_t^s}{\partial P_{t-1}} . \frac{P_{t-1}}{Q_t} = \pi_1 . \frac{\bar{p}_{t-1}}{\bar{Q}_t} \ldots\ldots (3.9)$$

and long run supply elasticity can be derived as fallows;

$$\epsilon_L = \frac{\epsilon_s}{\gamma} \text{ where } \gamma = 1-\pi_2 \ldots\ldots (3.10)$$

Short run supply elasticity is the response of supply to a price change in the first period of reaction. It is expected that the largest incremental change in supply will occur in the short run. While the long run elasticity indicates supply responses to price change in long run.

Empirical Model

Taking log of both sides of equation (3.8) yields the empirical model employed in the study.

$$\ln Q_t^s = \lambda_0 + \lambda_1 \ln P_{t-1} + \lambda_2 Q_{t-1}^s + \lambda_3 \ln P_{m(t-1)} + e_t \qquad (3.11)$$

Where Q_t^s is the quantity supply, P_{t-1} is the previous year price, Q_{t-1}^s is the lagged quantity supplied, $P_{m(t-1)}$ is the lag competitive crop (maize) price and e_t is the error term. Since time series data is used in the study, therefore, autocorrelation between the error terms was expected to be an estimation issue. The study used Durbin-h statistics for the detection of autocorrelation problem. No autocorrelation problem was detected.

This equation was estimated using vector auto regression in stata software, before estimation Augmented Dickey fuller test was carried for stationarity and Durbin h statistic for the detection of autocorrelation.

3. RESULTS AND DICUSSION

Autocorrelation (Durbin h statistics):

The model contains lag dependent variable (Lag production) so for the detection of autocorrelation Durbin h statistics was used.

h= ρ √n/1-n [var (α)]

ρ= 1-1/2 d

d= Durbin Watson

Var (α) = variance of lag dependent variable

Var= $(S.E)^2$

Pr (-1.96≤h≤1.96)

Durbin h-statistics= -0.33812

The value of Durbin h statistics lies within the range showing that there is no auto correlation problem in the data.

Stationarity (Augmented Dickey fuller test):

By stationarity we mean that the variance of data is constant i.e. there is homoscedasticity in the data, for the detection of stationarity we used Augmented Dickey fuller test using Stata software.

Table I Stationarity (Augmented Dickey fuller test)

Variable name	p-value (zero lag)	p-value (one lag)
Production	0.0446	0.127
Price of rice	1.000	1.000
Price of maize	0.967	0.938

Table I shows the results for stationarity. For the detection of stationarity we used augmented dickey fuller test. The hypothesis to be tested is that there is stationarity in the data. The table shows p-values of all variables at zero lag and at one lag. At zero lag some variables are significant showing that the data is non-stationary then we run the data with one lag, the results showed that all variables were non-significant at the significance level of 0.05 and the data follow stationarity.

Vector auto regression:
Vector auto regression is used in this study because the dependent variable (production) is dependent on its endogenous variable (lag production).

Regression analysis

$$ln\, Q_t^s = \lambda_0 + \lambda_1\, lnP_{t-1} + \lambda_2 Q_{t-1}^s + \lambda_3\, lnP_{m(t-1)} + e_t$$

$$ln\, Q_t^s = 1.814 + 0.037\, lnP_{t-1} + 0.597\, Q_{t-1}^s - 0.066\, lnP_{m(t-1)} + e_t$$

Table II Regression analysis

Variable name	Estimated coefficient	S.E	p-value
Log production$_{(t-1)}$	0.597	0.091	0.000
Log rice price$_{(t-1)}$	0.037	0.021	0.045
Log maize price$_{(t-1)}$	-0.066	0.022	0.003
constant	1.814	0.389	0.000

Summary statistics:
$R^2 = 0.8464$ p > chi^2= 0.000 Dependent variable = log production
Table II shows the vector auto regression analysis at one lag. The model indicates that log production is a dependent variable while log production, log price of rice and price of competitive crop (maize) with one lag were taken as independent variables. The results show that lag price, lag production and lag maize price has significant effect on production level at significance level of 0.05. All the variables bear right signs i.e. the lag rice price and lag rice production has positive effect on the production of rice. While lag maize price has significant but negative indirect effect on the production of rice which means that if price of maize decreases the production of rice increases and vice versa.
The value of R^2 is 0.8464 which shows that 84.64 % of the dependent variable is explained by the independent variable. The value of p > chi^2 is 0.000 showing that the model is overall good fit.

Calculations for γ
The coefficients of log model give short run elasticities of the corresponding variables. The long run elasticity can be derived as fallows;

$$\epsilon_L = \frac{\epsilon_s}{\gamma}$$

γ value for production

$(1- \gamma) = 0.597$

$\gamma = 1 - 0.597$

$\gamma = 0.403$

Elasticities:

Table III Short and Long run elasticities

Variables name	Long run	Short run
Production	1.481	0.597
Rice price	0.091	0.037
Maize price	- 0.163	-0.066

Table III shows that all the variables both in short and long run are inelastic except lag production in the long run. 1 % change in independent variable will bring very little change in dependent variable. The maize price shows negative effect on the production of rice i.e. increase in maize price will decrease rice production. A change in 1% in lag production will bring 0.597% units change in short run and 1.481% change in long run in the dependent variable (production). 1% change in rice price will bring 0.037% change in short run and 0.091% change in the long run in production.

4. CONCLUSION AND RECOMMENDATIONS

This study was aimed at investigating the supply response of rice in Khyber Pakhtunkhwa. The study used time series data from 1976-2010. The results were significant and bear correct signs and were according to the economic theory i.e. the lag market price of rice has positive and significant effect on production, the lag production has also positive and significant effect on production. The competitive crop price (maize) has negative but significant effect on the supply of rice.

The prices should be kept stabilized by the government so that the farmers can easily take their decision regarding allocation of land to a specific crop. For the use of modern technology loans should be disbursed to the farmers with reasonable interest rate. The farmers should be properly educated through extension workers so that they are able to adopt new technology and increase productivity.

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