ACREAGE RESPONSE OF SUGARCANE TO PRICE AND NON PRICE FACTORS IN KHYBER PAKHTUNKHWA

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Abstract

This study analyzed 42 years' time series data from 1970-2011 for the acreage response of sugarcane to price and non-price factors in Khyber Pakhtunkhwa. Data was tested for major expected problems of time series i.e. Autocorrelation and Stationarity. For autocorrelation Durban h statistics was used and the value (0.539) indicates no serial Autocorrelation in the data set. While Augmented Dickey Fuller test was used for detection of Stationarity and the data was stationary at lag one. The study follows Nerlovian Partial Adjustment linear and non-linear models for acreage response. While Vector Auto Regression technique was used to estimate the effect of price and non-price factors on acreage allocation decisions of the farmers for sugarcane in the study area. The empirical results show that short run and long run elastisities are inelastic for all the variables and statistically significant at 5% significance level except average rainfall. Further, the influence of price, yield, and lag area are positive and significant in affecting acreage allocation decision. This means that if price, yield and lag area are enhanced, the acreage allocation of sugarcane might improve in-elastically. The relatively low values of coefficients obtained from the regression analysis indicates that sugarcane producers in making acreage allocation influenced more by their ideas of expected price than by previous year price. Similarly the magnitude of the linear and log coefficient of yield (0.676) and (0.208) suggesting that if rising trend in sugarcane yield persists it will help farmers' expansion of sugarcane cultivation in future. Further, the relatively high value of the coefficients of lagged area (0.300) and (0.298) of sugarcane suggests that their area allocation adjust quickly for changes in expected profit. As the literature shows that mostly price is the main factors in shifting the area allocation of any crop while this paper shows that lag area was a main factor because the land of Khyber Pakhtukhwa is suitable for sugarcane production and mostly they produce Gurr from sugarcane which they used for self-consumption. . Improved technological innovations will boost the sugar-cane production. Hence, the Government should explore ways to make available the same to the farmers.
Key words: Acreage response, Price and non-price factors, Sugarcane, Khyber Pakhtunkhwa

1. Introduction

Sugarcane is an important industrial and cash crop in Pakistan and in many countries of the world. It is grown in tropical and sub-tropical regions of the world in a range of climates from hot dry environment near sea level to cool and moist environment at higher elevations. Besides sugar production, sugarcane produces numerous valuable byproducts like, alcohol used by pharmaceutical industry, ethanol used as a fuel, bagasse used for paper, and chip board manufacturing and press mud used as a rich source of organic matter and nutrients for crop production. In Pakistan, like most developing countries, sugar is considered a basic food item and is obtained primarily from sugarcane. Sugarcane is one of the main cash crops which are grown in almost all of the irrigated areas of Pakistan. In terms of area under sugarcane Pakistan is one of the top ranking countries in the world. However its position regarding sugar production is not that high, mainly due to lower yields and sugar recovery rates. Pakistan occupies an important position in cane producing countries of the world. It ranks at the fifth position in cane acreage, production and almost 15th position in sugar production.

Sugarcane is an important source of income and employment for the agricultural community and imperative cash crop of Pakistan. Sugarcane contributes 0.8 percent to the GDP and is grown almost on 987.6 thousand hectares of land during 2010-11. In Khyber Pakhtunkhwa 85-95% of the crop was grown in various districts namely Charsadda, Peshawar, Mardan, Nowshehra, Swabi, Bannu, D.I. Khan and Malakand, respectively. The highest production was documented in Punjab with an average production of 37,481.0 thousands Metric tons per thousand hectares, while the lowest was recorded in Baluchistan at 30.8 thousand Metric tons. Out of total 80-85 % of the sugarcane production goes towards the production of sugar and the remaining 15-20 % is converted into g*urr,* a local variant of sugar, which is largely produced and consumed in the Khyber Pakhtunkhwa and rarely take out to neighbor countries.

Presently, there are 83 functional sugar mills in the country of which 45 are in Punjab, 31 in Sindh and 07 in Khyber Pakhtunkhwa. The total crushing capacity of the mills is about 600,000 tons per day. The capacity utilized by the mills is about 60 to 70 % depending upon the sugarcane production and sugarcane purchased by the mills.

Production of sugarcane is complex process where various inputs with different combination are utilized. It is a function of different inputs such as labor, land, capital, management practices and other various factors. Along with these resources the production depends on the combination of different inputs which have a great contribution in the overall productivity. The variations in use and combination of various factors of production cause the changes in crop yield. These combinations are considered as technology. Across the farms, input use level and inputs combinations are different resulting different yields. Furthermore there is a broad gap in the yields of farmer's field and experimental stations showing the suboptimal use of inputs.

1.1 Problem Statement

Assessing acreage response is also fundamental to analysis of farm programs. The inelastic agricultural supply functions are one of the stylized facts that have underpinned farm subsidy programs (McDonald *et al.,* 2002). In this regard, Galbraith and Black (1938), provide evidence that farm supply was extremely inelastic in the US. However, Johnson (1950) showed that the US farm supply functions are more elastic than had been implied by Galbraith and Black (1938). This raises the question that whether supply functions are elastic or inelastic in the presence of farm programs like price support in Pakistan. Specially it needs

to be investigated that whether the supply response of sugarcane growers to change in price support in the country.

Weersink *et al.,* (2009) show that own and competing crop prices are the basic variables to explain acreage response. Therefore agricultural support policies effect production level, as the government interventions effect the expected price and reduce the variability of prices. Previous studies (Bewley *et al.* 1987; Coyle, 1993; Barten & Vanlot, 1996) have greatly increased our understanding of how prices affect crops area allocation decisions, but with the exception of Lin and Dismukes (2007) and Weersink *et al*. (2009) none have separated the effect of price and yield on acreage allocation despite the potentially significant effects that climatic conditions can have on acreage allocation. Hence, this study proposes to estimate acreage response functions for sugarcane in Khyber Pakhtunkhwa separately price, yield and climatic effects.

1.2   Objectives of the study

The objective of the present study is to estimate the response of farmers by developing relationship between dependent variables (acreage) and explanatory variables (market price, yield and weather) with the help of Nerlovian Adjustment model. The specific objectives of the study was to estimate the effect of price on the sugarcane acreage allocation decisions of farmers in Khyber Pakhtunkhwa and to estimate the effects of yield, rainfall and area on the acreage allocation to sugarcane in Khyber Pakhtunkhwa.

2.   Research Methodology

The study was conducted in whole Khyber Pakhtunkhwa. Due to availability of data the empirical analysis of this study was limited to annual data of 42 years from 1970 to 2011.Data on rainfall was taken from Pakistan Meteorological Department Peshawar. Data regarding Sugarcane yield, (Tons/hectare), area (hectare) and prices (Rs/kg) was obtained from various issues of Agriculture statistics of Pakistan.

2.1   Data analysis

Data was analyzed by using SHAZAM (Professional edition) and STATA (12 version) The Following techniques from sample mean to use of econometric modeling was applied for the data analysis. The Durbin h statistic (SHAZAM), and Vector auto regression were performed in (STATA).
   1.   For the purpose of stationarity of time series Augmented Dickey Fuller test (ADF) was used.
   2.   Vector Auto Regression (VAR) was used to capture the linear interdependency among multiple time series. All the variables in VAR model were treated symmetrically: each variable had an equation explain its evaluation based on its own lag and the lags of all other variables in the model.
   3.   To check likely serial Autocorrelation in the auto regressive model, Durbin h statistics was applied.

2.2   Conceptual frame work

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; production already took place and needs to be disposed off.

Area cultivated in the current time period (X_t) is determined by the price expected in the current time period (P_t^*), expected yield period (Y_t^*) and weather in current time period (Z_t^*), than

$$X_t = a + bP_t^* + cY_t^* + dZ_t^* + e_t \qquad (1)$$

Where, *t* indexes time period, *a*, *b*, *c* and *d* 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 .

2.3 Empirical Model

We used the following finalized model for determining the acreage response to various factors that are lagged price, lagged area, lagged yield and lagged average rain fall.

$$X_t = a\gamma + b\gamma P_{t-1} + c\gamma Y_{t-1} + d\gamma Z_{t-1} + (1-\gamma)X_{t-1} + e_t \qquad (2)$$

We also estimate our empirical model in STATA in log form for the measurement of short run and long run elasticties.

$$lnArea = a\gamma + b\gamma lnPrice_{t-1} + clnYield_{t-1} + dlnAvg\ Rain_{t-1} + (1-\gamma)lnArea_{t-1} + e_t \qquad (3)$$

where X_t is the acreage, P_{t-1} is the price in the previous year, Y_{t-1} is the yield in the previous year, Z_{t-1} shows average rainfall of the previous year, X_{t-1} shows acreage in the previous year, and e_t is the error term.

These variables were chosen because it is extensively used in most research papers and the literature shows that these are the major agents who shift the supply of any crop either to increase or decrease. Theoretical frame work shows that Price and Area should be positive while Yield and Rainfall may be positive or negative. (Niamatullah *et al*, 2010; Ramulu 1996; Weersink *et al*., 2009)

3. Results and Discussion

3.1 Autocorrelation Problem

Mostly the time series data have the problem of Autocorrelation. Normally for detection of autocorrelation Durban Watson statistics is used but when the dependent variable in the lagged form as an independent in the model so Durban Watson statistics is not applicable and such models are known as Autoregressive or lagged models. For such Durban has developed *h* statistic to test the first order autocorrelation which is known as Durban *h* statistics. The Durbin *h* value (0.53911) in table 1 indicates that calculated value of *h* statistics is within the critical values (-1.96 and +1.96) suggesting that there is no serial-autocorrelation problem in the sampled data.

3.2 Stationarity Problem

Stationarity refers to data having constant variance means that there should be homoscedasticity in the data. For the analysis of time series data it is necessary that the data

should be stationary. For the purpose a test known as Augmented DickeyFuller (ADF) was used in Stata software. The data was run with zero and lag one; with lag oneall variables except yield were stationary (table 2). The effect of this one variable is considered minimal so the data set as a whole was assumed Stationary (Weersink *et al*., 2009).

Table1. Durbin h statistics

Variable Name	Estimated Cofficient	Standard Error
Area	0.25	0.12
Price	0.32	0.14
Yield	0.89	0.37
Avg_Rain	0.35	0.64
Constant	87.83	5.25
Durbin Watson=1.78	Rho=0.053	Durbin *H* Statistic=0.539

Table2. Augmented Dickey Fuller Tests

Variable name	P-value (zero lag)	P-value (one lag)
Area	0.0562	0.0093
Price	0.1177	0.0240
Yield	0.7078	0.5270
Avg rainfall	0.1370	0.0189

3.3 Acreage Response of Sugarcane

The acreage estimating equation was fitted by Vector Autoregressive Models for the sampled period. The following results were obtained from both the linear and log-log regression analysis.

Table 3. Empirical results of Vector Auto Regression in Linear and Log Form

Variable Name	Linear Coefficient	Linear Standard Error	Linear P value	Log Coefficient	Log Standard Error	Log P value
$lnArea_{t-1}$	0.300	0.144	0.05	0.298	0.129	0.021
$lnPrice_{t-1}$	0.0192	0.009	0.022	0.017	0.008	0.038
$lnYield_{t-1}$	0.676	0.328	0.039	0.208	0.102	0.012
$lnAvg\,Rain_{t-1}$	0.0196	0.042	0.644	0.024	0.025	0.351
$Constant$	34.88	13.62	0.010	2.280	0.636	0.000

Linear R-square=0.6297   N=42 $P > Chi^2$=0.000

Log R-Square=0.7077   N=42 $P > Chi^2$=0.000

3.4 Price Response

The economic theory shows that price should be positive and significant. The empirical results in table 3 shows that estimated coefficient for acreage on lag price (lagged one year) differed significantly from zero at 5 percent significance level and were of correct sign. The relatively low values of coefficient obtained from the regression analyses indicates that sugarcane producers in making acreage allocation are influenced more by their ideas of expected price than by previous year price. This is confirmed by the low coefficient of expectation. The values of the coefficient in linear and log form are 0.0192 and 0.017 with P

values (0.022) and (0.038) respectively. Results were same as with (Niamatullah *et al*., 2010, Weersink *et al*. 2009).

3.5   Yield Response

The theoretical frame work explain that yield may be positive or negative if comes positive so the farmers allocate more to the same crop if comes negative so due to the high yield farmers allocate to the other crop. The estimates for acreage on sugarcane yield (lagged one year) in table 3 further indicates that coefficient of lagged yield is positive and statistically significant at 5 percent significance level. The magnitude of the linear and log coefficient (0.676) and (0.208) suggesting that if rising trend in sugarcane yield persists it will help farmer's expansion of sugarcane cultivation in future.

3.6   Area Response

The results in table 3 shows that lagged planted area is also statistically significant and the coefficient are less than on as required. The relatively high value of the coefficients on lagged area of sugarcane suggests that their area allocation decision adjust quickly for changes in expected profits. Its values are 0.300 and 0.298 with P- values 0.05and 0.021.Similar results were found by Weersink *et al*. (2009).

3.7   Average Rainfall Response

The result of rainfall in table 3 shows that its coefficient is positive but insignificant at 5 percent of level of significance which confirms that farmers are not taking the decision on the previous rainfall regarding acreage allocation. Same results as that of Ramulu (1996).

3.8   Calculations for coefficient of adaptation (γ)

Log form was estimated for the measurement of the elasticities so the coefficients of log model gives short run elasticities of the corresponding variables while the long run elasticity can be derived as fallows;

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

(a). γ **value for total area**

$1 - \gamma = 0.298$

$\gamma = 1 - 0.298$

$\gamma = 0.702$

The γ is known as coefficient of adaptation or expectation when it is derived from price coefficient then it is known as expectation and when derived from area coefficient then it is called coefficient of adaptation this 0.702 means that any 1 percent change in theses selected variables will bring change 70% in the first year while the remaining will be adopt in the coming year.

Table 4 shows the short run and long run price and non-price elasticities. It shows that the short run and long run elasticities of all variables are inelastic. In short run 1 % increase in market price will increase total area by 0.017% and will increase 0.024% in the long run. Similarly 1 % percent increase in yield and lag area will increase total area allocation to sugarcane by 20.8% and 29.8% in short run and 29.6% and 42.4% in long run respectively.

Table 4. Short Run and Long Run Elasticities for Sugarcane Area

Dependent variable	γ	Price Elasticities		Non-Price Elasticities					
		Market Price		Yield		Rainfall		Lag Area	
Log Area	0.702	Short run	Long run	Short run	Long run	Short run	Long run	Short run	Long run
		0.017	0.024	0.208	0.296	0.024	0.034	0.298	0.424

4. Conclusion and Recommendations

This study investigated that how price and non-price factors affect Sugarcane acreage decisions in Khyber Pakhtunkhwa. It was concluded based on findings of the study that price has positive and significant effect with the area allocation to sugarcane crop; if the expected price of sugarcane increased the area allocation to sugarcane will also increase. The relatively low values of coefficient obtained from the regression analyses indicates that sugarcane producers in making acreage allocation are influenced more by their ideas of expected price than by previous year price. Similar effects of yield and lagged area on acreage allocation was showed both in linear and log model. The magnitude of the linear and log coefficient suggesting that if rising trend in sugarcane yield and area persist it will help farmer's expansion of sugarcane cultivation in future. Further, rainfall showed insignificant effect on farmer's decision regarding area allocation to sugarcane crop. Improved technological innovations will boost the sugar-cane production. Hence, the Government should explore ways to make available the same to the farmers. There should be a regular contact between Extension worker and the farmer's so that to adopt new techniques and increase productivity.

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