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SUPPLY ANALYSIS OF JUTE WITH CONSIDERATION OF RISK

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ABSTRACT

Jute production has always been a risky venture in Bangladesh. A general methodology recently developed is used to estimate supply elasticities as well as to calculate impact of risk aversion on acreage planted. The traditional adaptive expectations model of Nerlove is extended for the purpose by way of adding the second moment of prices. Results testify both the acreage responsiveness and risk-aversion attitude of *jute* farmers. Furthermore, past memories of farmers are found to have significant influence on current planting decisions.

I. INTRODUCTION

In the case of major agricultural commodities, the need for good estimates of supply elasticities is great. Developing outlook information, predicting changes in government policy, analyzing welfare implications of buffer stock policy and quantification of commodity models are some of the research areas that require reliable estimates of supply elasticities. Supply estimation is however difficult for commodities subject to risk factors. These factors greatly complicate supply estimation because prices and structural parameters may change over time.

In Bangladesh, jute cultivation is a risky venture as farmgate prices continuously fiictuate. The risk factor assumes further significance as jute competes with rice for the farmer's plot of land and as the latter's price also fluctuates. A number of econometric studies exist on jute supply (Askari and Cummings 1976), however with the exceptions of few (Mujeri 1978; IBRD 1980) no attempts were made to incorporate farmer's responsiveness to changing risk. A risk analysis may seem helpful in generating reliable estimates of supply elasticities for jute. The present study seeks to quantify the impact of risk a version on acreage planted by farmers for jute. The study may prove helpful in formulation of policies designed for domestic stabilization of jute production and prices.

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II. CONCEPTUAL FRAMEWORK

In most of the jute-producing areas, farmers have flexible production capacity that can be used to produce jute or summer paddy (mainly aus paddy and to some extent aman paddy). We assume that farmers allocate acreage among competing crops to maximize expected profit. Under free market conditions, acreage planted to jute may be viewed as a function of expected crop prices (e. g. of jute and rice) and exogenous input prices (seeds, fertilizers, plant protection measures, land preparation, sowing, weeding and retting input prices can, however, be expressed in a single variable by way of deflating expected crop prices by those of its inputs. Moreover, the acreage function can be augmented by a 'price relationship' that generates expected prices as a function of the current prices. One such model is that of Nerlove's (1958) adaptive expectation model.

His model appears as

$$X_t=a_0+a_1P_t^*U_t : \qquad (1)$$

$$P_t^*-P_{t-1}^*=B(P_{t-1}-P_{t-1}^*) \qquad (2)$$

Where X_t=the acreage of the crop in question during the period t, P_t=its observed price, P_t^*=its expected "normal" price, U_t=a random residual, and B=coefficient of expectation.

One limitation of Nerlove model is that it works with normal expected prices and does not consider any variation in it. It is, therefore, unsuitable for supply estimation with consideration of risk. Just (1974, 1975 and 1977) had attempted to incorporate risk factor in the above model by way of adding to second moment (i.e. variance) of the explanatory variable to the first moment (i.e. expected value) that features in Nerlove's adaptive expectations model. An implied hypothesis to be tested is that the larger the variation in prices (and hence greater the risk), the more reluctant the farmers become in cultivating jute.

III. METHODOLOGY

In this methodology, first moment or subjective expected value of farmagate jute (PDJ) and the competing crop rice (PDR) prices i.e., $PEDJ_t$ and $PEDR_t$ depend upon fixed adjustment parameters (w_1 and w_2) and can be regarded as geometrically weighted sums of past observations on variables PDJ_t and PDR_t, respectively.

For expected jute price :

$$PEDJ_t\ (w_1)=w_1 \sum_{m=0}^{\alpha} (1-w_1)^m PDJ_{t-1-m}' \qquad (3)$$

$m=0, 2, 3, 3, \ldots\ldots\ldots\alpha$

or, equivalently :

$$PEDJ_t\ (w_1)=w_1\ PDJ_{t-1}+(1-w_1)^m\ PEDJ_{t-1}(w_1) \qquad (3a)$$

Similarly, for expected rice price :

$$PEDR_t\ (w_2)=w_2 \sum_{m=0}^{\alpha} (1-w_2)\ PDR_{t-1-m}' \qquad (4)$$

or, equivalently,

$$PEDR_t(w_2)=w_2 PDR_{t-1}+(1-w_2)\ PEDR_{t-1}(w_2) \qquad (4a)$$

Similarly, the second moment (or variance) of jute price ($PVDJ_t$) depends on (w_1) [through the relation, $PEDJ_t=f(w_1)$] and on a further stable adjustment parameter, z_1, for the geometrical weighing of past observations on variance, as measured by squared deviations from mean, as

$$PVDJ_t\ (w_1, \Sigma_1)=z_1 \sum_{m=0}^{\alpha} (1-z_1)^m (PDJ_{t-1-m}-PEDJ(w_1))^2 \qquad (5)$$

$m=0, 2, 3, 3, \ldots\ldots\alpha$

or, equivalently,

$$PVDJ_t\ (w_1, z_1)=z_1\ (PDJ_{t-1}-PEDJ_{t-1}(w_1))^2+(1-z_1)\ PVDJ_{t-1}(w_1,z_1) \qquad (5a)$$

We make the following assumptions for w_i ($i=1, 2$) and z_1

$$0\leq w_i,\ z_1\leq 1,\ \sum_{m=0}^{\alpha} w_i(1-w_i)^m=1\ ;\ \sum_{m=0}^{\alpha} z_1(1-z_1)^m=1$$

$m=0, 1, 2, 3, \ldots\ldots\alpha$

The first and second moment can be used as explanatory variables in our acreage equation, as in

$$BAJ_t = a_o + a_1 \; PEDJ_t \; (w_1) + b_1 \; PEDR_t \; (w_2) + c_1 \; PVDJ_t \; (w_1, z_1) + V_t \qquad (6)$$

Where V_t is a well-behaved disturbance term, i.e. normally and independently distributed with zero expected value and constant variance.

The above equation (6) is linear in the parameters and therefore for the given values of w_1, w_2, and z_1, can be extimated by ordinary least squares (OLS) regression analysis. The estimation procedure is that of searching feasible space $0 \leqq w_1, w_2, z_1 \leqq 1$, for those values of the adjustment parameters that give the minimum error sum of squares in the OLS equation. With the assumption that U_t is normally distributed, this becomes a maximum likelihood search procedure.

There is one difficulty to be confronted in estimation of equation (6). The equation system (3-5a) implicitly involve infinite series whereas sample acreage and price data for (6) are available for a finite series of observations. Therefore, the effect of the presample period mean and variance needs to be clearly discerned to arrive at correct values regression coefficients. Among the several methods available for dealing with this difficulty (Just 1974), one method is reviewed which is subsequently used in the following empirical work. Supposing that available data on BAJ_t cover period $t_o \ldots . t_k$, but that additional (prior) observations are available on prices PDJ_t and PDR_t so that they span $t_g \ldots . t_{k-1}$ i.e. $t_g \leqq t_0 \leqq t_k$, then the prior mean of PDJ_t and PDR_t can be estimated by

$$\hat{PEDJ}(w_1) = \left[w_1 \sum_{m=0}^{t_o - t_g} (1 - w_1)^m \right]^{-1} w_1 \sum_{m=0}^{t_o - t_g} (1 - w_1)^m \; PDJ_{t_o - 1 - m} \qquad (7)$$

and

$$\hat{PEDR}(w_2) = \left[w_2 \sum_{m=0}^{t_o - t_g} (1 - w_2)^m \right]^{-1} w_2 \sum_{m=0}^{t_o - tg} (1 - w_2)^m \; PDR_{t_o - 1 - m} \qquad (8)$$

The above two prior meats would be incorporated in our sample OLS data matrix to be presented later. Effect of prior variance would be considered in the process of estimating the other parameters and this can be done by adding an additional variable to (6), namely,

$$BAJ_t = a_o + a_1 PEDJ_t(w_1) + b_1 \; PEDR_t(w_2) + c_1 PVDJ_t(w_1, z_1) + d_1(1 - z_1)t + V_t \qquad (9)$$

The additional variable $(1-z_1)^t$ corrects thae sample data for the influence of prior variance. Now, letting t range from 1, 2,....n, it is clear that as the sample size n increases, the influence of the initial conditions of the process diminishes in importance. The additional coefficient d_1, can be regarded as embodying the prior variance as in $d_1 = c_1 \hat{PVDJ}$.

The first few rows of the OLS data matrix corresponding to equation (9) are presented below. The procedure of estimation is similar to Dhrymes' (1971) truncation remainder approach.

$$\begin{array}{c|llll}
t & & & & \\
1 & 1 & & & \\
2 & 1 & PEDJ_2 = w_1\ PDJ_1 + (1-w_1)\ \hat{PEDJ}^{1}_1 & PEDR_2 = w_2\ PDR_1 + (1-w_2)\ \hat{PEDR}^{1}_1 & \\
3 & 1 & PEDJ_3 = w_1\ PDJ_2 + (1-w_1)\ PEDJ_2 & PEDR_3 = w_2\ PDR_2 + (1-w_2)\ PEDR_2 & \\
\cdot & 1 & \cdot & \cdot & \\
\cdot & \cdot & \cdot & \cdot & \\
\cdot & \cdot & \cdot & \cdot & \\
\cdot & \cdot & \cdot & \cdot &
\end{array}$$

$$\begin{array}{ll|}
\overset{0}{PVDJ}_2 = z_1\ (PDJ_1 - \hat{PEDJ})^2 & (1-z_1)^1 \\
PVDJ_3 = z_1\ (PDJ_2 - PEDJ_2)^2 + (1-z_1)\ PVDJ_2 & (1-z_1)^2 \\
\cdot & \cdot \\
\cdot & \cdot \\
\cdot & \cdot \\
\cdot & \cdot
\end{array}$$

In the above OLS matrix, 1's correspend to the intercept, PEDJ to expected jute price, PEDR to expected rice price, PVDJ to variance of jute price and $(1-z_1)$ to the correction term for prior variance. The approach was applied to estimate jute acreage equation in Bangladesh. The variables finally chosen, as shown in equation (9), includes area harvested, BAJ_t as dependent variables and expected deflated prices of jute and rice and variance of jute price as explanatory variables. The variance of rice price and the covariance of jute and rice prices were not included in the estimating equation, as initial trials with the data revealed that they were unimportant in determining jute acreage Although minimum prices of jute have sometimes been set by the government, through the Jute Board, these prices cannot be said to have been relevant. There was limited government participation in the market with few purchases.

An application of this methodology occurs in IBRD (1980) and the present study differs from it in the following respects. Unlike in the previous work where the ratio of subjective expected prices are used, there expected prices of jute and rice are separately treated. This formulation allows an estimation of the supply elasticities (and calculation of risk impact) separately for prices of jute and rice. Moreover, inflation is explicitly accounted in the preasent model. Consumer price index is used as a proxy for the domestic inflation which itself is used as an indication of expectations regarding input prices. Consumer price index of period t-1 has been used for deflating prices of period t : on the assumption that farmers expectation of the level of inflation is based on that of the previous year. Though the present formulation is not without any limitations : its one advantage is that unlike in the previous study, here the prior variance term too involve deflated prices. Moreover, the formulation can additionally test the hypothesis whether the jute farmes

base their expectations of domestic inflation on its rate prevailed in the previous year or correctly foresee an inflation rate actually occurring in the current year. Finally, the present study focuses on more recent series of data (1950/51-77/78) than the IBRD study (1952/53-74/75).

BAJ is area harvested of jute in Bangladesh in 1,000 hectares (a constant relationship between planted and harvested hectarages was assumed) PDJ is farmgate price of raw jute in Taka per metric ton deflated by general consumer price index (1959/60=100) ; PDR is farmgate price of rice in Taka per metric ton deflated by general consumer price index (1959/60=100) ; PEDJ is expected deflated price of raw jute in Taka/metric ton ; PEDR is expected deflated price of rice in Taka/metric ton ; PVDJ is variance of deflated price of raw jute in Taka/metric ton. The data is collected from Jute Division, Ministry of Jute, Government of Bangladesh and Bangladesh Bureau of Statistics (Appendix A).

IV. EMPIRICAL RESULTS

Equation (9) in its estimated form is shown below, with t-ratios in parentheses.

$$BAJ_t = 1059.77 + \underset{(5.98)}{1.80}\ PEDJ_t\ (w_1=0.4) - \underset{(-5.92)}{2.66}\ PEDR_t\ (w_2=0.1)$$

$$\underset{(-3.12)}{0.0025}\ PVDJ_t\ (z_1=0.2) - \underset{(-3.86)}{294.13}\ (1-(z_1=0.2)^t \qquad (10)$$

$R^2=0.64$ S.E.E.=101.2 ESS=256077.12

D.W. Statistic=1.65

Pre-observation sample size (2) 1948/49-49/50

Observation sample size (27) 1950/51-77/78

In general, the signs of the coefficients are as expected. Acreage planted to jute is quite responsive to expected jute and rice prices as well as to variance in jute prices. The t-ratios range from 3.12. to 5.98 and exceed the critical value at the 1% level of significance using a two-tailed test.

The mean adjustment for jute and rice prices are respectively 0.4 and 0.1 while the variance adjustment for jute is 0.2. The jute ($PEDJ_t$) and rice ($PEDR_t$) price elasticities of jute acreage at mean values are (1.57) and (-1.83), respectively. However, the short run elasticity values are much lower. This is not too surprising in view of the fact that only 40% and 10% of any increase in current prices (for jute and rice, respectively) is regarded as permanent. Thus, in the short run, 1% increase in the current jute price raise expected jute price ($PEDJ_t$) by 0.4%, which in turn raise jute acreage of the next year by 0.628% (1.57×0.4). Similarly, 1%, increase in the price of rice raise expected rice price by 0.1 %, which is turn lower jute acreage of the next period by 0.183 % (1.83×0.1). Similar comment applies to variance adjustment and acreage response. Thus, a 1 % change in current jute price affects variance of jute price by 0.2 % which is turn would lower jute acreage of the next year. Interestingly enough, for a unit change in jute price the increase in jute cultivation would have been higher by as much as 38 hectares, had not there been a disincetive effect on jute cultivation due to increasing risk associated with increase in variance of jute price by Taka 94.57.

The results of jute price elasticities broadly conform to those of other studies. Clark (1957) found short run price elasticity of production of jute with respect to price of jute in the previous year to be 0.6 at the mean, while Mac Bean (1962) and Mujeri (1978) in their studies found the elasticities to be 0.37 and 0.71, respectively. IBRD (1980) study as contrast to the present study utilized ratio of expected jute to rice prices as explanatory variables and the adjustment parameters for expected prices and coefficient of variation were found to be 0.37 and 0.08, respectively.

V. CONCLUSION

The present study brings about some interesting features about the supply response of Bangladesh jute. Besides offering evidence of the much-debated responsiveness of subsistence farmers to economic incentives, it importantly tests the hypothesis of risk-aversion behaviour of jute farmers. The past memories of the farmers are found to have significant influences on current planting decisions so that a one percent increase in the current price of jute would affect their expected price and variance by only 0.4 percent and 0.2 percent, respectively, that would in turn influence jute acreage of the next period by

0.68 percent. The long term price elasticities of jute acreage at mean values are found to be 1.57 and -1.95 with respect to jute and rice prices, respectively. The long run elasticity magnitudes are much higher than those of short run implying that a small proportion of current change in prices are regarded as permanent, while the major portion of price changes are transitory. The selection of the present form of acreage equation as compared to others (not cited) lead us to believe that farmers base their expectation regarding inflation on its rate prevailing in the previous year rather than correctly foreseeing a rate that actually occurs in the current year.

Some suggestions for future agricultural supply analysis may be offered on the basis of findings discussed above. First, expected prices appear to merit consideration as an alternative to using current prices. Second, risk factors become highly significant in supply analysis. Third, change and expectations in input prices are important to be analyzed.

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Appendix A : Data and their Sources

	YEAR	BAJ	PGJ	PGR	BPI
1.	1947-48	833.6	580.5	434.16	80.20
2.	1948-49	759.7	816.7	541.0	82.13
3.	1949-50	631.8	540.0	440.9	82.84
4.	1950-51	692.4	513.0	348.8	80.89
5.	1951-52	719.9	695.2	398.2	85.85
6.	1952-53	771.6	276.7	378.0	89.17
7.	1953-54	390.6	418.5	276.7	83.53
8.	1954-55	503.1	422.2	197.9	71.90
9.	1955-56	661.5	509.5	372.3	85.39
10.	1956-57	497.9	649.0	568.0	89.35
11.	1957-58	632.4	541.6	476.0	94.75
12.	1958-59	618.5	432.0	457.9	95.70
13.	1959-60	556.5	542.4	479.2	100.00
14.	1960-61	614.2	1294.3	433.3	100.66
15.	1961-62	833.3	671.7	459.5	105.50
16.	1962-63	691.6	592.6	474.3	107.21
17.	1963-64	688.0	608.0	425.5	109.12
18.	1964-65	671.0	849.6	450.0	113.83
19.	1965-66	845.8	739.5	577.2	114.85
20.	1966-67	875.2	972.8	771.9	126.11
21.	1967-68	970.9	744.6	763.8	127.94
22.	1968-69	878.2	919.8	832.1	124.34
23.	1969-70	997.2	804.0	814.5	138.58
24.	1970-71	917.8	954.4	796.5	141.73
25.	1971-72	694.0	1071.0	945.0	150·50
26.	1972-73	896.3	1392.6	1,076.7	251.54
27.	1973-74	888.9	1428.5	1,386.7	349.77
28.	1974-75	607.0	2499.1	3,202.4	565.26
29.	1975-76	526.0	2650.0	2,038.5	526.74
30.	2976-77	659.2	2785.4	1,800.9	529.92
31.	1977-78	730.8	3780.0	—	604.20

	Variable	Definitions	Source
1.	BAJ	Area harvested of jute in thousand hectares	Jute Division Ministry of Jute.
2.	PGJ	Farmgate Price of Raw jute (Taka metric ton)	Monthly Statistical Bulletin of Bangladesh Bureau of Statistics
3.	PGR	Farmgate Price of Aus Rice (Taka metric ton)	As above
4.	BPI	Bangladesh General Consumer Price Index (1959/60 = 100)	Economic Indicators of Bangladesh, Bangladesh, Bureau of Statistics