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Supply Response in Pakistan with "Endogenous" Technology

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I. INTRODUCTION

Considering the significance of agriculture sector in Pakistan's economy, one of the major objectives of agricultural policy has been to raise the level of real income of the farmer by stabilising the agricultural output through a system of price support programme. In the recent past, a number of studies have confirmed that Pakistani farmers respond to changes in output prices.[1] The prime objective of these studies was to estimate price, acreage or yield elasticities based on the Nerlovian Adjustment Model under alternative expectation schemes. Naqvi and Burney (1992) estimated output supply and input demand functions based on the profit function approach.[2]

Surprisingly, the single-equation supply model has been used extensively for policy analysis without noticing the fact that such a model does not guarantee that the harvested share of each crop will always be non-negative and the sum of shares of *all* crops will be unity. Similarly, models which are based on applied duality theory do not take into account the actual decision-making at the farm level. The sequence of events is such that farmer first allocates area across crops and then chooses the input levels conditioned on the allocation of area across crops. Mundlak (1988) has shown that the optimisation model in this case will have to be modified to provide for sequential solution for area allocation and input use. This model clearly distinguishes the changes in optimal input and output combinations for each crop from changes in the quasi-fixed inputs across crops.

In this paper Mundlak's theoretical framework has been applied where technology, and quasi-fixed inputs are *endogenously* determined. Using a simul-

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[1]See for instance, Cummings (1975); Ashiq (1981); Tweeten (1986); Ali (1990); Khan and Iqbal (1991) and Naqvi and Burney (1992).

[2]Short-run Own- and Cross-price elasticities based on earlier studies have been reported in Ali (1990) and Ahmed and Siddiqui (1993).

taneous model, this procedure enables us to evaluate the impact of prices and other policy variables on the allocation of area across crops, yield of these crops, and input demand functions especially the demand for labour and fertiliser. Rosegrant and Kasryno (1992) and Kumar and Rosegrant (1993) have successfully estimated a similar model for Indonesia and India respectively.

This paper is arranged as follows. Section II briefly explains the theoretical framework. The specification of the model is presented in Section III. Sources of data and the method of estimation are explained in Section IV. The results of the empirical model as well as elasticity estimates are discussed in Section V and the last section concludes the study.

II. THE THEORETICAL FRAMEWORK

In the choice of technique framework, the decision-making is done at the farm level. To achieve the desired level of output of different crops, the farmer has to choose an optimal combination of variable inputs (v) and quasi-fixed inputs (b). Let the production function associated with jth technique be $F_j(v_j, b_j)$. Further assume that the technology (T) is defined as the collection of all techniques, i.e., $T = [F_j(v_j, b_j)]$. For simplicity, let us start with a single period optimisation problem where the production function includes a single output.[3] In this case the optimisation problem will be

$$L = \sum_j P_j F_j(v_j, b_j) - \sum_j wv_j + \lambda(b - \sum_j b_j) \quad \dots \quad \dots \quad \dots \quad (1)$$

where $F_j(.) \varepsilon T$; P and w are output and factor prices and b is the constraint on $\sum b_j$. The first order necessary conditions for the solution are

$$L_{vj} = P_j F_{vj} - w \leq 0 \quad \dots \quad (2)$$

$$L_{bj} = P_j F_{bj} - \lambda \leq 0 \quad \dots \quad (3)$$

$$\sum_j L_{vj} v_j + L_{bj} b_j \leq 0 \quad \dots \quad (4)$$

$$v_j \geq 0; \; b_j \geq 0 \quad \dots \quad (5)$$

$$L_\lambda = \sum b_j - b \leq 0 \quad \dots \quad (6)$$

$$\lambda L_\lambda = 0 \quad \dots \quad (7)$$

[3] Generalisation to multiperiod is simple and straight forward extension.

The solution gives the optimal levels of inputs and output for each crop, i.e., $v^*_j(s)$, $b^*_j(s)$ and $F_j[v^*_j(s), b^*_j(s)]$, where '*s*' represents exogenous or *state* variables such that $s = (P, w, b, T)$ i.e., the solution not only depends on the available technology (T), it also depends on the constraint b, and output and factor prices (P and w). The solution determines both the techniques used and the level of their use, as determined by the optimal allocation of variable inputs v^*_j and fixed inputs b^*_j.[4]

Since the data does not reveal information about techniques that are actually implemented, we make a distinction between technology (T) and implemented technology (IT) as

$$IT(b, P, w, T) = [F_j(V_j, b_j) \mid F_j(V^*_j, b^*_j) \neq 0; F_j \varepsilon T] \quad \ldots (8)$$

For any set of state variables, Equation (8) describes a well-behave technology which results in the following profit function

$$\pi(s) = \sum_j P_j F_j(v^*_j(s), b^*_j(s)) - \sum_j w\, v^*_j(s) \quad \ldots \ldots \ldots \ldots (9)$$

Using Hotelling's lemma, the factor demand and output supply functions at the technique level $v^*(s)$ can be derived as

$$-\frac{\partial \pi(S)}{\partial w} = v^*_j(s) \quad \ldots \ldots \ldots \ldots \ldots \ldots (10)$$

$$\frac{\partial \pi(S)}{\partial P_j} = F^*_j(s) \quad \ldots \ldots \ldots \ldots \ldots \ldots (11)$$

The solution to the optimisation problem determines allocation of land and other quasi-fixed inputs and the level of use of inputs and optimal output by crop.

When sequential decision-making is incorporated in this model, then both optimal output and inputs depend on a revised set of state variables.

III. SPECIFICATION OF THE MODEL

Using the theoretical framework of the last section, we now specify the model for major food crops (wheat, rice and maize) that will be used for estimation.

[4]This can be seen by substituting Equations (2) and (3) in (4) as

$$\sum_i [(P_j F_{vj} - w) v_j + (P_j F_{bj} - \lambda) b_j] = 0$$

Equation (5) confirms that whenever Equation (2) or (3) is negative, then $v^*_j = 0$ and $b^*_j = 0$.

The model consists of four blocks of equations which relate to quasi-fixed inputs, choice of technique, area share equations and yield and input demand functions.

Quasi-fixed Inputs

For wheat, rice and maize, the equations related to total and irrigated area are specified in this block. The difference of total and irrigated area provides the data for *barani* (rainfed) area.

The total area per hectare under crop (A_T) is specified to depend on expected net revenue index relative to value-added index in non-agriculture (R/V_m), expected value-added index in agriculture other than wheat, rice and maize relative to value-added index in non-agriculture (V_0/V_m), and area allocated to crop in the previous period (A_{T-1}). It is expected that the farmer will allocate area to a crop on the basis of rate of return to that crop. The expected net revenue is thus defined as the gross expected returns to production less fertiliser and labour costs.[5] Favourable returns to investment in other crops are expected to force the farmer to reduce his allocation of area to wheat, rice and maize. The distributed lag formulation is included because adjustment costs to capital do not allow actual investment to its optimal level in a single period.

The specification of equations for irrigated area resembles to those for the total area except for the lagged dependent variable.

Choice of Technique

In this block crop specific equations representing the extent of investment in technology are specified. Three sets of equations include (i) the percentage of area under irrigation (A_{IR}), (ii) the percentage of area under high yielding/modern varieties (A_{HY}), and (iii) the percentage of area under intensification programmes (A_{RE}) where intensification programme includes government's expenditure on research on modern varieties and extension in irrigation.

These equations are specified to depend on expected net returns to these crops, expected returns to other crops and irrigated and *barani* area. We expect that the percentage of area under wheat, rice and maize will be directly proportional to expected returns to these crops and inversely proportional to returns in other crops.

[5]The rationale of using net revenue formulation is provided in Sanderson, Quilkey and Freebairn (1980).

Area Share Equations

In the third block, area share equations (W_i) are specified which constrain the crop shares to be non-negative. The share of area allocated to wheat, rice and maize depends on normalised expected net revenue of each crop and crop specific irrigated and *barani* area.

Yield Response and Input Demand Functions

This block relates not only to yield response functions for wheat, rice and maize, it also specifies equations for fertiliser and labour demand for the three crops. Using Diewert's specification of generalised Leontief profit function (1971), these supply and demand relationships are derived by using Hotelling's lemma. The yield response and input demand functions in this case are specified to depend on normalised prices, quasi-fixed inputs and choice of technique variables.

IV. THE DATA AND THE SOLUTION METHODOLOGY

For the three food crops, namely wheat, rice, and maize aggregate data on Pakistan are used for the period 1971 to 1990. While the information on area, yield and production of these crops has been taken from various issues of the *Year Book of Agricultural Statistics* and *Pakistan Economic Survey,* data related to wages and crop specific labour use were taken from different issues of *Cost of Production of Major Crops* and Chaudhry (1982).

Due to sequential nature of decision-making, the equations related to quasi-fixed inputs, choice of technique, area allocation and yield and input demand functions have been estimated in a block recursive fashion using the Zellner's Seemingly Unrelated Regressions (SUR) technique with correction for heteroskedasticity. The estimated values of total, irrigated and *barani* area, area under modern varieties and area under intensification programme are thus used in subsequent blocks. For speedy convergence of SUR estimates, parameters estimated by OLS were used as initial guesses.

V. THE RESULTS

The results of estimation for each block of equations are presented in Tables 1–5. While Tables 1 and 2 report the results for quasi-fixed inputs and choice of technique equations, Table 3 presents the parameter estimates of area share equations. The results related to yield and input demand functions for three crops are given in Table 4. The elasticity estimates based on the estimated coefficients are provided in Table 5.

Table 1

Parameter Estimates for Quasi-fixed Input Equations Estimated Using Zellner's GLS Seemingly Unrelated Equation (SUR) with Correction for Heteroskedasticity (All Variables are Expressed in Logarithms)

Dependent Variables/	Wheat Area		Rice Area		Maize Area	
Explanatory Variables	Total	Irrigated	Total	Irrigated	Total	Irrigated
Expected Net Revenue Index for						
Wheat	0.12 (3.89)***	0.08 (3.01)***	–	–	–	–
Rice	–	–	0.21 (5.53)***	0.25 (5.43)***	–	–
Maize	–	–	–	–	0.20 (5.74)***	0.10 (2.84)**
Value-added Index in Other Agriculture	–0.08 (1.75)*	–0.01 (0.40)	–0.09 (1.92)*	–0.12 (2.50)**	–0.34 (5.16)***	–0.12 (2.33)**
Lagged Area						
Wheat	0.63 (5.91)***	–	–	–	–	–
	–	0.86 (12.14)***	–	–	–	–

Continued –

Table 1 – (*Continued*)

Rice	–	–	0.42 (5.49)***	–	–	–
	–	–	–	0.25 (3.07)***	–	–
Maize	–	–	–	–	0.34 (3.96)***	–
	–	–	–	–	–	0.41 (3.30)***
Adjusted $\bar{R}^2$	0.94	0.98	0.89	0.85	0.93	0.84

Note: *t*-statistics in parentheses.
*** Significant at 1 percent level.
** Significant at 5 percent level.
* Significant at 10 percent level.

Table 2

Parameter Estimates Related to Choice of Technique Equations Estimated Using Zellner's GLS Seemingly Unrelated Equation (SUR) with Correction for Heteroskedasticity (All Variables are Expressed in Logarithms)

Dependent Variables/ Explanatory Variables	Percentage Area Irrigated			Percentage Area under Modern Varieties		Percentage Area under Intensification		
	Wheat	Rice	Maize	Wheat	Rice	Wheat	Rice	Maize
Expected Net Revenue for								
Wheat	0.002 (0.95)	–	–	–	–	0.05 (1.42)	–	–
Rice	–	(–0.01) (5.27)***	–	–	–	–	0.13 (3.23)***	–
Maize	–	–	–0.17 (4.55)***	–	–	–	–	0.003 (0.03)
HYV Wheat	–	–	–	0.34 (5.75)***	–	–	–	–
Basmati Rice	–	–	–	–	0.005 (7.51)***	–	–	–
Value-added Index in Other Agriculture	–0.002 (0.55)	–0.007 (1.92)*	0.38 (6.69)***	–0.25 (4.34)***	–0.008 (3.03)***	0.02 (0.64)	–0.13 (0.40)**	0.23 (1.24)
Irrigated Area under								
Wheat	0.21 (17.06)***	–	–	–	–	0.85 (2.81)***	–	–
Rice	–	0.099 (8.31)***	–	–	–	–	–	–

Continued–

Table 2 – (*Continued*)

Maize	–	–	0.39 (3.08)***	–	–	–	–	0.37 (0.97)
HYV Wheat	–	–	–	–	–	–	–	–
Basmati Rice	–	–	–	–	0.001 (0.22)	–	–	–
Rainfed (*Barani*) Area under								
Wheat	–0.18 (33.41)***	–	–	–	–	–0.26 (3.47)***	–	–
Rice	–	–0.03 (22.74)***	–	–	–	–	0.03 (1.6)	–
Maize	–	–	–0.56 (–80.63)***	–	–	–	–	0.59 (2.83)***
HYV Wheat	–	–	–	0.23 (1.82)*	–	–	–	–
Basmati Rice	–	–	–	–	–0.01 (13.20)***	–	–	–
Area under HYV Wheat	–	–	–	–	–	–0.52 (3.70)***	–	–
Area under Basmati Rice	–	–	–	–	–	–	–0.42 (5.66)***	–
Adjusted $\overline{R}^2$	0.997	0.95	0.72	0.92	0.92	0.51	0.49	0.71

Note: *t*–statistics in parentheses.
*** Significant at 1 percent level.
** Significant at 5 percent level.
* Significant at 10 percent level.

Table 3

Parameter Estimates of Area Share Equations Estimated Using Zellner's GLS Seemingly Unrelated Equation (SUR) with Correction for Heteroskedasticity (All Variables are Expressed in Logarithms)

	Normalised Expected Net Revenue per Hectare				
Area Share (Wi/W*)	(Wheat/ Maize)	(Rice /Maize)	Area Irrigated	Area Rainfed	Adjusted R^2
Wheat	0.03	0.006	–0.03	0.03	0.44
	(2.51)**	(0.59)	(2.55)**	(1.40)	
Rice	–0.16	–0.04	–0.17	0.006	0.41
	(2.12)**	(0.61)	(1.83)*	(1.84)	
Maize	0.14	0.03	–0.39	–0.36	0.80
	(2.70)***	(0.64)	(3.17)***	(7.05)***	

Note: *t*-statistics in parentheses.
*** Significant at 1 percent level.
** Significant at 5 percent level.
* Significant at 10 percent level.

The results presented in Table 1 indicate that total as well as irrigated area respond positively to expected net revenue and negatively to the value-added index in other agriculture. This demonstrates the rational perception of the farmers who allocate area on the basis of expected returns to that crop. The results further indicate that the estimated coefficients for total area are relatively larger than for irrigated area. This is because the development of irrigation extension requires longer duration. This phenomenon is clarified a bit further by the results obtained for rice for which the estimated parameters are almost identical for irrigated and total area as the cultivation of rice on unirrigated area is negligible.

Since all variables are expressed in logarithms, the estimated coefficients are short-run elasticities. The long-run elasticities computed from Table 1 also confirm that for wheat the elasticity of irrigated area with respect to expected net revenue is larger than for total area indicating that there is a displacement of rainfed area by irrigation. In the case of rice, the area elasticities with respect to expected net revenue area are approximately equal in magnitude for irrigated and total area.

Table 2 presents the results for (i) percentage area irrigated, (ii) percentage area under modern varieties of wheat and rice, and (iii) percentage area under

Table 4

Parameter Estimates for Yield, Fertiliser Demand and Hired Labour Demand System for Wheat, Rice and Maize, Estimated Using Zellner's GLS Seemingly Unrelated Regression (SUR) with Correction for Heteroskedasticity

Dep- Vari	Wheat			Rice			Maize		
Exog- Vari	Yield Kg/Ha	Fertiliser Kg/Ha	Labour Day/Ha	Yield Kg/Ha	Fertiliser Kg/Ha	Labour Day/Ha	Yield Kg/Ha	Fertiliser Kg/Ha	Labour Day/Ha
$(P_f/P_c)^{1/2}$	289.57 (1.16)	–	–	–687.98 (3.83)***	–	–	–45.19 (0.73)	–	–
$(P_w/P_c)^{1/2}$	–112.09 (1.09)	–	–	7.43 (0.84)	–	–	–73.98 (3.10)***	–	–
$(P_c/P_f)^{1/2}$	–	102.50 (3.90)***	–	–	176.05 (4.14)***	–	–	63.99 (4.33)***	–
$(P_w/P_f)^{1/2}$	–	–11.78 (2.05)*	–	–	–37.46 (4.28)***	–	–	–64.60 (2.67)***	–
$(P_c/P_w)^{1/2}$	–	–	7.84 (0.94)	–	–	–53.64 (5.83)***	–	–	3.78 (4.50)***
$(P_f/P_w)^{1/2}$	–	–	1.32 (0.24)	–	–	11.52 (8.04)***	–	–	–3.57 (6.23)***

Continued –

Table 4 – (*Continued*)

Dep-Vari / Exog-Vari	Wheat			Rice			Maize		
	Yield Kg/Ha	Fertiliser Kg/Ha	Labour Day/Ha	Yield Kg/Ha	Fertiliser Kg/Ha	Labour Day/Ha	Yield Kg/Ha	Fertiliser Kg/Ha	Labour Day/Ha
% Crop Area Irrigated	11.42 (0.48)	–	–	–	–3.91 (2.43)**	–0.19 (1.79)*	3.07 (0.71)	0.29 (0.66)	0.046 (2.68)***
%Crop Area HYV	49.03 (0.76)	0.16 (0.62)	0.20 (2.26)**	65.08 (4.85)***	8.38 (2.82)***	0.40 (2.09)**	–	–	–
%Crop Area Intensification	49.63 (0.98)	8.47 (5.79)***	2.36 (4.48)***	–	4.13 (1.77)*	0.39 (2.73)***	10.87** (2.50)**	0.93* (2.05)	–0.15 (5.84)***
Crop Area	0.16 (1.78)*	0.03 (5.80)***	0.009 (4.26)***	–0.14 (1.74)	–	0.005 (4.29)***	0.08 (0.78)	0.06 (5.45)***	–
$\bar{R}^2$	0.85	0.97	0.96	0.53	0.95	0.77	0.63	0.97	0.96

Note: *t*–statistics in parentheses.
*** Significant at 1 percent level.
** Significant at 5 percent level.
* Significant at 10 percent level.

Table 5

Yield and Input Demand Elasticity for Wheat, Rice and Maize in Pakistan

	Expected Crop Price	Fertiliser Price	Wage	% Irrigated Area	% Area Under Modern Varieties	%Area Under Intensi– fication	Crop Area
Wheat							
Yield	0.21	–0.15	–0.06	0.26	0.13	0.30	0.45
Fertiliser	0.64	–0.52	–0.12	–	0.16	1.46	2.05
Hired Labour	0.02	0.005	–0.025	–	0.07	0.20	0.28
Rice							
Yield	0.03	–0.23	0.2	–	1.84	–	0.06
Fertiliser	1.69	–1.13	–0.56	–3.87	7.86	0.69	–
Hired Labour	–0.04	0.05	–0.01	–0.10	0.22	0.04	0.05
Maize							
Yield	0.13	–0.04	–0.09	0.08	–	0.13	0.05
Fertiliser	0.69	–0.15	–0.54	0.22	–	0.32	1.12
Hired Labour	0.01	–0.01	0.0	0.009	–	0.01	–

Note: Elasticity estimates are based on Table 4.

intensification programme. In a block recursive fashion these crop-specific relations use the predicted values of irrigated and rainfed area from block one. The results show the importance of irrigation in determining the level of technology. In all equations, irrigated area has statistically significant effect on the quasi-fixed inputs and rainfed area affects them negatively. In most of the cases, we observed expected signs for own crop revenue and value-added for other agriculture. The unexpected sign for these parameters in the percentage irrigated area equation for rice can be explained as follows. An increase in expected revenue for rice could induce plantation of rice on marginal rainfed lands which may result in reduction of proportion of irrigated rice area.

Table 3 reports the results for area crop share equations where endogenous variables are the transformed crop shares i.e., the ratio of the crop share to the weighted geometric mean of crop shares. Normalised expected revenue, predicted values of irrigated and rainfed areas are used as explanatory variables. Expected revenue is normalised, with returns to maize as the numeraire, in order to keep homogeneity in expected revenues per hectare.

The results indicate that for majority of the cases, the coefficients for irrigated and *barani* area are statistically significant. The area share responds negatively to irrigated area of wheat and maize, and positively to rice. This implies that the area under rice increases more than proportionately to increases in irrigated area. As expected, an increase in revenue leads to an increases in wheat cultivation, whereas for rice the response is unfavourable yet statistically insignificant.

The summary of results for yield and input demand relations is presented in Table 4. Exogenous variables are the expected price ratios (which are normalised relative to the expected output or input prices of the endogenous variables in the equation) and the estimated values of the quasi-fixed inputs.

On the whole, the presented results have expected signs and the parameters are statistically significant. The results confirm that a decrease in price of fertiliser tends to increase both fertiliser and hired labour use. This is plausible because increased use of fertiliser requires higher labour for crop care. In other words, this means that labour-use and fertiliser are complementary in nature. The impact of quasi-fixed inputs on yield, labour-use and fertiliser use is positive and statistically significant for all cases with few exceptions. The results presented in this paper are consistent with the earlier studies of India and Indonesia which have applied the same technique of estimation. However, slight variations in results could be noticed with those studies which have used single equation models. This is to be expected as supply response based on simpler models fails to capture the sequential nature of decision-making at the farm level.

Table 5 provides the short-run elasticities for yield and input demand computed from Table 4. A comparison of elasticities for wheat, rice and maize show that rice has larger elasticities as compare to wheat and maize which is expected because rice is one of the major cash crops in Pakistan. The sensitivity of yield elasticity of rice to fertiliser price is according to our prior expectations. Over the time, farmers are adopting modern varieties of rice which are responsive to fertiliser. Comparing the elasticities of wheat and maize one observes that yield of wheat is more sensitive to fertiliser price as compared to yield of maize. As in the case of rice, there is a relatively high adoption of improved varieties and higher level of fertiliser use relative to labour in wheat. On the other hand, the maize elasticities with respect to wages are higher than maize elasticities with respect to fertiliser price. Labour and fertiliser elasticities with respect to their own respective prices and other input prices are negative which imply that labour and fertiliser are complementary in nature, therefore the increase in price of one leads to a decrease in demand for both inputs.

VI. CONCLUDING REMARKS

This paper uses the choice of technique framework advanced by Mundlak to estimate supply response of three food crops, wheat, rice and maize. In the light of sequential decision-making, the estimated model consists of four blocks of equations for quasi-fixed inputs, choice of techniques, area share equations and yield and input demand functions. The result, which are in conformity with earlier studies which adopted the same methodology show that crop-specific quasi-fixed inputs are directly proportional to their respective revenue and inversely proportional to the value-added index in other agriculture. The second block of equations confirm the importance of irrigation in determining the level of technology. Using Zellner's Seemingly Unrelated Regression (SUR), estimated values of crop-specific quasi-fixed inputs are used in area share, the i.e. yield and input demand equations. The results of this block reveal that fertiliser and labour are complementary inputs and the impact of the quasi-fixed inputs on yield, fertiliser and labour use is substantial and statistically significant.

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Comments on
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There have been numerous attempts to analyse the supply response of various food and cash crops in Pakistan. In this respect the paper by Ather Maqsood and Rizwana Siddiqui is an innovative attempt to analyse the supply response of three major food crops in Pakistan. The theoretical framework of this paper draws heavily from Mundlak (1988). A distinct feature of Mundlak's study is that the changes in exogenous variables, apart from changing the input-output combination, also cause changes in the implemented technology. In other words, the technology is endogenously determined as it depends on variations in the state or exogenous variables.

While using a simultaneous model, the authors have applied Mundlak's theoretical framework to assess the impact of state variables on the allocation of area across crops, crop yield, and input demand function for labour and fertiliser. Their application of Mundlak's model is based on the notion that farmers follow a sequential decision-making approach, i.e., farmers first allocate area across crops and then choose the input level based on the allocation of area across crops. Given the sequential nature of decision-making process, Zellner's Seemingly Unrelated Regression technique is used to estimate the supply response model which consists of four blocks of equations for fixed inputs, choice of technique, area share equations, and yield and input demand functions for labour and fertiliser.

Although there have been recent studies on supply response of food as well as cash crops in Pakistan, I believe that this study is not a mere exercise of product differentiation. As the study attempts to explicitly incorporates the sequential nature of decision-making process in a theoretical framework where implemented technology is treated as endogenous.

There are, however, some criticisms that I would make of this paper. First, according to the authors, "one of the major objectives of the agricultural policy has been to raise the level of real income of the farmers by stabilising the agricultural output through a system of price support programme". But, among other factors, the extent of any increase in *real income* of the farmers depends on the behaviour of the general price level in response to support price increases. Second, this study assumes a sequential nature of decision-making process at the farm-level, i.e., to achieve the desired output of different crops, a farmer first allocates area across crops and then chooses the input levels based on this allocation. This particular sequence of events, however, may turn out to be an exception rather than a rule for a large number of farmers. As it is possible to have a situation where it is the availability of inputs which determines the allocation of area across crops and not the other way around. Even if one assumes the existence of a sequential decision-making process at the farm level, there is need to make a distinction between the inputs chosen and the inputs actually applied. The inputs applied are usually sensitive to weather conditions. Third, technological and price uncertainties play an important role in determining the supply response of food and cash crops. The authors have nothing to say regarding the influence which the above two factors may have on the estimates of supply response. Fourth, this study uses time-series data to estimate the supply response of food crops without acknowledging the shortcomings associated with the time-series studies. A consensus is emerging that estimation of a regression with time series that are non-stationary (variable which trend over time) can not be relied for their statistical efficiency or reliability as the use of nonstationary tendencies result in spurious regression results. These concerns, however, can be addressed by using the cointegration technique to estimate the supply response function for the given crops. Finally, the question arises that what policy implications can be drawn from this study? Although this paper deals with the empirical side of a major agriculture policy issue, it falls short of drawing any policy implications in this regard.

Overall I believe that authors deserve credit for venturing into an interesting area and tackling head on an issue which continues to be contentious in the context of Pakistan's agriculture policy.

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