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DETERMINANTS OF RICE SUPPLY IN BANGLADESH : A CASE OF PROFIT FUNCTION APPROACH USING CROSS SECTION DATA

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ABSTRACT

As rising fertilizer prices translate into bleak implication for "apparent" incentives for rice production-an undoubtedly important segment of Bangladesh's rural economy-a research question assumes key importance. Of price and nonprice class of variables determining rice output, which is more potent? We answer this question using a cross-section data set for 1989/90 on the basis of a profit-function based approach. Use of cross-section data is justified on account of timeseries data being unable to evaluate the absorption of fixed factors as required by the analytical method chosen. This of course means that the time frame is the long, and not the short run. We show that prices overall are more often insignificant determinants of rice output, while nonprice variables-farm size, the adoption of high-yielding-variety (HYV) technology and farmer's managerial ability-often register statistically significant influences on rice supply. Within the class of price variables, the wage rate is alone that decisively matters to output in the aman season; fertiliser prices, the cause of much recent discussion, do not make any difference to output supply. In the long run, it is the price of labour and not fertiliser prices that deserve more analytical and policy attention. It is adaptive research on, and the diffusion of, modern rice technology, and access to education and capital by the farmer that is more fundamentally important to rice production. In the atmosphere of Bangladesh today, this finding, however trite and shopworn, can take a wellattended recital, *de novo*.

1 INTRODUCTION.

Sharply falling rice prices amid rapidly increasing unit user costs of fertiliser and irrigation have recently become a common and nagging aspect to agricultural landscapes of Asia's rice-belt countries (ASIAWEEK, May 26, 1993) : policy makers and farmers are facing a new rice crisis. Not so long ago, governments, having equated solving the problem of hunger with the achievement of rice "self-sufficiency" at any costs, were massively subsidising the cultivation of the irrigation-led, fertiliser-fed high-yield rice varieties (HYVs).[2] Bangladesh is not untypical of this class of countries. In this paper the focus is on rice sector of Bangladesh. As the proportion of HYV intractably chalked up higher and higher[3], the governments instituted one or the other versions of "price support" programmes (Ahmed et al, 1993). And rice in South and East Asia has, until recently, had little marketing risks: rice has

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dense market contacts, especially at initial, upstream, marketing stages (Barghouti et al, 1990). In Asia, rice yields in the two decades through 1990 increased at a trend growth rate of 2.1 (IRRI, 1991, Table 3). From a pattern of single-peak production seasonality, rice system in several key economies have evolved towards a regime of growing equality of relative shares of dry and wet seasons (see, for example, Chowdhury, 1993). This has dampened temporal spreads. Under the impact of growing purchased-input bills, rice is being heavily marketed (Chowdhury, 1992 Table 67), while the farmer has a noteable measure of access to own-account irce stocks relative to his consumption requrements (Choowdhury 1992, Table 68). Rice supply, in effect, has continued to shift. However, consumers either do not or can not muster effective demand for as much rice as farmers are producing (Ito et al, 1989).[4] Demand has in effect shifted a lot less.[5] The purchasing power parity of rice therefore has fallen.

Changes in price ratios germane to Bangladesh's rice production turned discouraging in 1992/93 (Table 1) : the quantity or rice that pays for the cost of kilo of fertiliser rose from 0.49 kg during the quinquennium through 1991/92 increased to 0.70—a gain of 43%. The quantity of rice that trades off against one manday of casual labour rose over the same period from 3.65 kg. to 4.10 kg.— a gain of 12%.

Such statistics have, as would be expected, drawn anxious responses (Crow, 1993). Commentators have stressed the possibility of output contraction as a direct consequence of the price debacle. This provides the point of departure for the present paper.

Table 1. Parity between rice and variable farm inputs, 1985/86 - 1992/93

Year	Rice price/kg. (Tk.)	Farm wage rate/day (Tk.)	Urea price Tk/kg.	TSP price Tk/kg.	MOP price Tk/kg.	Average fertiliser price Tk/kg.	Rice quantity that trades off per unit of Fertiliser	Labour
85/86	7.51	29.54	4.91	5.00	3.80	4.88	0.65	3.93
86/87	9.13	31.91	4.80	5.00	4.00	4.81	0.53	3.50
87/88	9.44	31.15	4.80	5.00	4.00	4.81	0.51	3.30
88/89	9.71	34.25	4.80	5.00	4.00	4.80	0.49	3.53
89/90	9.51	37.35	4.58	4.73	3.73	4.56	0.48	3.93
90/91	10.41	40.00	4.83	4.99	4.28	4.87	0.47	3.84
91/92	11.01	40.00	4.99	6.25	5.13	5.27	0.48	3.63
92/93	8.30	34.00	5.32	7.60	6.59	5.84	0.70	4.10

Note : Average fertiliser prices is obtained using annual fertiliser sales for three different types for weights.

Source : IFDC, BBS.

In a still mainly agricultural economy where rice production contributes about one-fifth of domestic product, a price change of such magnitude, even when it were predicted in advance, is bound to have been disruptive in its income, distributive and expectational effects. In fact the sharp price fall took most people by surprise. While the sharp fall of and the unusual seasonal changes in rice price have been explained in terms of structural change in private rice supply and unpredictable public interventions in rice markets, (Haggblade and Rahman, 1993) these developments have added a sense of urgency to the appropriate evaluation of the determinants of rice supply. In particular, we believe, they have set the stage for an evaluation of the comparative influence of price and nonprice variables as determinants of rice output. Some current thinking is about the impact of "unfavourable" price relatives on expected rice oupput; the implicit assumption is that rice supply is significantly input price responsive and, moreover, is significantly fertiliser price responsive. To conduct such a discourse while crucial assumptions are not put to the empirical tests leaves something to be desired. In this paper, we make a modest effort to examine

(a) the relative potency of price and nonprice variables as determinants of rice supply;

(b) the relative potency of fertiliser and labor prices as determinants of rice supply. The analytical framework for this study is presented in Section II. Results with corresponding policy conclusion are discussed in Section III. Major conclusions are summarised again in the last Section.

II. THE ANALYTICAL FRAMEWORK

We use a normalised Cobb-Douglas profit function as our analytical scheme to estimate the elasticities of rice supply with respect to variable input prices, and a number of fixed factors, both sets assumed exogenously determined. We recall that econometric applications of the production theory based on the duality of the production function and variable profit functions have offered a reasonably robust yet convenient means of estimating coefficients of farm supply (and demand) responses amid the coexistence of price and nonprice variables (Lau and Yotopoulos, 1971, Yotopoulos and Lau, 1973, Sidhu and Baanante, 1981).[6]

The following functional form was estimated :

$$\ln(\pi^*) = \ln(\alpha_0) + \sum_{i=1}^{n} \alpha_i \ln P^*_i = \sum \beta_h \ln(Z_h) + \in \qquad (1)$$

where π^* = gross output net of variable costs normalised by rice price; P_i = price of labor, fertiliser and draft animal services, normalised by price, Z = fixed factors; ln represents the natural log operator, α_0, α_i and β_h are parameters to be estimated; and $\in$ is an error term with zero mean and a constant variance.

Define $S_i \equiv P^*_i X / \pi^*$ as the ratio of variable expenditures for the i^{th} input relative to resticted profit. Let $S_v = V/\pi^*$ be the ratio of output supply (v) to the normalised, restricted profit.[7] It is well-known that, under the assumption of a Cobb-Douglas specification, variable input demand equations collapse into the coefficient of the logarithm of the normalised profit function with respect to the price(s) of the variable.

This is shown as follows :

$$S_i = -\frac{P^*_i X_i}{\pi^*_i} = \frac{\delta \ln \pi^*}{\delta \ln P^*_i} = \alpha_i \qquad (2)$$

This implies that, in this setting, only output supply elasticities, remain estimable, even though, in reality, they become simplified.[8] The estimation of these elasticities remains subject to the assumption of price-taking behaviour by the farms under observation. This implies that the normalised input prices and quantities of fixed factors are here considered to be exogenous variables.

Output Supply Elasticities

Output supply elasticities with respect to output price, variable input prices and levels of fixed factors, evaluated at averages of the S_i and at given levels of the exogenous variables, can be expressed as linear functions of the parameters of the restricted profit function. The duality theory allows one to formulate as follows :

$$V = \pi + \sum_{i=1}^{n} P_i X_i \qquad (3)$$

One can rewrite (3) as follows

$$V = \pi + \sum_{i=1}^{n} \pi \left(- \frac{\delta \ln \pi}{\delta \ln P_i} \right) \text{ or}$$

$$V = \pi \left(1 - \sum_{i=1}^{n} \frac{\delta \ln \pi}{\delta \ln P_i} \right)$$

One can write

$$\ln V = \ln \pi + \ln \left(1 - \sum_{i=1}^{n} \frac{\delta \ln \pi}{\delta \ln P_i} \right) \qquad (4)$$

Where the assumption of Cobb-Douglas production technology is imperative, the elasticity of supply with respect to price of i-th variable input is equal to

$$\varepsilon_i = \frac{\delta \ln \pi}{\delta \ln P_i} + \frac{\ln}{\delta \ln P_i} \left(1 - \sum_{h=1}^{n} \frac{\delta \ln \pi}{d \ln P_i} \right) \qquad (5)$$

$$= \frac{\delta \ln \pi}{\delta \ln P_i}$$

(because second-order terms are equal to zero in a Cobb-Douglas situation).

A methodological justification

It is an adequate procedure to use cross-section data to estimate supply elasticities using the competitive assumptions required by the profit function approach. Inasmuch as a crosssection of prices may be influenced by several other factors (e.g., income distribution, spatial differences with respect to expectations regarding the future, and the like) than shifts in demand and supply, the ensuing price coefficients may, in theory, not correspond well to price effects, *per se.* Also, cross-section farm sizes represent an outcome of a longrun process of change. Also, a cross-section coefficient measure the difference between the allocative behaviour of a small farm and a large farm at a given point in time. As large farms over time become smaller through a demographic process, they might adapt to the allocative patterns of smaller farms only with a certain time lag. If smaller farms, reflecting conditions of relative resource scarcity, are nore price-responsive than large farm, this lagged adaptation would mean that the use of cross-section data would underestimate the responsiveness of supply to prices over time, other things being equal.

It has been argued that some serious problems attach to the use of cross-section data in estimating parameters of output supply function using profit function approach (Quiggin and Bui-lan, 1984). The difficulty, essentially, is that "the user of cross-section data faces a dilemma. If perfectly competitive conditions prevail, the profit function is theoretically valid, but the absence of any variation in the data will make estimation of profit function impossible. If, on the other hand, there is variation in prices, it is unlikely that profit functions can validly be derived from competitive assumptions" (Quiggin and Bui-lan, 1984). Price variation may be due to quality variation : this may rule competitive assumption out. We concede much of the criticism that Quiggin and Bui-lan levelled against the use of crosssection data in this context with three qualifications.

First quality differences may be endemic in cross section data, as maintained by Quiggin and Bui-lan. But is that the end of the story? Can not quality differences materially affect timeseries evolution of particular crop economies? Indeed, there is at least some persuasive evidence that, especially as regards evaluation of rice output in the context of the adoption of high-yielding variety (HYV) rice, a nonnegligible degree of quality-induced price variation may survive even the use of time-series data.[9]

Second, Quiggin and Bui-lan have stressed the possibility that even though the actual vector of prices faced by farms are equal, be true of time-series data on commodity or input prices, especially in developing countries with weak public effort in generating consistent price data over time. 10

Third, developing country agricultures all too often have an evolving regime of agricultural input subsidies. Subsidies, which are captured by middlemen (and not passed to the consumers) create series problems for the evaluation of user-costs, and measured price, when the latter is merely evalutated as administered price plus "competitive" marketing margin.[11] A growing roll-back of the subsidy regime *over time* means that what Quiggin and Bui-lan have to say about cross-section data may also apply *mutatis mutandis,* to time-series data. In developing countries, all data, including the time series data, are imperfect for estimating accurately the parameters of a production technology. However, the key advantage of purpose-designed set of cross-secton data is that at least it will be based upon consistent, well-defined cencepts, with reasonably unambiguous implications.[12] Such a thing can not be said about time-series data in Bangladesh, at any rate pertaining to unit fertiliser use and user-level prices and farmgate rice prices.

This, finally, implies that both time-series and cross-section data bring in their wake a litany of inherent limitations. In Bangladesh, moreover, it is exceedingly difficult, if not impossible, to put together a time-series on fertiliser and labour use for rice cultivation as a precursor to estimating the parameters of the profit function : only aggregative "absorption" are available.[13] Panel data, generated through sample surveys, while a better basis in this context, are usually extremely expensive to generate. Hence, it remains popular to use cross-section data in order to estimate the parameters of the profit function for rice (Hossain, 1988).

The data

The data for this paper were collected by a number of specifically-trained field staff of a country-wide farm survey conducted in two rounds between June 1990 and September 1991. Farm budget data were collected from a sample of 310 farms drawn from twenty one of Bangladesh's 64 new districts.[14] Virtually, all of Bangladesh's agro-climatic zones are included in this sample. Farm budgets were evaluated for two major crops seasons in Bangladesh, namely, the aman and the boro. There was a prima facie justification for this disaggregation, as the character of rice technology as between the two seasons is rather dissimilar.

The following procedures of evaluating the various variables used in this paper may be highlighted, Farm capital (CAPITAL) is measured as flows; the rate of discount used in that connection is 16% per year. By farmsize (FARMSIZE) is meant cultivated area under rice. Education (EDUC) is measured in terms of the number of years of formal schooling. Irrigation (IRRG), following Sidhu and Banaante (1981) is measured by the number of time farm was irrigated. Wage rate (WAGERATE) was evaluated in terms of the wages paid (including value of food given to casual labourers. Cost of animal draft power (BULLRATE) was evaluated in terms of the charge per hour for a pair of oxen. A number of dummy variables were tried. Most important among them was the high-yielding-variety dummy (HYV), taking the value of 1 where the rice variety grown by the farmer at hand is a HYV, and zero otherwise.[15]

A few observations related to expected coefficient signs may be in order. The three variable inputs are expected to register negative signs. The four fixed factors are each expected to return positive signs.[16]

III RESULTS AND POLICY CONCLUSIONS

The results discussion is structured as follows. We first argue that the data set used here is representative of current rice technologies in Bangladesh. We then report the results of our econometric exercise. Subsequently, we draw a few policy conclusions. In the end, we emphasise certain limitations of this research.

Representativeness of the Sample in Farm-technology terms

In the face of the diffusion of modern farm technology for rice production, the adoption of the HYV technology, yield and labor use, and rice cropping intensity offer a basis for evaluating this particular sample. We revert for nationally representative data to a nationally representative largescale survey of Bangladesh's rice economy completed more recently at BIDS (Hossain, et al 1991; Rahman and Hossain, 1992).

Tables 2 reports on the technological attributes of the samples. Overall, the sample appears to be adequately representative of the technology of the rice sector as a whole. Several features of the information presented prompt this conclusion. First, the proportion of area under HYV strains during both aman and boro growing seasons, at 43% and 85% compare quite favorably with BIDS estimates. The proportion of land under irrigation is found to be 63% on average on this sample, as against 52%. Yield are quite similar.

Table 2. Comparative Indicators between BIDS and IFPRI Survey

	IFPRI sample	BIDS sample (N = 1264)
% of rice area under HYV aman	43	40
% of rice area under HYV boro	85	84
% of households using irrigation	63	52
% of land in tenancy markets	38	37
Output (in paddy) per ha, broadcast aman(md)	38	35
Output/ha, HYV aman (md)	94	94
Output/ha, local transplant aman (md)	67	66
Labour/ha, HYV aman (person-days)	166	161
Labour/ha, local transplant aman	133	130

Source : IFPRI Farm Survey, 1989/90; Rahman et al. 1992

Regression results

Table 3 presents the statistical distribution of the variables of interest to the study. Table 4 report the estimated coefficients of the normalised profit function. Several ovservations may follow.

First, with the exception of wage rates in the aman season, variable input prices do not register themselves as statistically significant determinants of rice supply, even though the profit function is everywhere falling and convex with respect to variable input price, as it indeed should. In particular, wages rates dwarf fertiliser prices in both seasons in their effect upon output: however, the differential effect of labor costs is highly significant for the aman crop. This cross-seasonal contrast is perhaps due to technology-induced productivity gains, providing an offset to price-induced downsizing of employment and output, being quantitatively less important in aman than the boro season. Prospective developments in agricultural labor markets especially relative to wage rates are potentially more decisive than the changes in fertiliser prices for supply. The farmers try to maintain fertiliser use at a customary level regardless of the relative prices, given the widespread perception of a secular decline in the natural soil fertility in Bangladesh.[17] In contrast, the relative share of labor costs is so large that given increase in wage rates is matched by a fairly liberal cutback in hiring of casual workers.

Second, by comparison, several nonprice variables, exert intuitively signified and statistically significant effects on rice supply. In both seasons, the HVY dummy variable is found to significantly shift supply, particularly so in the boro season. Among fixed factors, farmsize supply augments output supply.[18] The educational preparation of the farmer makes a favourable difference to rice output in boro season. This is probably due to the cultivation of

Table 3. Arithmatic Mean and Coefficient of Variations of Variables Used

	Aman season	CV (%)	Boro season	CV (%)
Profit per farm (Tk.)	5582	149	6530	208
Education (no. of yrs.)	8	68	8	69
Irrigation (nos.)	3	274	11	120
Wage rate (Tk./day)	34	20	37	79
Bullock rate (Tk./bullock hr.)	3.54	13	3.60	13
Urea price (Tk./kg.)	4.87	6	4.92	5
TSP price (Tk./kg.)	5.09	8	5.18	6
MOP price (Tk./kg.)	4.32	9	4.24	9
Capital flow (Tk./season)	3769.75	110	3815.53	110

Notes : TSP stands for Triple Super Phosphate;
MOP stands for Murate of Potash
CV stands for Coefficient of Variation

Source : Sample survey directed by the senior author

Table 4. Estimates of Profit Functions using Cobb-Douglas Form

Variable	Aman		Boro	
	Coefficient	T-Ratio	Coefficient	T-Ratio
Constant	3.57	4.93*	0.42	0.5
Wage rate	-0.91	-3.2	-0.36	-1.06
Fertiliser price	0.27	0.67	-0.23	-0.41
Bullock service rate	-0.67	-1.89	-0.24	-0.57
Irrigation	-0.05	-1.1	-0.009	-0.2
Farmsize	0.94	19.1	1.06	18.2*
Capital	-0.035	-0.93	.08	1.66
Education	0.054	1.10	0.132	2.51*
HYV Dummy	0.141	1.62	0.96	6.65*
R^2	0.57		0.76	

Sources : Computed by the authors using data from IFPRI Farm Survey 1989/90

* Significant at 1 per cent level or below

HYVs—the staple activity during season—being, culturally, more demanding of knowledge and farming skills. And the access to farm capital matter to supply in the boro season.[19] IRRG *per se* does not significantly affect output, when the effect HYV adoption is isolated.[20] Capital, too, registers a negative albeit statistically insignificant coefficient in the aman season.[21]

The highlight of these results that nonprice determinants of rice production are more important in the long run than prices. This is unlikely to be highly revealing, but in the climate currently prevailing can do with a reiteration.

Some Further Implications

Bangladesh's rice economy has a productive slack during the aman season : less than one-half of the aman area is under HYV strains and under one-third is under supplementary irrigation during that season, implying an under-exploitations of potentials. If, however, rapid increase in diffusion of HYV strains and supplementary irrigation is to be had, both will likely imply increased labor demand. However, wages rates have to remain restrained, if production momentum is to be maintained. And yet this prompts two observations, both regarding agricultural wages.

Insofar as rice prices may themselves set the tone for nominal wages demands, the primacy of nonprice variables—especially the technology and educational endowment variables as supply-shifters—underscore the following causal sequence : a more effective agricultural research, yielding a more efficacious set of varietal strains, coupled with improvement of farmer's managerial abilities, translate into a timepath of rapidly expanding supply and falling rice prices, thus allowing real wages in agriculture to fall, thus providing rice supply further fillip.[22] Put differently, forging a vigorous set of non-price interventions carries with it the prospects of second-order and favourable *price effect* on future rice supply.

Second, incomes policies that can effectively put a cap on agricultural wage rates are expensive to formulate and fractious to implement, even in politically mature societies. Absent such political structures, those policies may be matters of academic interest alone. For all its strong effects on rice supply, the direct relevance of the evidence regarding wage rates for foodgrain policy is thus hard to take. Even so, at any rate wage-setting for industrial and urban workers assumes some considerable importance. Industrial wage restraint likely would contribute towards constant or declining agricultural wages.

Implications of these results for fertiliser pricing are twofold. For one thing, if 1989/90 price relatives were to be held contant, this analysis could well conclude that fertiliser prices do not significantly influence rice ouput. Secondly, and more important, by early 1993, the price relatives had quite fundamentally changed. At the new relativities, the returns to fertilisers are found to fall by about 45% (Chowdhury, 1993b). That conclusion is inescapable even if trend—as opposed to actual—prices were to be used. The present round of increases in fertiliser prices so far appear to result quite inescapably from a regime of border pricing.[23] That should be unexceptionable : especially so, remembering that Indian fertiliser-to-rice price ratio is higher than Bangladesh's by 30 or so percent. Given the porous borders, resubsidisation of some varieties of fertilisers is a sure recipe for vigorous overland but illicit fertiliser trade. These results suggest that status quo can legitimately be maintained versus pricing regime for fertilisers. Because the reality of the rice technology is such that it is the real labor costs in aman rice production that clinch the input pricing issue, the falling rice prices are not without a saving grace : they imply low rates of wage inflation. And that provides a fillip to further production.[24] The policy strands these results implicate are (i) further diffusion of cost saving production technology and (ii) farmer's educational/managerial endowment. The assertion that fertiliser prices are critically important determinants of rice output, we believe, is less true today, than perhaps in the relatively distant past.[25] Farm wage rates during aman season, however, are important price signals. To keep relatively low money wages demands appears to be an important policy objective, if growth in aman supply, traditionally relatively sluggish, has to make some headway.

Limitations of the paper

The results reported in the above need to be taken with some caution, for two main reasons. For one thing, the use of cross-section data implies underestimation of the elasticity of supply with respect to the fixed factors, especially farm size, even education. This is because as large farm operators were to become smaller over time (say as a result of demographic change), they would adopt the pattern of allocative behaviour of their smaller peers only with a lag. This implies that cross-section supply elasticities with respect to farm size may underestimate the elasticity of supply over time, other things remaining the same. For another, price variables may brook a significantly lower degree of variation in a cross-section than over time. Again, this may lead to under-estimation of price elasticities over time.

This paper estimates two classes of elasticities—that is, those respecting price as opposed to non-price variables—and both classes seem to understate. There is no *prima facie* evidence to differentiate between the relative degree of understatement affecting either class of variables.

IV SUMMARY OF MAJOR CONCLUSION

In overall terms, it is the nonprice variables, which are the primary long run determinants of rice supply. Price variables on the whole do not matter, except for the wage rate during the aman season. Among nonprice variables, the diffusion of HYV, and educational endowment of the farmer, are the most potent shifters of rice output. This is not surprising : HYVs raise yields, and the quality of management of the farmer increases with the educational endowment. Labor market assumes a key significance in influencing the fundamentals of rice market; fertiliser prices, the cause of much recent discussion, do not appear to significantly affect rice output. (This does not rule out that the relativity between fertiliser and rice prices can change sufficiently to make a visible impact upon the potential incentives for rice production.) The diffusion of HYV - technology and the access to credit and farm managerial performance that clinches the issue of accelerating rice production in Bangladeh in the long run at issue in this paper.

Footnotes

1 In many Asian languages, the words for rice and food are the same (Khan, 1973)

2 In Bangladesh, for example, rice breeders have diffused 25 new high-yield varieties in fifteen odd years, of which 18 can be grown in the boro or aus season under irrigated conditions and 7 can be grown in aman season. (Aman is on the fields July-August through November , boro, between January through June; and aus, between April and August/September.) Area irrigated by nontraditional means grew at trend of nine percent annually between 1974 and 1990 (Goletti and Ahmed, 1990); its diffusion heavily weighted towards rice. And it has been heavily subsidized (Osmani and Quasem, 1985).

3 In Bangladesh, 68% of rice output in 1992 are HYVs, as against 15% or so in 1972.

4 The emerging consensus seems to be that the literature overstates the income elasticity of demand for calories (Bouis and Haddad, 1992); and overstates the income elasticity of demand for staples (Bouis, 1991; Chowdhury, 1992). High initial estimates were due to insufficient conceptual refinement (Bouis and Haddad, 1992), and a gloss over structural change in model specifications using time series data. As incomes grow, people switch to processed food, where wheat, corn, maize have a technology and marketing advantage, bread, cookies, fast-food noodles, sandwitches, high-fibre bran and cereal begin to force into an average consumer's menu.

5 As well as being due to fundamental force of long term movements in supply and demand, the severe, indeed unprecedented, fall in rice prices in 1992/93 in Bangladesh is also due, to an important degree, to certain specific governmental interventions in rice markets (Haggblade and Rahman, 1993) as well as miscued stock operations by marketing agents involving subsequent drawdowns at a loss. Fundamental as well as transitional forces, entwined as they are, are both germane to Bangladesh's price experience in 1992/93.

6 We opt for the Cobb-Douglas specification not as a *datum*, but as a matter of econometric warrant : appropriate F-test indicated that the restrictions imposed by all second order terms in an unrestricted form (i.e. the translog specification) being jointly equal to zero could not be rejected at 5% error probability level. This required that we had to reject the translog form as the estimator, given the data at hand. Presently, therefore, heterogenous exogenous factors that are, in theory, expected to differ in their impact within and across input demand and output supply functions can, without loss of generality, be treated aggregatively : the structure of production is thus somewhat more simplified. The use of Cobb-Douglas form in studying the aggregating feature of a production structure, while still in theory restrictive, does remain widely in vogue (Lau and Yotopoulos, 1971). Further below, we try to defend our procedure of estimating such a form with cross-section rather than time series data.

7 Of course S_V is also equivalent to the ratio of gross value of output to restricted profit.

8 It may be noted in this context that the state of the pricing policy debate in Bangladesh at the moment is one where some "plausible" but contemporary estimates of the output supply elasticities are likely to be of some avail.

9 To cite an example, coarse traditional rice and course HYV rice may have significantly different storability. Both in Korea and Indonesia, HYV coarse rice have continued to be worth a discount relative to traditional alternative)Burmeister, 1987, p. 773 : the discount is due to strongly felt quality differences. The same is true for Bangladesh. In both countries as also in Indonesia, the HYV coarse rice has *over time* increasingly dominated the formation of coarse rice prices for Bangladesh evidence, see Chowdhury 1992 and Chowdhury 1994.

10 Official area and yield statistics in Bangladesh, for example, have at various times, been found to involve varying methods of collection (Pray, 1979; Mahmud et al. 1993).

11 The shortcut implied here has at times been adopted due to want of resources prerequisite to sample serveys to evaluate closely the user costs of subsidised inputs. This is a fairly intractable difficulty with time series data. In a not unrelated context, see Khan (1981) and Osmani and Quasem (1990).

12 Downside of cross-section data is about the lack of dispersion of prices.

13 In effect, only "sales" data are available. To translate such data into "fertiliser used for rice cultivation" would usually involve making certain questionable, however plausible, assumptions.

14 These districts are Thakurgaon, Dinajpur, Rangpur, Bogra, Joypurhat, Noagaon, Rajshahi, Tangail, Sherpur, Mymensingh, Netrokona, Sunamganj, Sylhet, Comilla, Feni, Noakhali, Chittagong, Cox's Bazar, Jessore, Satkhira, Patuakhali.

15 Regional dummies were tried, but produced unsatisfactory econometric results. Hence they have been ommited.

16 Frequency of availment of irrigation by farm is usually determined by the specifics of morphology. The latter is part of a farm's physdical endowment. This of course is largely predetermined and, *ipso facto*, can be highly variable across farms. (This is why coefficient of

variation for IRRG is extremly high, see Table III). This means that IRRG can be treated as a fixed factor.

17 Recent data from CIMMYT/IFPRI produced Survey in twenty one new districts of Bangladesh report using chemical analysis of soil sample that 100%, 100% and 85% of the samples are deficient with respect to nitrogen (NH_4 - N), organic matter and zinc (Meisner et al. 1994).

18 However, because the total supply of land is fixed in the long run, this finding does not have a great deal of policy significance.

19 When capital is measured *qua* stock , its coefficient in both seasons is found to be significantly positive.

20 When IRRG is dropped from model specification, results remain virtually unaltered, except that, during the aman season, coefficient of FERTIPRI has a perverse (positive) sign. Overall, losing IRRG makes the results less intuitive, and is untenable on theoretical grounds, The fact that IRRG, as measured, registers a negative coefficient, albeit insignificant, is not totally implausible, either.

21 The procedure we used to evaluate the capital input is implicitly based on a proportionality between capital service flow and capital stock. This oversimplification carries the potential of registering biased coefficients to the capital variable (Yotopoulos, 1967, 1968a). This seems to be the case with the aman season data here.

22 This argument assumes as though the cross-sectional coefficients could be perceived as valid representation of time-series casualities. In reality, the cross-sectional results would tend to, in part, *understate* the matched cross-time effect. For evidence of the interactions between rice prices and wages rates, see Ravallion, 1990.

23 Some casual observers think that fertiliser marketing have very recently run into some imperfections, probably associated with the access to the specific fertiliser creditline recently created. Unconfirmed reports have appeared in the press that private importers have taken turns in availing of the opportunity to open Letters of Credit. If true—and only future research will fell—this suggests that an undoubtedly privatizing fertiliser market has, however, been less than fully liberalised.

24 Annual inflation rate in Bangladesh in the last year or so has fallen to the low range of 4-6%. Low rice prices have contributed heftily to this favourable development. This year, inflation rate is forcast to fall again. This may foster restraints in matters of agricultural wages.

25 We take note that the government has lowered the ex-mill price of Urea produced by the parastatal Bangladesh Chemical Industries Corporation in the budget for 1993/94.

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