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MARKETED SURPLUS OF BANGLADESHI RICE AMID GROWING TECHNICAL CHANGE: A MICROECONOMETRIC SEASONAL STUDY

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The author is grateful to the Ministry of Food, the Government of Bangladesh for jointly conceiving the Bangladesh Food Policy Project, to USAID for joint conceiving the project and for sponsoring the study, to Dr. Raisuddin Ahmed for valuable interactions and strong support to the Farm Survey, to Dr. Harold L. Rice for being extremely supportive to this research in BFPP, to Drs. Akhter Ahmed and Wahiduddin Mahmud for fruitful discussion. He is grateful to participants in a BIDS seminar where an earlier draft was presented. In particular, he is grateful to Mr. Abu Abdullah, and Drs. Sajjad Zahir, Sultan H. Rahman, and Q. Shahabuddin for their comments.

* This paper would not have been possible but for the members of IFPRI Farm Survey field staff, viz. M/s. K. Bhuiyan, Ghulam Kibria, Ashequl Islam, Shamshul Areffin, Pranab Saha, Khairul Anam, Md. Zakariah, Mohsin Mahmud, Dilip Adhikari, A. Sattar Mollah, Ayub Ali, Mizanur Rahman. These IFPRI staff made a very good effort, often going beyond the call of duty. We are very grateful to them. Ms. Rahima Kaneez ably assisted this research. None of these dutiful persons are responsible in any way for the shortcomings of this paper, which are solely the author's disadvantage.

ABSTRACT

The paper presents partial and total price and output elasticities of marketed surplus of 1989/90 aman paddy crop. Aman is the single most important field crop of Bangladesh, and accounts for about half of about 8 million tons of rice privately marketed during 1989/90. The empirical analysis, essentially, identifies the more important household level determinants of marketed surplus. It is shown that the ratio of marketed surplus to production of rice has secularly risen in Bangladesh. From about one third in the late 1970s, the ratio in 1989/90 is estimated at 45%. Marketings during the aman season increase disproportionately with output. Prices have positive but quantitatively insignificant overall effect. However, the technologically forward farm and the average farmer in the surplus district both have significant degree of positive price response of supply. Marketings fall with household consumption. Setasides for future consumption or sales lower current marketings, as expected. Overall, output elasticity of marketed surplus is 1.6 while price elasticity is only .08. If average price per unit time increases by 10%, marketings increase by less than 1%. Total price elasticity is 0.29 in the short run and 0.54 in the long run. Total price elasticity of home retention is -.04 in the short run, and -.01 in the long run.

Estimated coefficients are found to differ significantly across small-large farm divides, or high-low high-yielding variety (HYV) adoption divides. There is some evidence here for policy to have a sectional constituency. The model estimated for surplus district is significantly different from that for the deficit districts. The price elasticity for the surplus districts and for the technologically forward farms is significantly higher. This result could be due to several reasons.

The proportion of HYV aman in total land is higher, and the average operated farm is larger in surplus districts, thus creating large surpluses. Endowment of local paddy-processing capacity and all-weather road per thousand population is far higher, too. The latter factors place the sources of demand for and supply of paddy in a market setting that, so to speak, permits trade at an arm's length. Suppliers can therefore anticipate better the expected price at a future date. Hence they can better take advantage of price increases.

The implication of this paper is that policy should stress yield and output enchancing policies (like farm technological change, diffusion of irrigation et.) to stimulate marketing. The theoretical merit of output price support policy--- something that currently does not in effect exist in Bangladesh--- is called into question by the results.

I Introduction

Marketed surplus, especially of major a wage good, like a staple cereal, represents a key aspect of economic development.[1] It determines the size of the market in that commodity, and reflects in turn the extent of commercialization prevailing in its economy. It denotes a capacity of the economy to sustain labor absorption outside of agriculture, and it simultaneously mirrors the capacity of the agriculture to purchase nonagricultural goods, services and production resources. Put differently, the ratio of marketed surplus to net production is a summary for the degree of inter-sectoral linkage. Marketed surplus is, therefore, a major entrypoint for discussion of a number of important policy alternatives which impact upon public management of commodity supply.

This note presents some new evidence bearing on marketed surplus of aman paddy during 1989/90. Using sample survey data, and a linear marketed surplus function, it is strongly shown that the marketing of paddy responds vigorously and disproportionately to output. In overall terms, prices do not significantly stimulate marketed supply. However, the average farm in the "surplus district" is significantly more price responsive in his beh
As expected, family size decreases marketings. Set-asides for future consumption or sales diminish current offerings. The paper has important implications for the relative advantages of output price policies and other output-augmenting policies.

The analytical issues are next taken up, followed by a discussion of the sources, scope and the limitations of the data. In the final section, the results are further detailed.

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[1]Following Krishna (1962), we use marketed surplus, marketable surplus and market supply synonymously.

The Analytical Issues

By identity, the output (Q) of a subsistence crop is equal to consumption of the producer household (C) and the marketed supply (M)

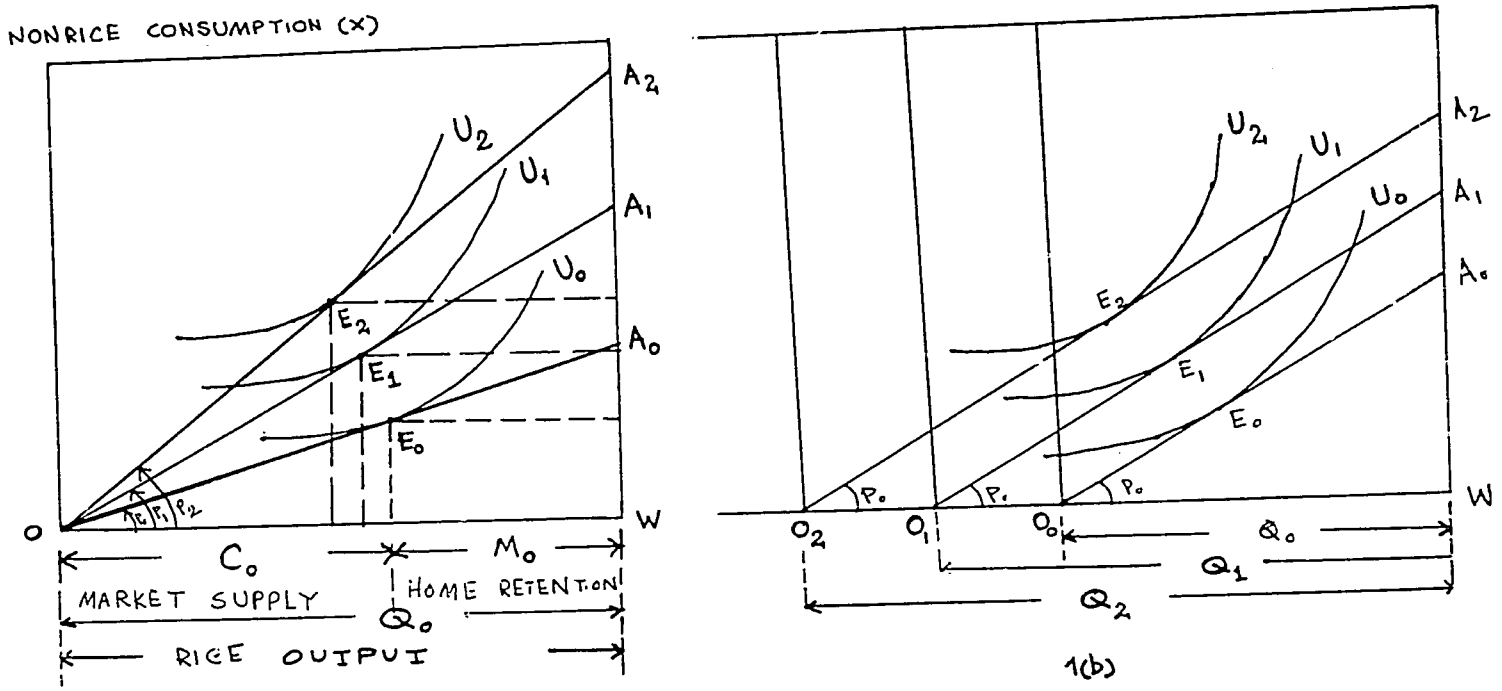
$$Q = C + M \qquad (1)$$

The allocation of a given quantity of output between market sale and home retention is shown in Fig. 1. [This presentation of analytical issues freely draws upon Toquero et al. (1975)].

Suppose that the raising of paddy is the farmers' sole income source. The distance from W to the left along the horizontal axis measures the quantity of paddy offered for sale, and the distance from O to the right measures the output retained for home consumption. Vertically, one measures the quantity of X, a composite of all non-paddy consumption of the households, including capital-account expenses.

Assume that the farmer will attempt to allocate output between home consumption and market supply in order to maximize the utility of his household. This further assumes that the household, and not individual members, is the maximizing behavioral unit of analysis. The consumption of rice and the non-rice composite X alone yields all of household utility. The farmer is assumed to possess an indifference map, comprising curves representing successively higher utility levels. Let $P = P_r/P_x$, where P_r is the price of paddy and P_x is the price index of non-rice commodities. In an initial period, the equilibrium allocation of paddy will be at E_0, where M_0 is traded and C_0 consumed. E_0E_2 defines a locus of successive equilibria as relative price of paddy increases. As relative price of paddy <u>increases</u>, the quantity marketed out of a

FIG. 1



SOURCE: ADAPTED FROM TOQUERO EL AL. 1975, P. 706.

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given output is assumed to decrease, while still permitting a trade between rice and non-rice to the household's advantage.[2]

The effect of changing output levels on the allocation between marketing and consumption is shown in Fig 1 (b). Here relative prices are assumed to remain unchanged. Increasing output levels trace out a locus of equilibrium points with the property that the incremental share of quantity offered for sale continues to get bigger than for quantity retained on farm.[3]

Given an indifference map, equilibrium quantities of marketed surplus and home retention depend on P and Q. In symbols,

$$M = f\ (P,Q) \tag{2}$$

The home retention demand is written

$$C = g\ (P,Q) = Q - f\ (P,Q) \tag{3}$$

The following elasticities may be defined:

Partial price elasticity of M, given Q: $\alpha_P = \frac{\partial f}{\partial P} \cdot \frac{P}{M}$ (4)

Total price elasticity of M, with varying

$$Q: \alpha = \alpha_P + \alpha_Q \cdot \theta \tag{5}$$

where α_Q is output elasticity of M and θ is price elasticity of output.

---

[2]Even while marketing fall, the household can still diversify into non-rice consumption, due to price-induced income gains measured in non-rice terms.

[3]Non-rice income sources would likewise have the same effect as increasing output by I_n/P_r, or the effect of shifting the OA line by (I_n/P_x), where I_n represents non-rice income.

From equation (3), the relationship between P and Q, and C are derived as follows

Partial price elasticity of C, given

$$Q: \beta_P = -\frac{\partial f}{\partial P} \cdot \frac{P}{C} = -\frac{\partial f}{\partial P} \cdot \frac{P}{M} \cdot \frac{M}{C} = -\frac{M}{C} \cdot \alpha_P \qquad (6)$$

Output elasticity of C, with varying

$$Q: \beta_Q = \left(\frac{Q}{C} - \frac{M}{C} \cdot \alpha_Q \right)^{\dagger} \qquad (7)$$

Hence total price elasticity of demand for home retention is given by

$B=B_p+B_q.0$ where B_p is equation (6) and the second term is equation (7).

In the way we apply this framework to our data, production is of course given. Because farms are price takers, and because equilibrium market offers during the aman season can vary among farms, the price response of marketing is a real behavioral aspect. Total price elasticity is therefore a valid concept. Exogenously determined increases in paddy price during the aman season are likely to impact current marketing as well as acreage during the following boro season, given that the Bangladesh's rice economy now has two major rice crops harvested. The boro is an irrigated crop and has a high estimated price response of acreage of 0.88 (Rahman, 1986). It would be legitimate to use this estimate in order to get at total price elasticity of marketed surplus in the short run (i.e. during one crop year). In practice, we use a much lower estimate of price response of acreage appropriate for aman (see below).

The above framework is apposite when stock buildup during the period of interest is zero on average. This is likely to happen with annual or marketing-cycle data: private storage almost invariably is inter-seasonal. There is virtually no year-to-year storage by farmers. It usually does not pay to carry year-to-year

† More elaborately, $\beta_Q = \left(\frac{Q}{C} - \frac{\partial f}{\partial Q} \cdot \frac{Q}{M} \cdot \frac{M}{C} \right) = \left(\frac{Q}{C} - \alpha_Q \cdot \frac{M}{C} \right)$ (7)

storage. We already have noted that our objective is in explaining aman-paddy marketing. The seasonal focus of this paper calls for a slight reformulation.

Production, consumption, marketing and stock changes at the household level are all related by the equilibrium condition (using time subscripts):

$$M_t = Q_t - C_t - (CS_t - OS_t) = Q_t - C_t - \Delta ST_t \qquad (8)$$

where OS_t and CS_t are opening and closing stocks, respectively.[4] However, data availability does not allow us to take advantage of this rationalization. Hence, we shall try an alternative rationalization, consistent with the data. Seasonal changes in stock will depend on expected demand (consumption plus sales) in future. At one level, it is arguable that marketings during current season on the one hand, and absorption during the rest of the year will be simultaneously determined. But it is also arguable that households' behavior is conditioned by minimum end-of-season stock cutoffs. Such thresholds may be distributed lag functions of past closing stock data. If so, then changes in stock will be properly assumed exogenous. In this paper, the latter assumption is retained. It is not implausible either. The inclusion of stock changes implies that the estimated price and quantity elasticities are net of farmers' inter-seasonal disposal of rice output.

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[4]At equilibrium, each farm equates the net present value of future disposal at an <u>individual</u> discount rate with the proceeds from current marketing. The discount rate as well as the unit cost of storage may of course vary among individuals farmers. For instance, a farmer who is unable usually to raise HYV boro may use a lower discount rate. Likewise, a farmer who borrowed during planting time from money lenders on condition of repaying in cash after harvest will use a very high discount rate - may be infinity. Farms are assumed to be pricetakers. Hence equilibrium marketings can quite plausibly vary among farmers due to discount rate, or storage cost variations. The point here is that (8) is not just an identity: it has plausible behavioral undertone in it.

Estimation Method

Eq. (8) can be estimated as a single-equation model, or a two-equation recursive model. Opting for the first course of estimation is to treat all the explanatory variables as exogenous and, in particular, to assume that home consumption and marketings are determined independently of each other. This is the assumption retained by Toquero et. al (1975).[5] This however is not an entirely satisfactory assumption. There must be a presumption that market supply and home consumption are jointly influenced by price and income variables. There is in effect a simultaneity problem here, which needs resolution. One usually looks for a solution to this problem by identifying predetermined variables which are correlated with one of the jointly determined variables but independently distributed from the error term of the relevant equation. In a cross-sectional data, evaluation of an appropriate number of such predetermined variables does not admit an easy solution. This is because, at the household level, there are not too many variables which are correlated with the explanatory variable of a given endogenous variable without at the same time being correlated with the error term, that is, being outside the behavioral relationship at issue.

For example, <u>district</u> level average income can properly be assumed to be a predetermined variable in order to <u>identify</u> a <u>household</u> level consumption function. But in a cross-section framework, such regional data are often not available on a consistent basis. Given this difficulty, how did we get around the problem?

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[5]In an earlier version of this paper, we followed this procedure. The size of the household was used as a proxy for home consumption. The above assumption means that the home consumption function is being specified upto a single intercept term. The result obtained by the single-equation estimation are presented in Appendix I.

Our proposed solution is not a perfect one, but it is workable. We posit a two-equation household model.

$$C = f_1(F,D,L,HYV,Q) \quad (9)$$
$$M = f_2(P,C,Q,Q^2,\Delta ST) \quad (10)$$

where C = household consumption of rice, ex-production

F = household size

D = % of minors (upto 14 years of age) in household population

L = % of permanently attached farm laborers (PAL) in household population

HYV = A dummy variable taking the value of 1 for households which are suitably placed to raise a high-yield-variety (HYV) second paddy crop, and 0 otherwise

Q = Quantity of aman harvest

P = Pr

Eq (9) is a reduced form household-level consumption function. Household size and the proportion of minors are clearly predetermined at the beginning of the data reference period. The HYV dummy is assumed predetermined on the basis that whether it pays to grow HYV boro is largely a question of the farm's agro-ecological environment that transcends his individual control. Q is assumed predetermined because the production plan that eventuated in it was prior to the observational period. L is measured as of the beginning of sample period, and hence is properly assumed predetermined.

Eq. (10) is a market supply function where the effects of a simultaneous determination of M and C have been unscrambled by using the components of C attributable to predetermined variables in estimating it. In effect, the eq. (10)-- the supply function -- can be successfully identified from the household rice demand

function. The system of two equations, (9) and (10), is mathematically complete. The eq. (10) is overidentified. But by using a variant of instrumental variable method, it has been identified. The model in effect is recursive, where eq. (9) feeds into eq. (10), but not the other way round.

The system of estimating equation finally adopted in this paper is therefore the following:

$$C = a_0 + a_1F + a_2D + a_3L + a_4HYV + a_5Q + e_1 \quad (9a)$$

$$M = b_0 + b_1P + b_2C + b_3Q + b_4Q^2 + b_5\Delta ST + e_2 \quad (10a)$$

$$b_1 \gtrless 0;\ b_2 < 0;\ b_3 > 0;\ b_4 \gtrless 0;\ b_5 < 0$$

C_p stands for predicted consumption, and is entered as a proxy for the consumption of the household. The inclusion of the Q squarred term owes to the hypothesis that as production increases, given relative price, per capita consumption may increase less than proportionately, and that, therefore, marketings may increase more than proportionately.

A word may be in order about b_5 sign. Farm opening stocks for aman season are low. Closing stocks are much larger; many farmers like to spread the consumption of aman throughout the year. Therefore, ΔST would mostly have a positive sign. Current-season marketing and stock accumulation substitute for each other. Hence the a priori sign on ΔST is negative.

In this paper, we estimate α_p and α_p directly from a cross-section survey.

For a value of O, we rely on a recent study of price response of aman rice acreage, due to Rahman (1986). The fact that our estimates of partial and total price elasticities in the aman season are net of the effect of inter-seasonal allocation needs

underscoring, as is the fact that household rice consumption demand is identified from rice market supply.

The Data and Variable Definitions

The data have been generated by a farm level survey of 620 households selected from throughout Bangladesh. The reference period is the five-month-long marketing season of the aman crop, viz. mid-November 1989 through mid-April 1990. All data were retrospectively collected. (For more details about the survey, see Appendix-II.)

Aman production, Q, is evaluated as gross output net of a percentage relating to seed, feed and wastage, assumed at 10%. P represents weighted average price (net of transport costs) received by farmers for paddy sold during aman season, the proportions of coarse and noncoarse varieties in aman-season marketings being the weights. None of the alternative measures of P was deemed acceptable. For example, to use average price of village markets in sample area would have begged questions about whether they reflected the variety-mix appropriate for any given farm. If prospective unit prices are highly specific to the variety and grade of the paddy on offer, it seems more appropriate to use farm level prices received by the farmer, suitably averaged. This has been done in the present paper.

All other variables have been appropriately measured.

The presentation of the results is organized as follows. The presentation of the results for the overall sample is first dealt with. Subsequently, tests are conducted to probe for whether the model coefficients are stable across classificatory divides (e.g. large-small farms, surplus-deficit districts, etc.). This is done by generating regression results in a territorially segregated

manner, viz. for twelve surplus districts and nine deficit districts. Surplus districts are those which generated a surplus in their cereal production during 1988/89 over cereal "normative requirement" on government definition.[6] As we shall see, important differences separate the surplus district functions from the others, as also intensive HYV adopters versus others.

We then investigate the comparative marketing behavior of "small" and "large" farms. Operational units of upto 3.75 acres are denoted small and those exceeding 3.75 acres large. Finally, we present the function estimated for owner-operators and mixed farms. (For the latter, Q represents output on self-cultivated land plus output net of what is shared.)

Using Chow test, we then examine whether null hypotheses about equality of coefficients between sub-sample specific regressions are to be maintained. (Chow tests were conducted versus the second stage regression.) Residuals from the second stage regression were homoscedastic by Glejser-Park test.

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[6]16 oz. per person per day of total cereal intake. Surplus districts were the following. Thakurgaon, Dinajpur, Rangpur, Joypurhat, Bogra, Naogaon, Sylhet, Chittagong, and Sherpur, Rajshahi, Satkhira and Cox's Bazar. The deficit districts were: Tangail, Mymensingh, Netrokona, Comilla, Chandpur, Noakhali, Feni, Jessore and Patuakhali. In alternative computations, the functions were fitted for a reduced set of none consistently surplus districts: this set omitted Satkhira, Cox's Bazar and Rajshahi. The conclusions as to price responsiveness are more strongly to be made for this reduced set, while for the corresponding deficit districts, the price variable returns a negative coefficient.

RESULTS AND DISCUSSION

Table I puts the year of our immediate interest, viz. 1989/90, in a historical context. It presents rice production, rice area planted with HYV strains and rice marketed surplus ratio for Bangladesh. The highlight of this information is in the gross MS ratio over time. This ratio has risen over time, from 34% in 1976/77-1978/79 to 49% in 1989/90. The overall quantity marketed indicates the size of the private rice market. Total marketing rose from 4.25 to 8.7 million metric tons (MMT) in 1989/90 - a compound growth rate of 5.8% per annum. That the size of private marketing of rice rose by more than twice the growth rate of population during this period is notable,[7] and echoes the favorable assessments of other observers (Crow, 1987). We note, too, that the proportion of HYV rice strains, in both aman as well as in total acreage, has been steadily increasing. The size of commodity markets reflects the degree of commercialization, with which technological change is usually thought to be directly related. The positive association between marketed surplus ratio and the HYV ratio is therefore suggestive.

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[7]Real price of coarse rice has over this period risen at about 1.5% per annum. Per capita income in the aggregate grew at 1.7% per year during this period. The rate of increase of the size of the rice market over and above the rate of increase of production is not quite matched by the change in incomes. But certain labor market developments specific to the 1980s can shed additional light. Growing yearround labor demand has increased the proportion of recruitment of permanently attached farm labor on farm. This class of laborers is largely paid wages in the form of large individual meals. Each PAL is estimated in IFPRI Farm Survey to consume about 1 kg. of rice a day, throughout the year. Their intensity of energy output, too, is roughly 1.7 times that of a sedentary male in rural farm households.

Table I — Growing Farm Technological Change and Commercialization in Bangladesh's Rice Economy, 1979-1990

Year(s)	Net Production (MMT)	Proportion of area planted with HYVs		Estimated marketed surplus ratio	Gross surplus (000 MT)
		Aman	Total		
1976/77-1978/79	12.5	6	13	34.0[a]	4250
1979/80-1981/82	13.4	16	21	36.0[a]	4824
1982/83-1984/85	14.4	18	26	38.7[a]	5573
1986-1987	15.4	21	30	42.0[a]	6468
1989-1990	18.2	28	38	49.0	8722

Notes: (a) These averaqes are computed from Dr. Madan Dey Ph. D dissertation (Dey 1988). The estimate for 1986/87 is from Dr. Akhter Ahmed Ph. D thesis (Ahmed 1990). For 1989/90, this is a direct estimate in which data from IFPRI Farm Survey were used.

Table II presents the regression results. Three observations seem apposite at this juncture. First, the functions estimated across "small farm-large farm", high-low HYV adopters, and surplus-deficit district divides are not equivalent, according to the Chow test. For the surplus-deficit district divide, the F statistic with 6,608 d.f. is 3.36 and significant at 5% probability level. For the high-low adopter divide, the F statistic with 6,608 d.f. is 6.1 and is highly significant. In both cases, the significant difference is owing, in large measure, to a positive response of marketings to price. These are the three analytically most significant divides conceivable in the present context. This means that aggregate results are less substantive than are sectional ones. This is not surprising: marketing and home retention are likely to be related to economic opportunities and constraints of the household. Therefore, our interpretations will seek to underscore the sectional results. The aggregate results are entered for the statistical record. Second, for each of the cross-sectional divides, the model fits the data very well index. This is invariably true of the model cast at the house hold level. But this is also true when a per capita form is used. Each coefficient has the a priori sign, and all other behavioral variables are highly significant in the sample equation. Even price variable is significant half of the times. The R_s^{-2} for all functions are quite adequate. The F-statistics, which can test the joint the significance of all explanatory variables, are all highly significant.

Second, the coefficient on Q is everywhere significantly positive, and that on the Q^2 term is positive too. This strongly suggests that current marketing, controlling for future marketings, increases disproportionately with output. Similar results were obtained by Toquero et al. (1975). C and ΔST always reduce quantity marketed. And there is a statistically significant

Table II — Determinants of Aman paddy marketed, 1989/90: 2SLS Results

Explanatory variables	All farms (N=620)	Small farms (N=375)	Large farms (N=245)	Owner-operatory farms (N=462)	Owner-cum-tenants (N=158)	Low HYV adopters (N=328)	High HYV adopters (N=292)	Farms in surplus districts (N=410)	Farm in deficit districts (N=210)
Constant	0.78 (4.25)	3.99 (2.59)	6.37 (13.2)	-2.26 (5.53)	7.04 (4.77)	1.985 (5.81)	-2.78 (6.39)	-4.33 (6.06)	5.28 (6.55)
P	0.024 (0.017)	0.01 (0.0098)	0.002 (0.055)	0.039 (0.022)	-0.018 (0.021)	0.014 (0.0235)	0.043* (0.02)	0.062* (0.026)	0.006 (0.024)
Q	0.84* (0.023)	0.97* (0.028)	0.83* (0.048)	0.83* (0.028)	0.95* (0.049)	0.799* 0.034	0.95* (0.033)	0.80* (0.033)	0.866* (0.056)
Q^2	0.00013* (0.00003)	0.00002 (0.00005)	0.0001* (0.00006)	0.0001* (0.00004)	0.0001 (0.0001)	0.0001* (0.00004)	0.0001* (0.00005)	0.0002* (0.00005)	0.0001* (0.00005)
C	-0.87* (0.087)	-1.024* (0.063)	-0.86* (0.18)	-0.86* (0.115)	-0.94* (0.095)	-0.78* (0.135)	-1.069* (0.097)	-0.97* (0.103)	-0.88* (0.17)
ΔST	-0.58* (0.023)	-0.87* (0.035)	-0.55* (0.036)	-056* (0.027)	-0.80* (0.047)	0.51* (0.031)	-0.77* (0.036)	-0.54* (0.026)	-0.67* (0.06)
R^2	0.917	0.916	0.901	0.917	0.93	0.91	0.94	0.924	0.89
F	1363.96	800.78	432.61	1008.2	406.86	661.78	912.47	983.04	338.94
SER	22.745	11.04	33	25.03	13.24	25.94	17.0	22.74	22.0
$\bar{M}$	61.1	33.98	102.62	64.23	51.95	62.63	59.38	73.11	37.66

Notes: $\bar{M}$ denotes average of quantity marketed.

* denotes significance at 5% error level.

Standard errors are in parenthese.

tradeoff between current marketing and setasides for future, controlling for current-period consumption.

The price response of marketed surplus significantly positive for the high adopters and for the surplus-district farmers. At first sight, this result about the impotence of prices to significantly mobilize marketed surplus for the low adopters and the deficit districts, given the cross-section data, is not too surprising. It is true of course that on most subsamples presently, prices have a much lower variance than production. But the point is that an inference of a significant causality can survive small variance of the explanatory variable. If there were a causality between prices and quantities marketed, then, whatever the explanatory variable variances, the regression coefficients would have been significant.[8] We shall therefore maintain that low adopters and deficit-district farms display significantly lower price responsiveness in their marketing behavior.

A disaggregation of all subsequent results using surplus-deficit divide, as also the technology adoption seems appropriate. This should also inform the presentation of the elasticities. However, we should perhaps include some information at this stage regarding the characteristics of the rice economies of the surplus and deficit districts. This is done in Table III.

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[8]Note that some models fit the data very well as judged by R^2 but with none of the explanatory variables significant. This may happen when both the dependent variable and the "explanatory" variables are explained by underlying variables not in the model.

Table III
Production and Marketing Regimes in Surplus and Deficit Districts, 1989/90 Aman Season.

Farm type	Surplus District							Deficit District						
	Own land (acre)	Operated land (acre)	Family size	Output	Marketing	HYV-ratio (%)	Average price	Own land	Operated land	Family size	Output	Marketing	HYV ratio (%)	Average price
Small	4.9	1.1	7.9	81	35	46	199	3.5	1.5	8.5	45	15	44	194
Medium	5.9	4.2	9.3	130	65	43	213	5.8	4.1	10.2	101	48	36	214
Large	13.2	11.1	12.9	328	218	33	222	22.5	14.8	11.2	428	253	7	206
All	6.4	4.0	9.3	137	72	40	214	5.2	3.2	9.5	84	39	34	209

Note: The number of small, medium and large farms were 97, 105 and 6 in the deficit districts; and 114, 256 and 42 in the surplus districts.

For both types of districts, operated land per farm is less than owned land. These farms rent out land on a net basis to farmers not in the sample.

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The following observations are prompted by Table III. First, the average farmer in the surplus district owns more land than the corresponding variable in the deficit district. For both regions, operated land per farm is 38% lower than owned land, implying that the size of the land rental market does not differ between the two types of districts. Nor does the family size differ significantly. Secondly, paddy output obtained per acre of operated land is significantly higher (34 mds) in the surplus district, as against 26 mds. for the deficit district. Marketing per unit of operated land is one third lower in the deficit districts, while the matched output is less than one fourth lower. The weighted proportion of HYV aman in total aman land is 40% for the surplus districts, as against 34% for the deficit districts, while the price per maund received is higher. The highlight of this comparison is in the extent of the adoption of modern farm technology being higher in the surplus districts. By other indicators of technological modernization, the surplus districts outperform deficit ones more visibly: fertilizer use per acre treated averages at 128 Kg. in the surplus districts, as against 63 Kgs. in the deficit district.[9] The advantage of the surplus districts in the adoption of modern technology is therefore to be conceded.

The surplus districts have, moreover, the balance of the physical infrastructure endowment firmly in their favor. First, all-weather road mileage per thousand population in the surplus districts is more than three times that in the deficit districts. Greater infrastructural performance amounts to lower unit transportation and transaction costs in grain trade, thus attracting paddy traders away from deficit districts. Likewise, the surplus districts retain the balance of the rice milling capacity in the country. The number of licensed rice mills - the

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[9]It has been argued that fertilizer use is more suggestive an indicator of the adoption of modern technology than the percentage of adopter of HYVs. (Hossain, 1988).

processors of paddy - per thousand population in the surplus districts is higher than for the deficit districts by a factor of five. This means that the sources of demand and supply are relatively contiguously located in the surplus districts.

Table IV presents the partial elasticities of marketed surplus. The outstanding feature of this information is about the partial output elasticities: they are invariably and significantly greater than one.[10],[11] Price elasticities are generally small by comparison. Consumption elasticities have comparatively larger role to play. Note, too, that consumption elasticity of marketed supply is significantly higher for small farm than for large ones, and for deficit districts than for surplus ones. Increased dependency, which raises subsistence requirement reduces the commercialization of production activity, more so on the small farms, and deficit districts. Note, too, that the average farm-size in the deficit districts is lower.

A low partial price elasticity may be consistent with a high total price elasticity, if the price response of aman output associated with production adjustments before harvests is relatively high. (For example, short run price elasticity of supply for the main dry-season boro rice 0.88). Hence it is important to calculate total price elasticity of marketed surplus using actual estimates of price elasticity of supply. This is done in Table V. (The estimates of 0 are from Rahman's paper (Rahman, 1986).

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[10]For all farms, the data were transformed into natural logarithm. Log-linear regression was run. The null hypothesis that the coefficient of the logarithm of output was unitary was rejected at 1% level for each of the functions fitted.

[11]Partial output elasticity of 1.4 was reported for a Filipino data set of rice growing farm for the early 1970s (Toquero et al., 1975).

Partial price elasticity of marketed surplus is 0.08 overall, while the output elasticity is as large as 1.64. Total price elasticity is 0.29 in the short run, and 0.54 in the long.

The estimate of the partial price elasticity of home retention (B_p) is, -0.06 and that of output elasticity is 0.33. Total price elasticity of home retention is -.04 in the short run. In the long run, the total price elasticity is small and positive for the overall sample.

Regional Focus versus the Marketing Elasticities

Clearly, it is warranted to proceed beyond an aggregate analysis, as we have already noted that the average farm in the surplus differs significantly in marketing behavior from that in the deficit districts. Hence it is necessary to compute the elasticities separately. Some important distinctions now emerge. First, most price elasticities are small, but they are generally much lower, absolutely, for the deficit-district farms than for the surplus-district farms. The latter are more price responsive. Second, they are more output responsive, too. Given the significant differences between these two estimated functions for surplus and deficit districts, the estimated elasticities are also significantly different. This further implies that the probable reasons for the greater price responsiveness of the surplus-district deserve greater analysis, to which we may now turn.

Greater price responsiveness, when demonstrated, is an important economic information. By itself, this indicates a positives feature in agricultural development. When this is caused, even partly, by the adoption of improved technology, this is even more interesting, for reasons to be detailed shortly. Presently, we ask ourselves what makes for the greater price responsiveness by the average farm in the surplus districts.

Table IV

Partial Elasticities of Gross Marketed Surplus

Explanatory variables	All farms	Small farms	Large farms	Farms in surplus districts	Farms in deficit districts
Price	.061	.065	.004	.18	.032
Q	1.64	2.23	1.48	1.52	1.91
C	-0.47	-0.86	-0.33	-0.44	-0.72
ΔST	-0.31	-0.56	-0.27	-0.28	-0.40

Note: These estimates use coefficients of eq. (10) in the text, and arithmetic mean of the variables in the right hand side of that equation.

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Table V
Total Elasticities of Gross Marketed Surplus at Variable Means: Usuing 2SLS Coefficients

Market supply elasticities partial elasticities	All farms	Surplus district	Deficit district	High HYV adopters	Low HYV adopter	Large farm	Small farm
Price (α_p)	0.08	0.18	0.03	0.155	0.044	0.004	0.065
Output (α_q)	1.64	1.52	1.91	1.86	1.56	1.48	2.23
Total price elasticity (α)							
Short run	0.29	0.38	0.28	0.40	0.25	0.20	0.36
Long run	0.54	0.81	0.7	0.68	0.53	0.42	0.76
Home retention elasticities partial elasticities							
Price (B_p)	-0.058	-0.202	-0.027	-0.16	-0.047	-0.005	-0.05
Output (B_q)	0.33	0.415	0.24	0.11	0.41	0.38	0.054
Total price elasticities							
Short run	-0.042	-0.148	0.004	-0.146	0.006	0.045	-0.043
Long run	0.007	-0.086	0.039	-0.13	0.067	0.105	-0.035

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Greater price responsiveness may result from one or more of the following: (a) greater adoption of modern variety strains which increases the proportion of cash costs of cultivation (Hossain, 1990). (b) better physical infrastructural endowment; (c) sizeable concentration of paddy processors; (d) the seasonality of demand for associated with seasonal pattern of farm input purchase or of non agricultural income generation. (For example, the HYV proportion in total boro/aus land and therefore the demand for purchased inputs per unit of land may be higher in surplus districts. Also, the proportion of hired workers in total labor demand may be higher.)

We have already seen that surplus districts have an advantage versus (a), (b) and (c) above. Now it will be argued that these three in combination can yield a behavior of greater price responsiveness of marketings. The argument is that a favorable agro-industrial and infrastructural endowment would place the sources of demand for and supply of paddy in a relatively contiguous spatial setting. Those sources would interact in exchange. But such trading can, so to speak, take place at "an arm's length". In such a setting, suppliers' can, at no or little cost, acquire information about expected demand at a future date. Movement in supply out of storage can thus better anticipate expected price movements. Suppliers' would normally have a forward-bending supply schedule. Such behavior and such a setting would combine to produce price responsive marketing.

As for (d), the decision to adopt HYV boro brings in its wake a certain seasonality of the demand for labor. The modern varieties generates proportionately greater demand for <u>hired</u> labor during transplanting, weeding and harvesting relative to traditional varieties. Transplanting for HYV boro begins in earnest in January/February in most areas, thus generating a seasonal peak in farm demand for liquidity. As it happens, aman

prices seasonally firm from January onwards. The decision to adopt HYVs in boro cultivation thus implies a demand-included seasonality of marketing in favor of months of rising prices. Average farm in the surplus districts has been shown to have a higher proportion of land under HYV. Expectedly, these farms have a significant price response of marketing.[12] We conclude therefore that the surplus-district farms are more price elastic. The average farm in the deficit districts is more output elastic, however. Because the partial price elasticity of marketed surplus dominates the calculation of total price elasticity, the surplus district farms return higher overall price elasticities in marketing. Again, the total price elasticities of home retention are significantly larger for the surplus district farmers and the high adopters, in both the short and long runs. These results have some important distributional implications, as between the surplus and deficit districts (Table VI).

The point, baldly put, says that the average farm in the surplus district is already larger in size, is technologically more forward, has higher land productivity and, a larger gross marketed surplus ratio, and take advantage of higher prices, as compared with the average farm in the deficit district. Relatively strong interactions loom within the behavior of this group of farmers involving choice of technology, the demand for purchased inputs and the necessity to "play the market" while generating the requisite cash resources. Here rice production and marketing are seen to be

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[12]It may well be argued that the increased marketing in January by the high adopter is associated with, but not caused by, seasonal increase in prices, and that, therefore, the term "price response" may be not warranted. This is conceded here. However, it seems worth stressing that our data suggest that, for the average farm in both surplus and deficit districts, revenue from paddy sales during January is much larger than labor payments during that month. Hence even in January, factors other than demand for labor motivate sales. We shall assume that one of these is the desire to raise revenues received per unit of sale.

Table VI

Percentage share of Different Farm Size Classes in Deficit and Surplus Districts in the Paddy Market, 1989/90

	Population	Operated land	Owned land	Production	Marketing	Stock building	Revenue from sale
Deficit districts	33	29	29	23	21	22	20.8
Small	14	6	9	6	4	3	3.5
Medium	18	19	16	14	13	14	13.4
Large	1	4	4	3	4	5	3.9
Surplus districts	66	71	71	77	79	77	79.2
Small	16	11	15	12	11	13	10
Medium	41	46	41	46	44	47	43.7
Large	9	14	15	19	24	17	25.3

Note: Small farms have upto 2.49 acre of operated land; medium farms have between 2.5 and 7.49 acre; large farms have more them 7.5 acres.

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mutually reinforcing each other in a seasonal process, and through the market place. The surplus districts therefore seem welplaced to combine technological change and commercialization more effectively. Hence the time path of productivity and farm incomes for the average farm ln the surplus districts will be more positively sloped relative to the deficit districts (Table VI).

Public Procurement Policy

Before proceeding any further, let us make one clarificatory observation. Public procurement was not an important factor in causing greater price responsiveness of surplus districts. The expectation of such a connection may wise for the following reason. If public purchase can support farm prices at a declared floor level for those who transact with the government, average prices realized by a given farmer may fall below the latter when he can not directly seel to the government. A positive price response of marketing must mean more sales when prospective prices are higher on average. Farms which can switch supplies from the private to the public tier of rice market, and back, in response to price signals will display greater price responsiveness.

Public procurement out of the aman crop during 1989/90 was about 4.25 lakh tons. It was about 11% the privately marketed supply out of the aman crop. This was a year of large procurement effort by the government. But only 3% of the surplus-district households sampled in the IFPRI Farm Survey had sold directly to the public procurers. Sales to public procurers accounted for 2.7% of the matched supply on the sample. About eighty percent of the government's procurement of paddy was in the form of milled rice equivalent from licensed rice mills, purchasing paddy privately. The government paid the miller at the rate of Tk 220 for each maund of paddy because that was the price below which coarse paddy was not to fall. Coarse paddy prices that farmers had received during

the crucial months of November and December of 1989, and even January 1990, remained below Tk 220 per maund.[13] The difference between administered and market prices represented rent in the system. Public procurement thus bought grain from the private sector without having really firming market paddy prices. Seasonal price changes were the result very largely of the interaction of private demand and supply. And seasonal movements in marketed supply were better orchestrated in the surplus districts to take advantage of such changes. Monthly distribution of sales for surplus and deficit districts separately support this. Public procurement, therefore, is not an issue in interpretting results of this paper.

Policy Implications of the Study

Because prices do not in the general case significantly directly influence market offering of aman paddy, the theoretical validity of a country-wide output price support program - one that does not really exist now - is called into question. But the general validity of yield - enhancing policies, e.g. in the areas of irrigation and drainage, agricultural research and extension, and in physical infrastructure is strongly demonstrated in these results.[14]

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[13]For a description of the conditions under which public procurement from licensed rice mills took place in 1989/90, see Ahmed et al. (1991).

[14] A companion paper by the author has demonstrated that the aman farmer can raise his yield by raising fertilizer use per unit of land on both local transplant as well as HYVs, but by reducing labor intensity in the cultivation of the HYVs. The labor intensity ought to be <u>increased</u> in the production of local transplant varieties in the interest of achieving allocative efficiency. That paper arrived at this conclusion after evaluating the alternative performance of three production function forms, viz. the translog, the quadratic and the Cobb Douglas.

The greater price responsiveness in the surplus districts does not appear to justify a two - slab output procurement system where the government buys at a higher rate in a small number of surplus districts than in the large number of deficit districts. Quite besides the political difficulties of such an approach, it would amount to a public underwriting of accentuation of regional disparities.

The results seem to bring to the centre of the stage issues of public investment in agriculture, and of the pricing of irrigation, to the relative disadvantage of output price support policies.

The second policy implication has to do with the lag on the part of the deficit districts in the degree of their commercialization in marketing behavior. Inasmuch as the lag is induced by low diffusion of modern farm technology, policy will want to tackle the drainage problem which in many areas constrain a changeover to modern aman varieties. Because of its regional character, relaxing a drainage-induced constraint will reduce the adoption differential between the deficit and surplus districts. Inasmuch as the low yield rates in deficit districts are due to higher unit fertilizer prices associated with poor state of physical infrastructure, then sectoral allocation of public investment will have to heed this.

Table AI.1

Determinants of Aman paddy marketed, 1989/90

Explanatory variables	All farms (N=620)	Small farms (N=375)	Large farms (N=247)	Owner-operatory farms (N=463)	Owner-cum-tenants (N=157)	Low HYV adopters (N=328)	High HYV adopters (N=292)	Farms in surplus districts (N=411)	Farm in deficit districts (N=209)
Constant	-2.66 (4.2)	2.35 (2.5)	-1.24 (12)	-4.23 (4.38)	4.17 (9.9)	-1.08 (5.6)	-7.62 (6.2)	-5.32 (5.80)	1.88 (6.17)
FAMSIZE	-2.378* (.24)	-2.94* (.18)	-2.174* (.48)	-2.357* (.254)	-2.62* (.71)	-2.14* (.39)	-2.85* (.27)	-2.78* (.31)	-2.29* (.43)
Q	0.805* (.022)	.92* (.03)	0.80* (.046)	0.804* (.023)	1.058* (.12)	.77* .032	.90* (.03)	0.763* (.033)	0.841* (.053)
Q^2	0.0001* (0.00003)	.00002 (.00005)	0.0001* (.00005)	.0001* (.00003)	.00008* (.0003)	.00013* (.00004)	.00012* (.00005)	.0002* (.00005)	.0001* (.00005)
P	.027 (.017)	.011 (.01)	.015 (.054)	0.033 (0.018)	-.038 (.04)	0.014 (.02)	.052* (.025)	0.057* (0.247)	.0067 (.024)
ΔST	-.577* (.023)	-0.86* (0.035)	-.545* (.034)	-0564* (.023)	-1.13* (.095)	-0.50* (.031)	-0.76* (.035)	-0.53* (.026)	-0.676* (.06)
R^{-2}	0.916	0.913	0.897	0.917	.946	0.91	0.94	0.922	0.89
F	1351	791	413	1288	128	657	899	977	341
SER	22.8	11.1	33	23.1	13	26	17	23	22
$\bar{M}$	61.1	34.0	102	61.5	54	63	59	72	39

Notes: $\bar{M}$ denotes average of quantity marketed.

Standard errors are in parentheses. * denotes significance at 5% probability level of error.

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Table AI.2

Total Elasticities of Gross Marketed Surplus at Variable Means

Market supply elasticities partial elasticities	All farms	Surplus district	Deficit district	High HYV adopters	Low HYV adopter	Large farm	Small farm
Price (α_p)	.09	.165	.035	.19	.045	.032	.071
Output (α_q)	1.57	1.45	1.82	1.77	1.5	1.42	2.11
Total price elasticity (α)							
Short run	0.29	.35	.27	.42	0.24	.22	.34
Long run	0.53	.57	0.54	.68	.48	.43	.66
Home retention elasticities partial elasticities							
Price (B_p)	-.09	-.16	-.03	-0.20	-.047	-.041	-.055
Output (B_q)	.40	.50	0.30	0.20	.47	.46	.14
Total price elasticities							
Short run	-.04	-.12	.01	-.17	.01	.019	-.036
Long run	.02	-.04	.05	-.14	.084	.088	-.014

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Data and Methodology

The data have been generated from a Bangladesh-wide sample of 620 farm-level interviews, investigating production, marketing, storage of rice in Bangladesh. The reference year is 1989/90. All major agro-climatic zones of the country were represented in the survey. It has recently been shown that the results of this survey in many important respects are reassuringly similar with a much larger countrywide sample survey conducted by a distinguished team led by Dr. Mahabub Hossain of Bangladesh Institute of Development Studies (BIDS) in the course of a joint BIDS-IRRI study (Ahmed et. al., (1991). These similarities involve (a) yield rate of paddy; (b) the proportion of HYV aman in total area; (c) cost of purchased input per acre in paddy cultivation; (d) labor use per acre, for both local transplant and HYV aman varieties; (e) total cost of cultivation of paddy. The relative smallness of the sample permitted a close supervision of data collection, and thorough cleaning of the data. IFPRI survey results are representative of the country while its size is about half that of BIDS/IRRI study.

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