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INTERACTIONS BETWEEN PRIVATE RICE STOCKS AND PUBLIC STOCK POLICY IN BANGLADESH: EVIDENCE FOR A CROWDING OUT

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Abstract

This paper shows that amid growing technological change, rice in Bangladesh has become a seasonal, rather than an annual, crop, with profound implications for the seasonality of prices, average period for private storage and the strength of the rationale for public rice storage. It is further shown that rice prices are determined in the process of interaction between market supply, future prices (proxied by public stocks) and onfarm demand for storage. The responsiveness of market prices to changes in public and private stocks is in opposite directions, as one would expect. However, farm stocks are far more potent in determining market prices than are public stocks. Evidence suggests, too, that public stocks significantly squeeze private rice stocks, although not farm-level stocks. Two policy - relevant conclusions emerge from the paper. One, that public stocks have to be pared back in order to provide a level playing field for private storers. Two, there should be a public effort to generate and disseminate information regarding the magnitude of private stocks, which have acquired the connotations of a public good.

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I Introduction

Price band policies using some variation of "buffer stocks" have been a common feature of food policies in several developing countries in the 1980s (Krishna and Chibber, 1983; Goletti et al, 1991). The underlying storage rules were usually formulated in a production context featuring one or two major annual crops --- a context that has been dramatically transformed by irrigation-led "green revolution." Price seasonals were typically large for these annual crops. Containment of such large price seasonals translated into fairly substantial public stock targets. For example, the government of Bangladesh had mandated itself to hold as much as 1.5 million metric tons (MMT) of foodgrains in storage on July 1 of every year by way of buffer stocks, working stocks and security stock (GOB, 1988).[1] This was nearly six times "normal" monthly injection during the 1980s. The analytical document underpinning this particular policy intent was probably prepared by World Bank staff in 1979, before largescale diffusion of high-yield-variety (HYV) rice.

Maintenance of such large quantities of grains within crop years has usually been expensive. And the costs of such storage have been an important part of the overall costs of public food distribution system. In Bangladesh, for example, food subsidies during 1989/90 amounted to US

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[1]This was at any rate the intent of public stock policy enunciated in clear print. In reality, the government usually could manage to hold in July storage a little over 1 MMT. The lion's share of additions to public storage were usually sourced from aid shipments. And the donors could not or perhaps would not ship enough grains for the government to realize the intent of the stock policy.

dollar 344 million, equivalent to a significant proportion of the government's own contribution to the financing of the country's annual development plan in that year. In sum, price band policies have been quite costly in budgetary terms.

Diffusion of seed-fertilizer-water technology has, meantime, given rise to large output increments during the dry season. Relative harvest shares of the wet and dry seasons in the year have tended towards essential equality (Chowdhury and Ahmed, 1993). Rice has changed from being an annual crop for purposes of intra-year storage to a seasonal crop. In these circumstances, rice seasonals, as Bouis pointed out (1983), are likely to be dramatically reduced as in the Philippines (Bouis, 1983) and Bangladesh (Chowdhury, 1992a). Technological progress has, moreover, been accompanied by growing commercialization (Chowdhury and Ahmed, 1993). The latter has spawned a state of relative financial solvency, especially among medium and large farms (Chowdhury and Ahmed, 1993). Instead of distress sales which, no doubt, characterized much of the peasantry in the past, the farmers now have both ample storage capacity, and fairly large stocks (Chowdhury 1992b). The diffusion of farm technology in rice cultivation has had very profound changes in the costs, incentives and constraints affecting private adjustment in grain markets. For instance, typical storage period for traders' stocks fell from seven months in late 1960s (Farruk, 1972) to about two months in 1990 (Chowdhury, 1992b). Presently, the point we want to make is that very little of these no doubt epochal changes have been integrated in the mainsprings of public stock policy. The latter is still implemented in the same costly way, partly because no one knows what the empirical relationships are between public stocks, private stocks and market prices.

Table I -- Rice production by wet and dry season, 1976-1992

Year	Wet season (000 MT)	Dry season (000 MT)	All season (000 MT)	Share (%)	
				Wet season	Dryseason
1975/76-79/80	7336.8	5278	12614.8	58.16	41.84
1980/81-84/85	7728.4	6443.8	14172.2	54.53	45.47
1985/86-89/90	8110.6	7780.6	15891.2	51.04	48.96
1990/91	9167	8685	17852	51.35	48.65
1991/92	9268	8983	18251	50.78	49.22

Source: BBS production data.

Objectives of the paper

In the light of the foregoing, this paper examines the following two important questions:

(a) In what manner do public stocks and private stocks together determine market price ?

(b) Does public stock crowd out private stock regardless of who owns the latter ?

This paper is structured as follows. The next section will briefly review the literature on this topic for Bangladesh and present the analytical framework and the data sources. Section III reports the results of the paper. Sections IV then summarizes the paper.

II Analytical Methods and Data

In the short run, rice prices are largely determined through a process of interaction between the private exchange system, and the public foodgrain distribution system (PFDS). Rice remains a subsistence crop, with strong interdependence between consumption and production. Given production, the private exchange involves a complex interaction between farm-level consumption, storage and marketing decisions. (In a more elaborate model, production would better be considered endogenous.) The PFDS is the locus of a variety of public interventions in the grain markets by way of procurement, offtake, imports and stock decisions.

In most recent analytical pricing-policy work in Bangladesh, one point of departure has been the recognition that public foodgrain stocks are a nodal point of the private-public interactions in the rice market.[2] In particular, Goletti et al. show that for both rice and wheat opening public stocks have an important negative effect on future prices. More to the point, Goletti et al show that current prices of rice increase with future prices. This pair of evidence was posited at the heart of IFPRI's optimal stock model for Bangladesh: the intuition was that public stocks could be optimally varied to achieve plausible range of price stability objectives of the government. In that particular model, the determination of rice prices was derived from a foundation involving the demand for both final consumption and private storage on the demand side

[2]Virtually all of this work has been done at the IFPRI, most recently at the Bangladesh Food Policy Project. See Goletti et al (1991) and Chowdhury (1990).

(Goletti et al, 1991, appendix 3). The influence of storage demand on prices was indirectly captured by lagged and future prices, as direct measurements were not available.

There are three main reasons why this paper attempts to go beyond having a transparent understanding of how to stabilize market prices through public stock action. First, we need to have an understanding, however elementary, of how private foodgrain stocks affects market prices. In Bangladesh, private rice stocks on average are more than three times as combined large as public stocks. The capacity of private storers together to influence prices is thus much greater. Second, by all accounts, private traders can move their stocks about more cheaply than can the government. Presently, there is no hard knowledge about the private stock - market price causality. If private storage demand can significantly change prices, at least a tradeoff (option) between using public stock quantity targets and inducing private adjustments to achieve a well-defined price stability objective will have been demonstrated. Third, virtually any worthwhile discourse on price policy begs the question of the <u>level</u> of private stocks.

The Analytical Framework

In equilibrium, we posit that demand for rice equates supply for each market,

$$D_t = S_t \tag{1}$$

In this district level model, market supply derives from net production plus net distribution from the PFDS plus net "imports" from other districts. Or,

$$S_{i,t} = q_{i,t} + O_{i,t} - G_{i,t} + X_{i,t} \quad (2)$$

where $q_{i,t}$ = rice production at time t
$O_{i,t}$ = rice offtake, monetized plus others
$G_{i,t}$ = procurement
$X_{i,t}$ = net imports from other districts

As pointed out by Goletti et al., the total rice demand equals consumption demand and storage demand. Or,

$$D_t = C_t + \Delta I_t \quad (3)$$

Equation 1 implies that supply of rice during any time interval will either go into consumption or be part of demand for stocks

$$S_t = C_t + \Delta I_t \quad (4)$$

where S = rice supply during period t
C = rice consumption
ΔI = $I_{t+1} - I_t$ = changes in private stock of rice.[3]

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[3] $\Delta I = \Delta FI + \Delta TI$, where ΔFI = onfarm stock (from production) and ΔTI = trade stocks. For the moment, we assume that farmers and traders display the same causal behavior in matters of rice stock. This may not be a valid assumption, as we shall see later. To anticipate that discussion, traders may have a different model of stock behavior from farmers. The point remains that farm stocks are the primary, motherlode, version of Bangladesh's rice stock. In Bangladesh, where very little rice is imported, farm stocks evolve into trade stocks over time. These reasons suggest that we estimate the model in two versions: a full model where private stocks sum over farm and trade stock, and where market supply relates to total supply; and a truncated model where either farm stocks or trade stocks alone are considered, and where market supply is output minus public procurement. In this last version, offtake is omitted from market supply, on the ground that the great

(Footnote continued)

I_t = Carryin of rice

I_{t+1} = Carryout of rice

While we have firsthand estimates of private stocks by districts, consumption is not similarly available. Consumption has to be treated relative to underlying variables, like rice price and district income.[4] That is,

$$C_{i,t} = f_1 \ (P_{i,t}, \ Y_{i,t}, \ P^w_{i,t}) \qquad (5)$$

where $P^w_{i,t}$ = price of wheat

A simple seasonal model of private stock is proposed. Stocks in this context are held by farmers and traders. In the main two factors govern their size of inventories, the size of the harvests and the structure of prices. As for any other storable crop with a marked seasonality, stocks are influenced by the size of available supplies. Farm stocks are the largest in the months immediately following harvest. They decline through the rest of the season, as the grain is consumed. This suggests that seasonal harvest size be included as one explanatory variable.

Structure of prices, intertemporally, will matter, too. Inasmuch as agents are amenable to incentives to arbitrage across time, stocks will depend on the difference between

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bulk of rice offtake sidesteps the class of rice cultivators or traders who matter as regards farm stocks for arbitrage purposes. This is admittedly an adhoc procedure. But it is less arbitrary than assuming that supply and demand balance, where changes in stock relates to farm stocks alone or trade stocks alone.

[4]Presently, we had to omit wheat prices as another underlying variable.

expected and current price: they will be adjusted according to expectations of future prices. Expected price is unobserveable of course. We used an instrumental variable method to predict prices. Additionally, we used prices lagged one period in recognition of the fact that a distributed lag on past prices could, in theory, more proximately influence market agents' own forecasts. It is thus that we use lagged price, current price and expected price in the stock equation.

Whether governmental stock operations squeeze out private stocks is a key motivation of this exercise. And finally, given that actual stocks may adjust only partially to the desired level, lagged endogenous variable will be used as another explanatory variable. Two dummy variables have been used. One of them is a dummy variable, taking value of 1 during the boro season, and zero otherwise. The other is a dummy variable, taking the value of 1 for progressive districts, and zero otherwise.

This discussion suggests the following specifications

$$I_t = I_1 (Q_t, P_{t-1}, P_t, E_tP_{t+1}, GI_t, I_{t-1}, D_1, D_2) \quad (6)$$

$$I_{t+1} = I_2 (O_{t+1}, P_t, P_{t+1}, E_{t+1}P_{t+2}, GI_{t+1}, I_t, D1, D_2) \quad (7)$$

$$\Delta I_{t+1} = I_3 (\Delta Q_{t+1}, \Delta P_t, \Delta P_{t+1}, E_{t+1}P_{t+2}-E_tP_{t+1}, \Delta GI_{t+1}, \Delta I_t, D_1, D_2) \quad (8)$$

The last equation states that changes in private stock depends on changes in prices in this and the previous period, changes this period in expected price, changes in government stocks and in the dependent variable this period, and the two dummy variables. Ideally, we ought to work in

terms of changes in stock. But the data better sustain a model using levels, rather than changes.[5]

Public procurement of rice

Because public procurement of rice is the major instrument for the mobilization of public stocks, the model endogenizes public procurement. The analytical foundation of this has been outlined in Goletti (1991). The argument is that, while the demand for rice in public procurement will be administratively determined as a quantity target, the quantity actually procured by the government depends on the capacity and willingness of the farmer to sell. The capacity to sell is a function of gross marketed surplus. Willingness to sell to government depends on difference between procurement price and open market price. It has been shown that an equation for public procurement which is faithful to profit-maximizing market supply by farmers can be written as follows (Goletti, 1991, pp. 58-59):

$$G_t = g(PP_t, P_t, Q_t, G_{t-1}) \qquad (9)$$

where PP_t = Procurement price of rice

Public offtake

Because public offtake of rice is the other route for public stocks to adjust, rice offtake (OFF) is the last endogenous variable in the system. Again, following Goletti (1991), the analytical basis of the inclusion of the rice

[5]Renkow (1990) too had worked with stocks measured as levels rather than changes.

offtake is as follows. While the determination of the quantity available for public distribution is part of a quantity-targeting exercise, the actual lifting depends on the difference between the market price and the administered price. The changes in the demand for grains in the public issue traces out the effective public offtake supply. The equation for public rice offtake that is grounded in profit-maximizing consumer demand for rice in a dual pricing regime can be written as follows:

$$O_t = O(IP_t, P_t, GI_t, O_{t-1}, Q_t) \qquad (10)$$

where IP = issue price of rationed rice.[6]

Because cross-section data are at use, procurement price will remain unchanged spatially and therefore will have to be omitted.

The term on interdistrict commerce may be expressed as follows:

$$X_{it} = x(P_{j,t}/P_{i,t}, m_{i,j}, Y_j) \qquad (11)$$

This states that shipments of rice from i^{th} region to the jth regions depends on price ratios and the spatial arbitrage costs from i to j. This suggests that, in a cross-section, price determination within regional markets

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[6]Rice harvests may bear upon availment of publicly issue rice independently of price. Consumers may be partial towards rice that is newly harvested in its own right. Second, Q_t can be rationalized as a proxy for seasonal appearance of income especially in rural areas. There is some merit in positing an income-responsiveness of the demand for public rice issue.

is jointly determined together with between-region market flows. The chief handicap here is data availability. Interdistrict shipments on monthly basis are unavailable.[7] Having failed to deal directly with this problem, a spatial dummy variable approach has been utilized instead.

In a full system, output should itself be deemed endogenous, as it would depend upon current and lagged prices, technology, endowment, seasons/weather, price of substitute commodity. That is,

$$Q_t = Q(P_t, P_{t-1}, \Psi, W, E, P^w_t) \qquad (12)$$

where Ψ = a technology variable

W = weather

E = Endowment

To keep the analysis relatively simple, we here treat output to be exogenous. We use a district type dummy to proxy the influence of technology, endowments and substitute prices, and a seasonal dummy to proxy that of weather and cropping pattern.[8]

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[7]Because a handful of Bangladesh's progressive farm districts regularly account for a very large proportion of her interdistrict rice trade, it is not possible to prorate the quantities thus traded on the basis of district level output.

[8]District dummy takes the value of 1 for nine progressive districts and 0 for other districts on the sample. A progressive district is one which generated from local production a surplus of rice relative to putative consumption requirement in 1989, or one that records above-average unit fertilizer consumption. Seasonal dummy takes the value of one for seven months of boro/aus season, and 0 for the five dry months of aman market season.

With supply and demand balancing, and with supply being exogenous in this monthly analysis, the task reduces into one of tracing how the demand for final consumption and for private stocks interact with government rice procurement and offtake to determine price. In effect, we shall estimate a four-equation system dropping regional subscripts:

$$P_t = P(S_t, GI_{t+1}, P_{t-1}, I_{t+1}, Y, D1, D2) \quad (13)$$

$$I_{t+1} = I(Q, GI_{t+1}, I_t, P_{t-1}, P_t, E_tP_{t+1}, D_1, D_2) \quad (14)$$

$$G_t = g(P_t, Q_t, GI_{t+1}, D_1, D_2) \quad (15)$$

$$O_t = (P_t, Q_t, GI_{t+1}, O_{t-1}, D_1, D_2) \quad (16)$$

where, the commodity being rice,

P = rice price

S = market supply

GI = public stock

I = private stock

Y = income

G = public procurement

Q = rice output

O = rice offtake

D1 = A dummy variable taking the value of 1 for progressive districts, and 0 otherwise

D2 = A dummy variable taking the value of 1 for boro/aus season, and zero otherwise.

Equation (13) tries to explain market price in terms of market supply, public stock, private stock, income, lagged prices, and two dummy variables. Equation (14) tries to explain private stock in terms of seasonal harvest, public stock, lagged private stocks, expected, current and lagged prices, and the two dummies. Equation (15) explains public procurement in term of seasonal harvest, market price and lagged procurement. The dummies isolates the purely spatial and seasonal influences from the observed causalities.

Equation (16) explains rice offtake from PFDS in terms of seasonal harvest, market price, public stock and lagged offtake. 3SLS is chosen as the estimator of this system of equations, as the errors are correlated across equations.

Of what consequence is it that we are limited to cross-district monthly data for twelve months, when in fact we want to explain changes in private stocks, which, in effect, are closely related to intertemporal adjustment ? An explicit incorporation of time, it can be argued, is essential in a satisfactory treatment of decisions of storage. The fact that the model is not across-time and does not admit of interest rate variations over time may therefore be seen as a fatal flaw.

We shall reply that the appropriate time unit is closely related to planned duration of storage. In theory, annual crops shall admit of year-to-year storage while seasonal crops shall quite legitimately admit of subannual planning horizons. The construction of a subannual model therefore does not *ex definitione* exclude a valid treatment of time. Nor are we totally omitting a treatment of interest rate variations among decisionmakers we model. It can be argued that interest cost differentials among spatially differentiated decisionmakers are closely related to prospective returns to investment. The latter would tend to be relatively higher in progressive agricultural districts than in nonprogressive ones. We attempt to capture, albeit grossly, interest rate differentials by incorporating progressive-nonprogressive divides in the model.

Finally, in Bangladesh, it has been convincingly shown using monthly data that rice markets are not segmented (Ravallion, 1987; Ahmed and Bernard, 1988; Chowdhury,

1992b). The upshot is that, within the domain of monthly prices, price *changes* are reflected across spatial unit. However, the acceptance of the absence of pervasive segmentation does not rule out the possibility of spatial difference in *levels* of market prices.

The data

This is a cross-district, cross-season model, using per capita observations for all quantities. Twenty districts and twelve months through November 1990 are involved. Lagged endogenous-variables lags caused loss of twenty degrees of freedom. Sample results from IFPRI Farm and Market Survey have been blown up to new district levels. Public rice stocks, offtake, procurement were obtained from the Ministry of Food data. District level income was generated through blowing up sample averages (of farmlevel disposable income) to new-district levels.[8] Data are of monthly intervals. Population data have been based on preliminary results from the 1991 census, after some downward adjustment. (The census took place after the year under study). Nine of the twenty districts are dubbed as progressive: they are Thakurgaon, Dinajpur, Rangpur, Joypurhat, Bogra, Naugaon, Rajshahi, Sherpur and Satkhira. Prices used are nominal: this is a cross-section study.

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[8]District level incomes thus estimated may not correspond to the matched data from the national accounts for the corresponding period, when they are eventually processed. At the time of writing, district-level product data are not available from the BBS. Use of blown-up income data was due to the want of official output data. We suspect that income data available to us are very inadequate. Not unsurprisingly, the coefficient on income was "wrongly" signed.

III Results

Estimated coefficients of both versions of the model can be seen in Table II. Table III reports on the reduced form matrices of the two models. Model elasticities are reported in Table IV. Results from model validation are reported in Table V. Some discussions relating to individual equations now follow.[9]

Price equation: Both market supply and public stock level decrease market price, while buildup of private stocks on farm increases it.[10] Given market supply, public stocks and private stock adjustments each have a mutually opposing effect on market prices. The supply elasticity of price in this monthly model is not large: one percent increase in supply eliciting a price decline of .022%. However, because prices are intertemporally sticky, given the very large coefficient of lagged price, it can be argued that the longrun response of prices to market supply is significantly greater. Production is the dominant component in market supply. The large responsiveness of prices with respect to market supply suggests the important role that a dynamic production system can play in stabilizing sharp price increases during lean seasons. This recognition is all the more apt, in that rice has become more of a seasonal, rather than an annual, crop. It has been argued, for example, that trend deviations from wet season and dry season rice have

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[9]This is a simultaneous-equations model and, as such models go, the direction of causality between two variables which both appear in more than one equation can change from one equation to another. When we attribute any specific causality direction in the following, this limitation should be kept in mind.

[10]The buildup of traders' stock has a negative but insignificant coefficient.

negatively correlated with each other (Goletti et al, 1991), suggesting the presence of a restabilizing production seasonality.

The elasticities of market price with respect to public stock and private stocks are, absolutely, are not grossly dissimilar to each other. This is quite intuitive. Increases in public stocks impact upon current prices through expectations of future prices. But that is also the route through which private stock impacts upon current prices.

Income registers an insignificant coefficient, while lagged price returns a highly significant coefficient.

Private stock equation: Farm stock are powerfully influenced by seasonal appearance of output. Farm stocks are the largest during the early months of the harvest period, and fall off towards its end. Lagged stocks significantly directly affect farm stocks. This is symptomatic of a strong partial adjustment behavior. Farm stocks respond to lagged prices alone among the three versions of the price variable. Expected price does not affect storage because profit-seeking temporal arbitrage is not an important component of farm stock. (Trade stocks provide an interesting variation in this respect.) For the same reason, current price, too, does not materially affect private farm storage. Public stock operations leave farm stocks unaffected. Coefficients on the dummy variables indicate that, as compared with the aman season, farm stocks during the boro season are lower.

It is apt at this stage to tender a few observations on the determinants of traders' stock. First, traders' build

up stocks, if at all, when harvests have been completed.[11] This is why Q returns a significantly negative coefficient in the trade stock equation. The traders see little point in investing in stocks over and above what is needed for current sales during months registering large production. Second, traders' stocks register plausible responses to price. They respond positively to both lagged and expected prices. However, they respond negatively to current prices. Coefficients on all three versions of the price variable are significant. Overall, traders' stocks are highly responsive to prices, as indeed one expects them to be. Third, lagged stocks are a significant and direct determinant of current stocks, suggesting a partial adjustment. Fourth, public stocks significantly crowd out traders' stock. Note that they leave farm stocks unaffected.[12]

Public procurement increases with output and lagged procurement, and decreases with market price. Public offtake decreases with output, and increases with public stock, lagged offtake and market price.

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[11]The qualification in the sentence in the text is included advisedly: in the general case, seasonal price movements in the study year had rendered speculation in stocks unprofitable (Chowdhury and Ahmed, 1993).

[12]The relevant explanation here is that while virtually all of traders' stocks are motivated by temporal arbitrage --- hence the responsiveness to public stock --- farms stocks spring from more mixed motivations, including a fixed security stocks (Jones, 1969). Insignificance of the price variable in explaining farm stocks in general, and vice versa for traders' stocks --- all over the same time period --- is an important feature of the adjustment in the rice markets of Bangladesh.

Validation of the model

Theil Inequality Coefficient (TIC) is calculated in order to validate the model.[13] TICs are reported in Table IV below. Because the determination of monthly rice price is among the central motivations of the estimation of the model, we look at TIC for the price variable with particular interest. And because farm stocks are three-fourths of total private rice stocks at any given moment, our validation exercise is more directly concerned with model version dubbed A in the paper. A few comments are apposite at this stage about this table.

The model tracks market prices especially well with farm stock version, the TIC being 4%. TIC is 15% for farm stocks. Remembering that farm stocks per capita on the sample has a coefficient of variation of about 40%, this degree of predictive accuracy is quite clearly adequate. TIC is 15% for public procurement, a variable of quite considerable policy interest. As compared with other econometric models of grain sector in Bangladesh, the predictive accuracy of the present model regarding public procurement is much higher.[14] The model, however, tracks public offtake less well, although still better than earlier models of Bangladesh's rice models. In sum, we consider the model version A fairly valid description of the interaction between farm stocks and rice prices in Bangladesh.

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[13]To calculate this, we perform historical simulation using the model over the estimation period of the twelve months through November, 1990. In performing this simulation, historical values are used for all exogenous variables.

[14]Cf. Shahabuddin (1990).

Version B is patently less satisfactory, although, even here, TIC for the crucial price equation is 8% only. The model tracks traders' stock very poorly. This should not be overly surprising, however. We have to remember that district-level per capita traders' rice stocks are very highly variable, coefficient of variation being 104%. Analytically, the models seem reasonably well-specified. Because direct measurements on private stocks, differentiated according to who owns them, have become available for the first time for a representative Bangladeshi sample, these results are worth sharing even though the traders' stock equation returns very low predictive accuracy. Note also that it is not one of our main objectives to forecast traders' stocks using this model outside the present estimation period. Our main objective in estimating the model is to predict prices. And even model version B registers a TIC of under 10% for its price equation.[15]

Policy Implications

Before summarizing the paper, we shall touch upon the chief policy implications of the paper. First, the government of Bangladesh has a clear choice between counting on expensive public stocks and allowing a production-cum-commercialization "strategy" in order to achieve the essential mandates of its rice pricing policy. Even though we have not costed the two alternatives in this paper --- a task for the future --- it is intuitively clear that the second option would be more "cost-effective", in the sense that millions of geographically and economically *dispersed*

[15]We assume that root-mean-squared percent error of under 10% should be an adequate standard for predictive accuracy.

owners of rice stocks would, in a self-coordinating manner, carry out the market-determined mandate of such a policy thrust.[16] There would scarcely be any "system loss" to brook for such an alternative, while the "system loss" for the buffer stock option has been deemed to be excessive (FAO, 1986). Second, public rice stocks are held at an excessive level during the year through November 1990, which is why they significantly squeeze out private traders' stocks. In retrospect, we know that the government procured a record quantity of 0.92 million metric ton (MMT) in the study year within the framework of the highly distortionary Millgate Contract mode of public procurement.[17] However, public offtake of rice during the study year was at a historic low. Public rice stocks thus rose a-historically, thus crowding out traders rice stocks. The moral seems to be that the government may like to consider ways of paring back its rice stocks. One way to achieve this would be to signal, quite unambiguously, to the market that it is the government's policy to publicly procure only in years/seasons of above-average production levels.[18]

Third, efficient private storage having acquired the connotations of a "public good," the timely generation and cheap dissemination of knowledge, however approximate, of the magnitude and location of private rice stocks, especially during the months of March-April and August-

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[16]Chowdhury (1992b) has amassed evidence that farm rice stocks are owned in a dispersed fashion in Bangladesh, under fairly competitive conditions.

[17]For a description of this distorted public intervention, see Ahmed, Chowdhury and Ahmed, 1993, and IFPRI Policy Brief # 2, Dec, 1992.

[18]Admittedly, the operational specifics of such a policy need to be expertly fleshed out, and are beyond the scope of this paper.

September, becomes a mandate of policy. Currently, there is no policy initiative to speak of to make information about private stocks available with adequate lead time so that market participants can make use of them. And yet there exists at least one fairly compact models of farm stocks which can be adapted to make aggregative dated forecasts of farm stocks for Bangladesh. This should be a continuing monitoring exercise in which the government, perhaps supported by appropriate analytical teams, should be involved. Fourth, seasonal pattern of institutional credit supply assumes some importance. Credit relations in Bangladesh's rice markets seem to suffer from a strong degree of segmentation, where a handful of large, mechanized rice mill have favored access to cheap bank credit (Chowdhury, 1992b). Much more numerous ranks of traders are left to draw upon trade channels. this segmentation is clearly in part policy-induced. The government has recently liberalized institutional credit access to facilitate participation in a series of public open rice tenders.[19] The market keenly awaits a liberalized access to institutional credit, sensitive to seasonal ebb and flow of farmer market offering of rice.

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[19]The government has decided to procure most of its buffer stock requirements of rice through public tenders which almost certainly will save money.

IV Summary of Major Conclusions

The diffusion of modern technology in Bangladesh by spawning an intricate pattern of seasonality has rendered rice from an annual to seasonal crop. Growing equalization in the dry season-wet season harvest shares has dramatically lowered price seasonal from 40% in the late 1960s to under 15% two decades on. Storage rules for public "buffer stocks" were formulated when rice was an annual crop. The budgetary implications of the emergence of a dynamic, market-oriented and geographically dispersed dry-season rice farming have yet to be well-integrated into the customary patterns of food policy implementation in Bangladesh.

It is shown in this paper that both private stocks and public stocks matter intuitively to the determination of rice prices. However, the former matters more: the elasticity with respect to change in private rice stock (i.e. farm stock, the fundamental stock source in the economy) is, in absolute terms, greater than to the corresponding change in public rice stock. This greater potency, more to the point, comes off comparatively cheaply: private storage occasions little or no public subsidy in Bangladesh. Public stock resources are, however, maintained at rather excessive costs. It is further shown that public stocks displace traders' stock, although not farm stocks. Third, traders' stocks display significant price responsiveness. Farm stocks are basically driven by seasonal appearance/disappearance of output, while trade stocks are fundamentally influenced by prices and government interventions. Between them, they hold the key to a more efficient and responsive rice price policy than an anachronistic preoccupation of "buffer stock" policy at public expense.

Two policy conclusions emerge. First, timely generation and cheap dissemination of information, even of approximate nature, regarding the magnitude and location of private rice stocks, especially farm stocks, has become a policy issue of priority. Second, the magnitude of public rice stocks should be lowered.

Table II -- Interactions between public interventions and private rice stocks in Bangladesh: using 3SLS and a cross-season data

Equations/ Variables	Model A (Private stock=farm stocks)		Model B (Private stocks=trade stocks)	
	Coefficient	T-Statistic	Coefficient	T-Statistic
PRICE EQUATION				
Constant	4.73779*	8.927	6.81297*	11.761
S	-.118616E-01*	-9.285	-.937409E-02*	-6.870
GI_{t-1}	-.202758E-01*	-2.834	-.157517E-01*	-2.229
I_{t-1}	.719742E-02*	6.028	-.117713E-01*	-4.343
P_{t-1}	.497212*	9.051	.353235*	5.789
Y	-.354905E-04	-.441	-.131804E-04	-.261
D_2	.463844E-01	.423	-.211893**	-1.799
D_1	-.150017	-1.283	-.268440E-02	-.022
PRIVATE STOCK EQUATION				
Constant	-138.574	-1.202	378.982*	8.512
Q	.820282*	3.530	-.512805*	-5.903
I_t	.566805*	8.843	.506216*	6.204
P_{t-1}	-26.4779*	-2.793	16.8332*	4.951
E_tP_{t+1}	-2.67223	-.595	.158984*	2.617
P_t	44.8965**	1.862	-56.8903*	-7.773
GI_{t-1}	.773033	1.743	-.827456*	-2.912
D_2	-11.6883	-1.478	-15.5196*	-3.484
D_1	2.53902	.461	.990286E-01	.023
RICE PROCUREMENT				
Constant	14.9283*	2.386	42.3495*	4.924
P	-1.58182*	-2.497	-4.33837*	-4.998
G_{t-1}	.844748*	11.564	.573197*	6.427
Q_t	.107345E-01	1.081	-.186700E-01	-1.420

Table continued

Equations/ Variables	Model A (Private stock=farm stocks)		Model B (Private stocks=trade stocks)	
	Coefficient	T-Statistic	Coefficient	T-Statistic
RICE OFFTAKE				
Constant	-1.24481*	-2.487	-1.31431*	-2.605
P_t	.140373*	2.784	.144994*	2.855
GI_{t-1}	.547998E-02**	1.826	.618313E-02*	2.195
Q_t	-.302771E-03	-.388	-.294786E-03	-.390
O_{t-1}	.939372*	27.954	.977209*	26.042

Notes: * and ** denotes significance at 5% and 10% error probability level

Source: Data from IFPRI Farm Survey, 1989/90; IFPRI Market Survey, 1989/90

Table IIIa -- Reduced form matrix of model version with trade stock

	S	GI	P_t	P_{t-1}	Y	Q	I_{t-1}	$PROC_t$	OFF_t	D_{t-2}	D_{t-1}	CONST.
P	-0.02802	-0.01801	-0.01770	0.467841	-0.00003	0.017914	-0.00552	0	0	-0.09071	-0.01147	7.075436
I	1.594138	0.297893	1.513216	-9.81548	0.002228	-1.53116	0.472506	0	0	-10.3493	0.752018	-23.5415
PROC	0.121612	0.078186	0.076838	-2.03043	0.000170	-0.09644	0.023992	0.573	0	0.393691	0.049817	11.63260
OFF	-0.00403	0.003585	-0.00254	0.067369	-0.00000	0.002284	-0.00079	0	0.977	-0.01306	-0.00165	-0.28113

Table IIIb -- Reduced form matrix of model version with farm stock

	S	GI	P_t	P_{t-1}	Y	Q	I_{t-1}	$PROC_{t-1}$	OFF_{t-1}	D_{t-2}	D_{t-1}	CONST.
P	-0.01742	-0.02172	0.006008	0.453133	-0.00005	0.008705	-0.02834	0	0	-0.05563	-0.19452	5.527843
I	-0.78214	-0.20217	0.835743	-6.12882	-0.00231	1.210795	-3.94246	0	0	-14.1775	-6.19203	109.5748
PROC	0.027529	0.034323	-0.00949	-0.71595	0.000081	-0.00305	0.044787	0.8447	0	0.087905	0.307342	6.186007
OFF	-0.00244	0.002422	0.000843	0.063574	-0.000007	0.000919	-0.00397	0.	0.939	-0.00780	-0.02729	-0.46444

Table IV -- Elasticities of endogenous variables with respect to exogenous variables

Endogenouns/ Exogenous variables	Model A (Private stocks=farm stocks)	Model B (Private stocks=trade stocks)
	Elasticity	Elasticity
PRICE EQUATION		
S	-0.022	-0.019
GI	-0.018	-0.016
I	.056	-0.022
P_{-1}	.356	.346
PRIVATE STOCK EQUATION		
Q	.226	-0.621
I_{-1}	.861	.166
P_{-1}	-3.33	8.59
P_{+1}	-0.346	.084
P	5.78	-29.68
G1	0.089	-0.445
PROCUREMENT EQUATION		
P	-5.46	-11.97
$PROC_{-1}$	.900	0.608
Q	.079	-1.195
OFFTAKE EQUATION		
P	1.64	1.83
GI	.057	.080
Q	-0.007	-0.009
OFF	.847	0.871

Source: IFPRI Farm and Market Survey, 1989/90

Table V -- Theil Inequality Coefficients for endogenous variables

Endogenous Variable	When model used only Farm Stock	When only Trade Stocks are used
P	.038	.083
I	.150	.70
G	.154	.606
OFF	.292	.173

Note: Theil Inequality Coefficient is estimated using the formula:

$$T.I.C = \frac{\sqrt{\frac{1}{n}\sum_{i=1}^{n}(PV-AV)^2}}{\sqrt{\frac{1}{n}\sum_{i=1}^{n}(PV)^2} + \sqrt{\frac{1}{n}\sum_{i=1}^{n}(AV)^2}}$$

PV = Predicted value
AV = Actual value
n = sample size

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