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PUBLIC INTERVENTION AND PRIVATE SPECULATION: THE CASE OF WHEAT PROCUREMENT

PULAPRE BALAKRISHNAN

Indian Statistical Institute, 8th Mile Mysore Road, R.V. College Post, Bangalore 560059, India

and

BHARAT RAMASWAMI

Indian Statistical Institute 7, SJS Sansanwal Marg, New Delhi 110016, India

The paper examines the competition between public authorities and private speculators in a two period seasonal model where speculators decide on the quantity of grain to be stored from the first to the second season. Most government procurement of grain also occur in the first season. The equilibrium no-arbitrage condition suggests that private storage and hence the volume of procurement, is sensitive to market anticipations of public grain sales in the second season. If market expectations are conditioned on the volume of government stock, procurement is subject to speculative attacks. The implications of such speculative activity for market responses to exogenous shocks are examined in a theoretical model. The empirical model tests for the importance of speculative activity in explaining fluctuations in wheat procurement in India during the period 1970-1990. The results suggest that government has used its trade and buffer stocking strategies in a manner that has achieved credibility for its intervention. (JEL : D84, Q18)

1. INTRODUCTION

Foodgrains markets, in developed and developing countries alike, are active arenas of government intervention. In the countries of the Indian sub-continent, the objective of food security has motivated policies of public storage, procurement and public distribution of foodgrains. This has led to the creation of a network, for the purchase and sale of grain, operated and controlled by a public authority. At the same time, coexisting with the public agency, private traders have carried on the business of buying, storing and selling grain. The relationship between the public marketing agencies and private trade is marked by competition for grain supplies.[1] The nature of this competition is the focus of this paper. Our objective is to explore the manner in which public policies affect private trade's actions and how that, in turn, affects the outcome of public policies. In particular, we examine the issue of credibility of public intervention and its role in determining the success of the government's procurement policy.

The competition for grain supplies between private and public trade manifests itself in two ways. First, if the government offers too low a procurement price it risks being outbid by private traders. Second, the speculative demand from traders depends on expectations of future price which in turn depends (among other things) on anticipations of future government actions as they impinge upon the supply-demand balance. The sales through the public distribution system, as is noted later, constitute a significant portion of market supplies. Hence, expectations of future grain sales through the public distribution network could substantially affect the demand for private storage and thereby the volume of procurement achieved.

Competition with private trade, thus, leads the volume of procurement to depend on procurement price as well as on speculative expectations (of government grain sales). Much of the literature has, however, modelled the public-private competition in a static setting and therefore investigated only the role of procurement price in determining procurement. Empirical studies of foodgrains markets in India and Bangladesh (Kahlon and Tyagi, 1983; Krishna and Chhiber, 1983; Krishna and Raychaudhuri, 1979; Ahmed and Bernard, 1989; Gulati and Sharma, 1990) have found procurement to be an increasing function of the procurement price and have in this sense, verified the public-private competition for grain supplies. However, as we argue later, the coefficient of purchase price in a fully specified model of the determinants of procurement, would reflect speculators' expectations of government action. The static models are, in this sense, misleading since they suggest (when used in policy analysis) that the estimated coefficients are policy invariant structural parameters. Furthermore, by neglecting the impact of speculative activities on procurement, the static models do not provide a consistent microeconomic model of procurement. Following Krishna and Chhibber, the usual practice is to specify procurement as an increasing function of the procurement price relative to an annual average market price. However, such a model cannot explain how, in the absence of a compulsory levy, wheat procurement occurs at all, for the annual average market price has systematically exceeded the procurement price. In our view, a coherent story of the procurement process can only be obtained in a dynamic model where the opportunity costs of selling to the

1. Indeed, to limit market competition, governments have sometimes resorted to coercive regulations (e.g., forbidding movement of grain, compulsory levies on large farmers and grain mills, imposing limits on trader's stocks and outright ban on private trading activity). Some of these measures have been more successful than others; but even so there are widespread instances of evasion (Subbarao, 1978).

government can be properly specified.[2]

While the existing literature does not assess the empirical importance of speculation in explaining fluctuations in procurement, the significance of this factor is widely acknowledged. More specifically, the argument that is commonly made is that private speculative behavior is conditioned by its perception of the ability of government to act in markets. Ahmed and Bernard (1989) cite a survey among rice traders in Bangladesh which shows that "more than 90% of traders in both wholesale and retail groups consider open market sales by the government as an important factor in their stocking decisions". The same authors conclude that "the ability of the government to conduct effective open market sales ..... depends greatly on opening stock". Other researchers have also suggested the level of public stock, being a measure of the possible extent of public sales, to be a major determinant of speculative expectations of traders and their behaviour (Gulati and Sharma, 1990; Ravallion, 1990). Kahlon and Tyagi (1983, pp 471) quote an official document which stresses the need to maintain wheat reserves for otherwise "this backdrop of a precarious balance in wheat stock can give rise to speculative tendencies". Similarly, Dreze and Sen (1989, pp 95) suggest that the "existence of public stocks ..... can go a long way towards reducing fears of future scarcity and also defeating the manipulating practices of private traders".

If speculative expectations are indeed driven by the level of public stocks, public intervention could be subject to speculative attacks. Such phenomena have been extensively analyzed in the context of price band rules of market stabilization (e.g. Anderson and Gilbert, 1989; Salant, 1983; Williams and Wright, 1991). The essential feature of such attacks is that if availability drops below a critical threshold all public stocks are bought up by private traders and if availability exceeds some threshold all private stocks are dumped on the public authority. The intuition behind these happenings is that private speculators cease to believe in the government's capability to defend the price floor or ceiling as the case may be. It is the loss of credibility which drives the attack.[3] Foodgrain market intervention in India does not follow price band stabilization rules. However, if speculative expectations are conditioned on public stocks, then procurement may suffer from a similar loss of credence about the government's capability to hold down future price through grain sales. A low stock level, for instance, signals a reduced capability for public intervention which feeds speculative demand and reduces sales to government. In this sense, speculative attacks are possible though not in the same dramatic fashion as in models of price band stabilization.

2. To our knowledge, the only previous work on the effect of future expectations on government purchases is Pinckey's (1989) study of wheat storage in Pakistan. He makes the point that "the amount of wheat procured by the government will be an inverse function of the allowed seasonal price rise". He uses this argument to empirically evaluate the consequences of alternative hypothetical price-band stabilization rules but does not explore its validity in determining the volume of government purchases. Moreover, Pinckney assumes that private trade believes in the government's ability to maintain the price within the announced band. He does not therefore deal with the issue of credibility of government policy which is central to this paper.

3. Siamwalla (1989) reviews the importance of maintaining credible policies in the practical management of buffer stocks.

The absence of a future in the static models of procurement provides the point of departure for our paper. In our model, the time between successive grain harvests is divided into two seasons. Private traders decide on the quantity of grain to be stored from the first to second season. The no-arbitrage condition that holds in market equilibrium implies that private storage and first season procurement are sensitive to market anticipations of public grain sales in the second season. If market expectations are conditioned on the volume of government stock, procurement would be subject to speculative attacks. The implications of such speculative activity for market responses to exogenous shocks are examined in a theoretical model. In our econometric investigation we look for evidence of forward looking expectations in determining wheat procurement and whether these expectations are conditioned on the level of public stocks. In this way, we are able to assess the importance of speculative attacks in explaining procurement of wheat in India.

The next section describes the mechanics of government intervention and presents a few stylized facts which motivate the assumptions of our theoretical model. Section 3 writes down a model and considers its comparative statics. Section 4 derives a forward looking wheat sales equation which is estimated using time series data (1970-1990) drawn from the Indian wheat market. Concluding remarks are gathered together in Section 5.

2. PUBLIC DISTRIBUTION AND PROCUREMENT IN THE INDIAN WHEAT MARKET

(i) *The Public Distribution System and its Sources of Supply*

In India, public intervention manifests itself (*a*) in isolation of the domestic market from world markets and (*b*) in the creation of a dual market for foodgrains at the retail level. The former is achieved by severe controls on exports and imports which are almost always on government account in order to meet temporary deficits or export temporary surpluses. World prices do not exercise a direct influence on the domestic market. Within the country, a dual market (at the retail level) is created by the public distribution system.

The machinery for the public distribution system (PDS) consists of a network of retail outlets through which grain (principally rice and wheat) is sold at a price typically lower than the market price. Not everyone has access to the PDS and those with access have limited and fixed entitlements. The supply of cheaper and rationed grain splits the retail market into a government controlled marketing network and an open market where prices are determined competitively. The subsidy is meant to protect the food consumption of the poor who are supposed to be the principal customers of the PDS. However, in practice, the PDS has been limited to urban conglomerations where there has been no discrimination between income groups in awarding access to the cheaper grain. Consumers without access to the PDS are not, however, unaffected by its existence. As a proportion of output, public sales of grain have averaged about 22% in the period 1970-1990. As a proportion of marketed surplus, i.e., the output which actually comes to the market after self consumption by producers, public sales of grain are more important, possibly amounting to as much as 50%.[4] PDS operations therefore exert considerable influence on market prices and is seen to stabilize prices between years (Dreze and Sen, Chapter 8). The government has valued this effect as much as that of providing subsidy to the consumption of groups with PDS entitlements.

The public distribution system is supplied with grain obtained from imports, withdrawal from stocks and from domestic purchases known as *procurement*. Government operations obey the following identity:

$$PR_t + M_t + (GS_{t-1} - GS_t) = PDS_t$$

where PR_t is the volume of grain procurement during year t, M_t is the volume of net grain imports on government account during year t, PDS_t is the volume of grain sales through the public distribution system and GS_t is the closing stock at the end of year t. Figures 1, 2 and 3 plot the time series of the fraction of PDS_t due to each of the three sources of supply. As a fraction of PDS sales, procurement shows a rising trend while correspondingly imports decline in importance. Withdrawal from stocks do not have any trend but seem to get more erratic over time. The transition from an import dependent public distribution system in the 1960's to a system relying on domestic purchases in the 1970's and 1980's can also be inferred from Table 1.[5]

(ii) *Procurement and its Seasonality*

The above discussion suggests that competition for supplies must have sharpened towards the end of the 1960's when procurement began to rise in importance as a source of supply to the PDS. As a proportion of output, government purchases of

Table 1
Sources of Supply to the Public Distribution System : 1961-88

	PR_t / PDS_t	M_t / PDS_t	$(GS_{t-1} - GS_t)/PDS_t$
Average (1961-69)	.325	.712	-0.037
Coefficient of Variation (1961-69)	.641	.204	2.59
Average (1970-88)	.970	.140	-0.110
Coefficient of Variation (1970-88)	.245	1.44	2.29

4. No firm figures for marketed surplus are available. However, the estimate of foodgrains sold in the major wholesale markets has never exceeded 35% of output during 1971-1981.

5. For a more detailed account, see Balakrishnan (1991).

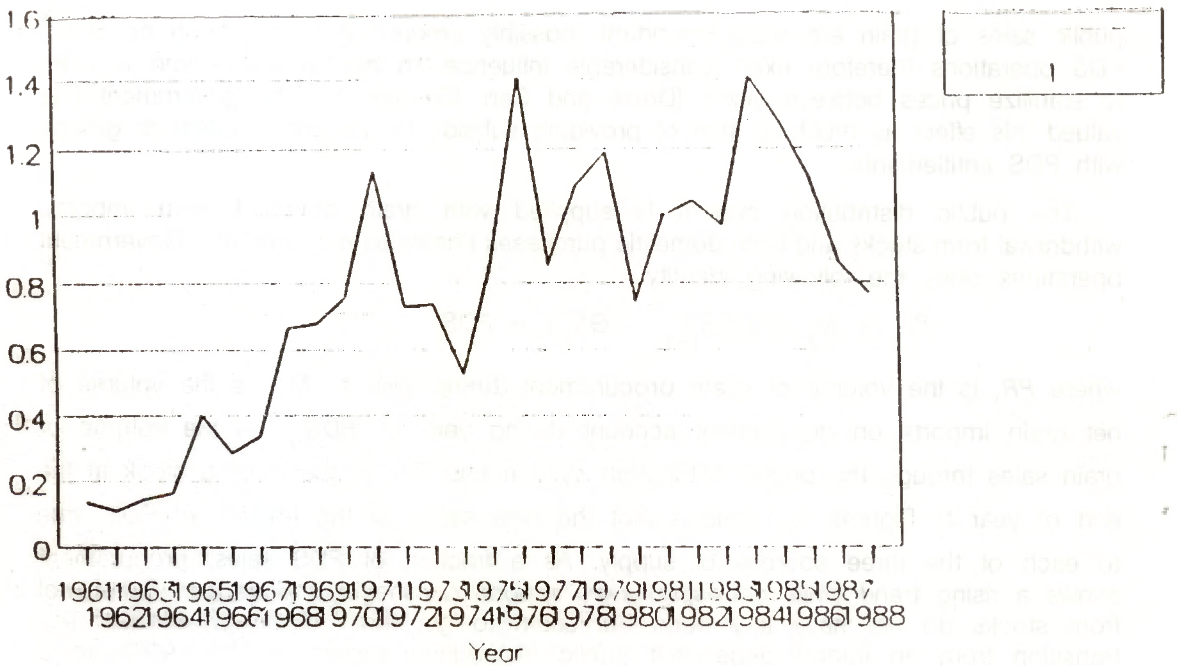

Fig 1: Foodgrain Procurement as a proportion of PDS sales

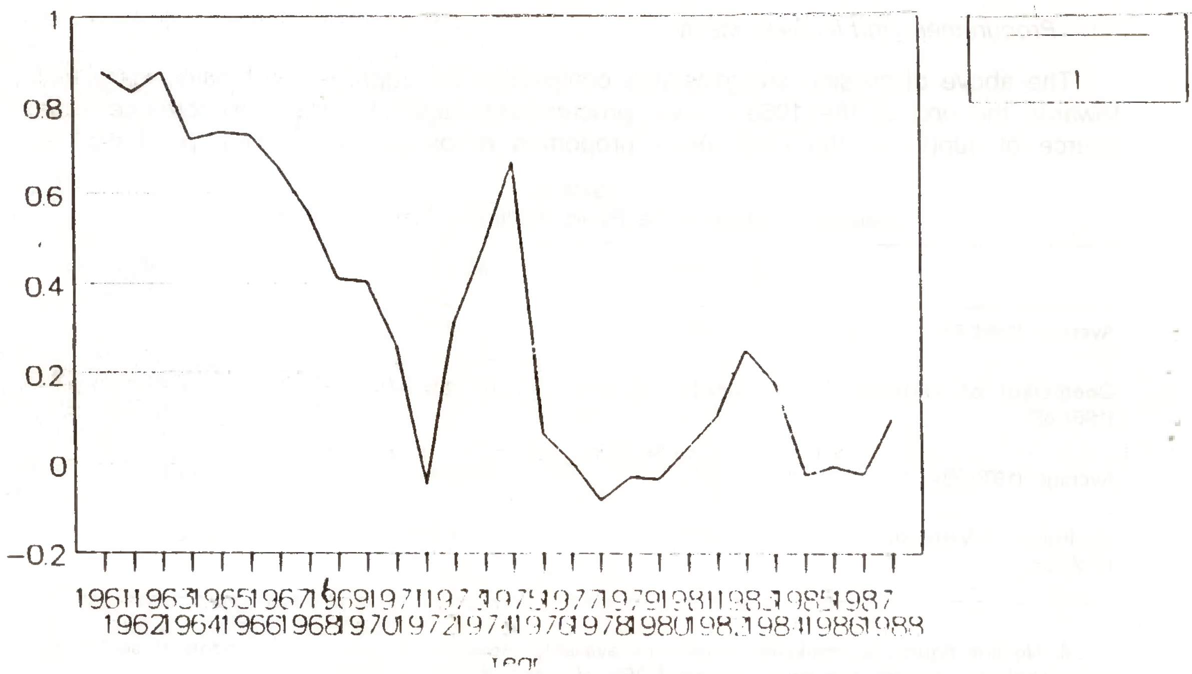

Fig 2 : Foodgrain Imports as a proportion of PDS sales

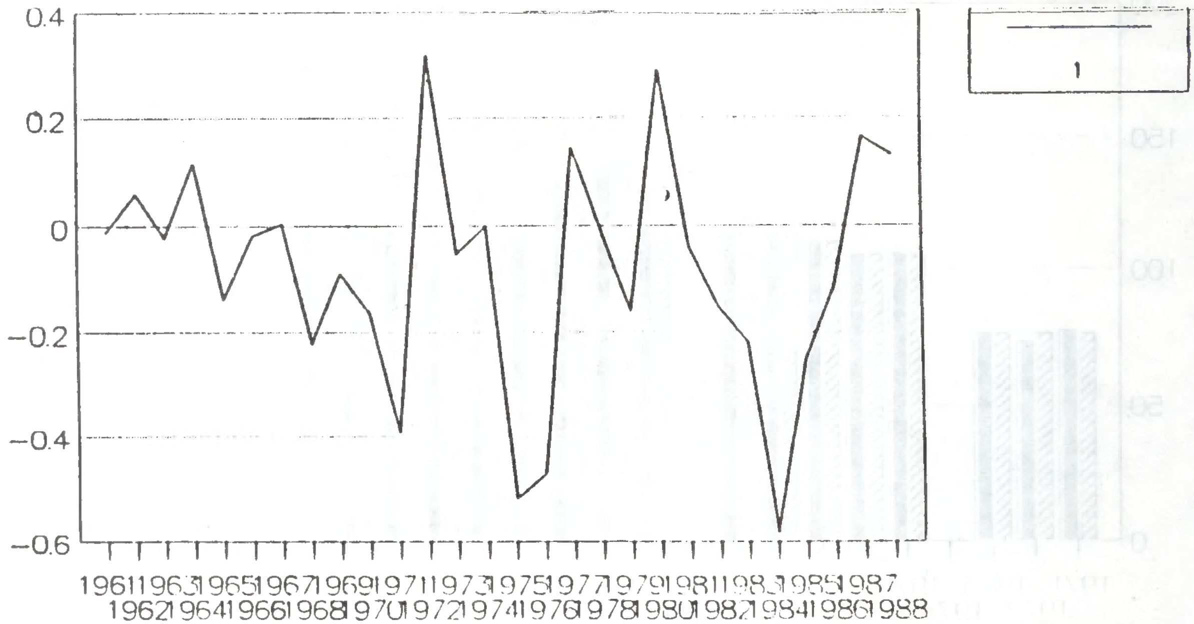

Fig 3 : Withdrawal from Stocks as a proportion of PDS sales

wheat have varied between 14% and 23%[6] and average about 20% for the period 1970-1990. Since estimated market arrivals of wheat are on average, only 30% of output,[7] the government is a major purchaser of wheat.

The government buys wheat at the *procurement price* which is announced just before the harvest in April.[8] The government commences its procurement immediately after the harvest. Since sales to the government are voluntary, effective procurement requires that the procurement price be not less than the market wholesale price[9]. Although the government is not committed to buy everything that is offered to it at the procurement price, in practice it has often worked out that way. As a result, the procurement price is usually not greater than the market price. Thus, we would expect that whenever procurement is positive, procurement price is quite close, if not identical to, the market price. This argument is confirmed in Figure 4 which compares the procurement price to the average first quarter price (April - June) in a major wholesale market for wheat.

6. This ignores procurement in 1974 when the figure was 9%. However, this was atypical year when the government tried to socialize the wheat trade.

7. The remainder is either consumed on-farm or is sold in unregulated and presumably smaller markets.

8. The economic and political calculations that matter in the determination of procurement price are described in many places, including Balakrishnan (1991), de Janvry and Subbarao (1986), Krishna and Raychaudhuri (1979), and Sarma (1989).

9. Methods of procurement other than free voluntary sales have, on occasion, been used. Compulsory levies (at below market prices) are not an important means of wheat procurement (Krishna and Chibber, 1983). However, the government has often been charged with administering informal curbs on the movement of foodgrains which has the effect of depressing market prices in the wheat surplus regions.

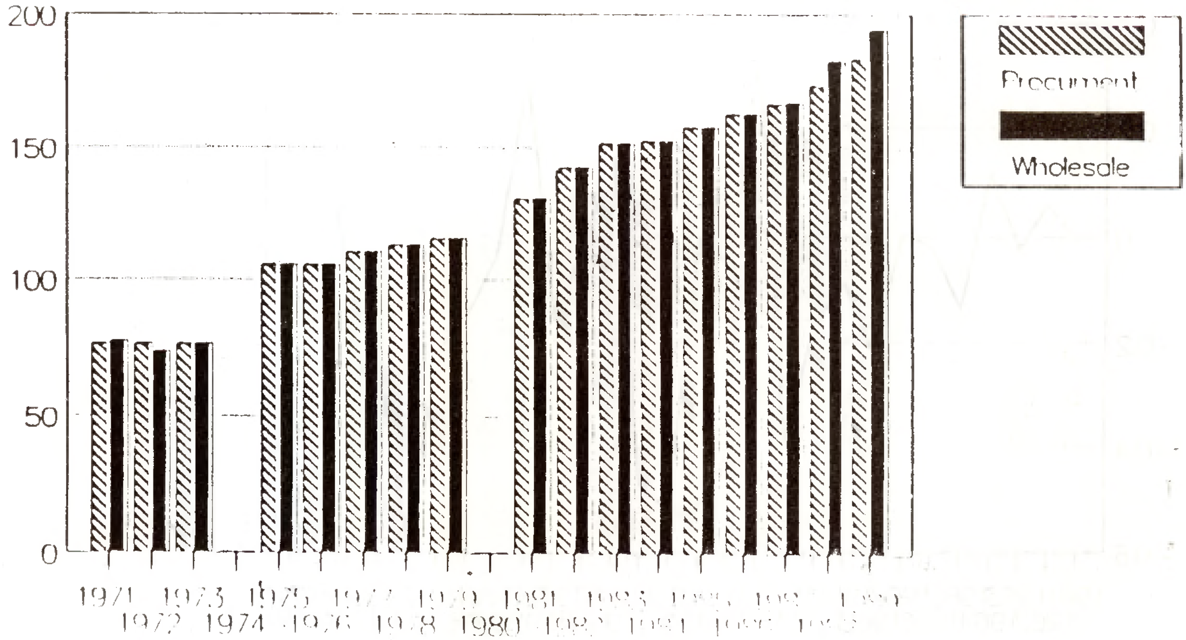

Fig 4 : Procurement Price and Wholesale Price of Wheat in Barnala (Punjab)

It is unlikely, however, that the market price remains at the level of the procurement price for the whole year. At some point, the costs of storage would bid up the market price above the procurement price as the usual seasonal pattern of foodgrain prices asserts itself. The marketing year for wheat extends from April to March and wheat prices are typically at the lowest in the first quarter (April-June) and highest in the last quarter (January-March) of a marketing year. Once the market price rises above the procurement price, farmers would stop selling to the government.[10] Consequently, we would expect procurement to be active in the early months of the marketing year, such as the first quarter, when it is more likely that the procurement price is the price rulling in the market. This is confirmed by the histogram in Figure 5 which plots the seasonal distribution of procurement across different quarters of a marketing year. As can be seen, virtually all wheat is procured in the first quarter of a marketing year.

(iii) *Intra and Inter-Year Storage*

Stocks are held by the government for short and long periods. Firstly, stocks are held to smoothen out the imbalance between seasonal procurement and year round PDS sales. Secondly, stocks are held from one marketing year to another in order to stabilize PDS grain releases and grain prices. Carrying inter-year stocks is considered essential for the food security system.

10. Once announced, the procurement price remains fixed at the same level for the whole of the marketing year.

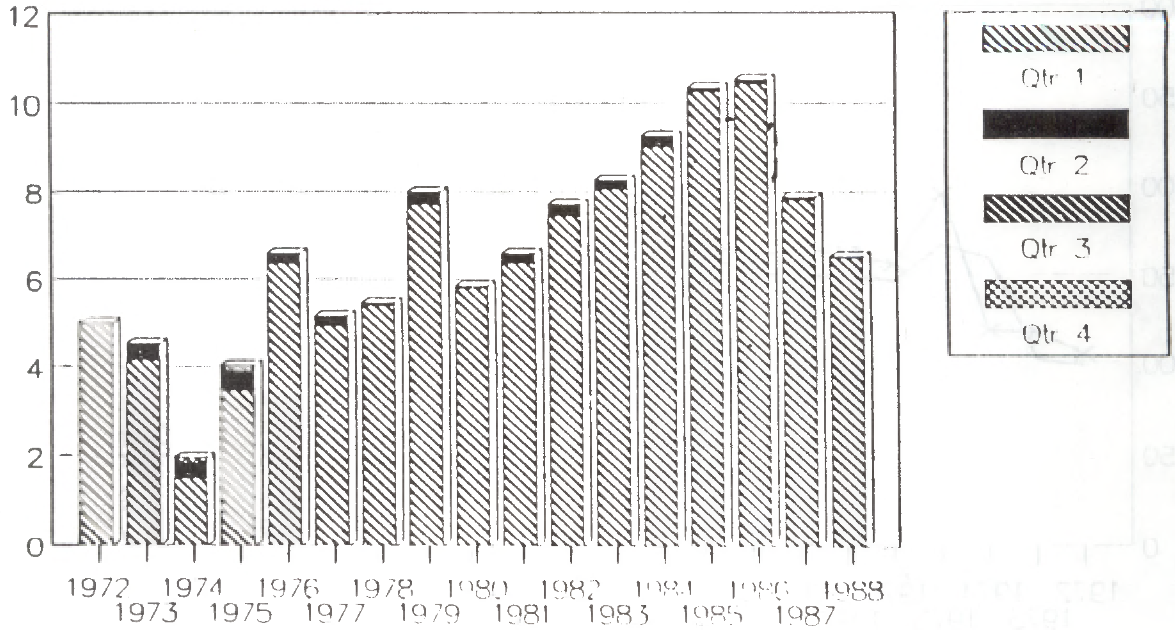

Fig 5 : Quarterly Distribution of Procurement

In contrast to public storage, private inter-year storage is likely to be insignificant. As Figure 6 displays, the wheat price at the beginning of a marketing year is generally less than the price at the end of a previous year[11]. This suggests that private carryover of grain from one year to another is generally unprofitable and private stocks are liquidated in anticipation of the new crop.[12] While it is impossible to verify this inference in the absence of data on private stocks, evidence from field studies support it (see Dreze (1990), pp 50).

3. PROCUREMENT AND PRIVATE SPECULATION: A MODEL

The model is one of perfectly competitive seasonal storage modified to approximate the details of government intervention in the Indian wheat market. We suppose a marketing year to consist of two seasons: *a* and *b*. A random harvest h_t comes in every year in season *a* . Season *b* supplies consist solely of carryovers of grain from the previous season. Demand is uniform and stable in both seasons.

Let $D(p)$ be the consumption demand curve satisfying $D(p) \rightarrow \infty$ as $p \rightarrow 0$ and $D(p) \rightarrow 0$ as $p \rightarrow \infty$. Private traders are risk neutral and have common expectations. Let S_{it} denote private market storage in season *i* of year *t* . Public intervention is indicated by the levels of three variables PP_t, X_{at} and X_{bt}, all of which are exogenous to this model. PP_t is a procurement price announced in season a of

11. The only exception occurs in 1974 when the first quarter price of 1974-75 is greater than the last quarter price of 1973-74 which can be explained by special circumstances particular to that year.

12. This point is also made by Lowry et al (1987) and Pinckney (1989).

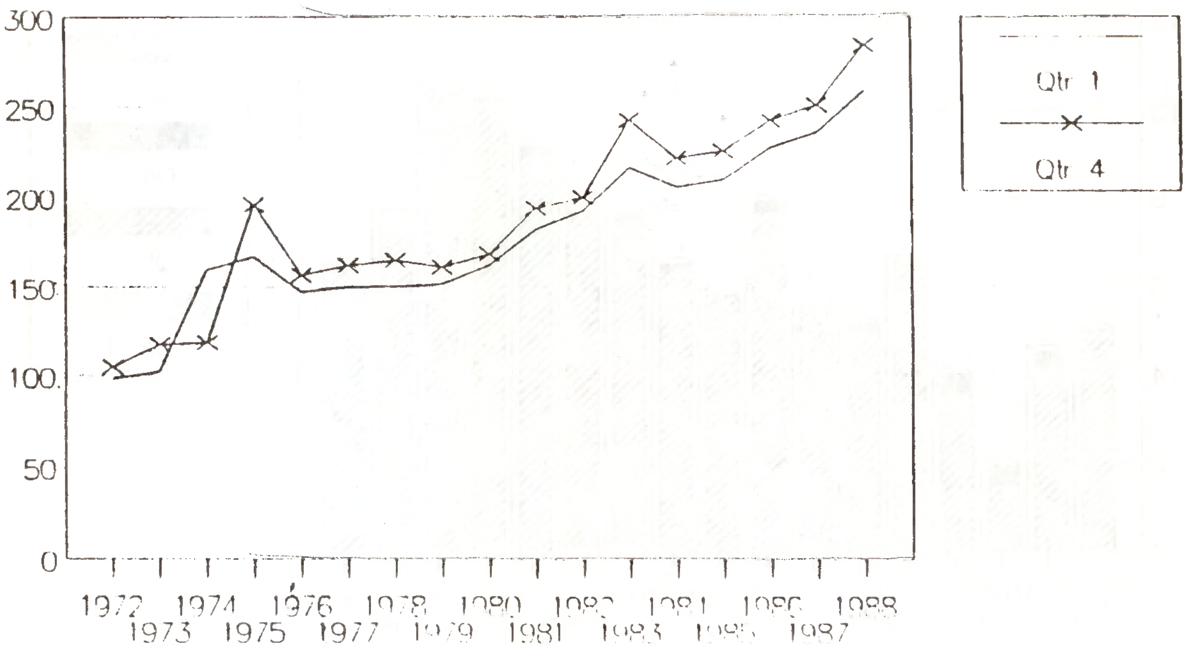

Fig 6 : First Quarter Price and Previous Year's Fourth Quarter Price

year t, at which the government offers to buy all grain that is offered to it. X_{it} is the level of public distribution grain sales in season i of year t. Let $\overline{P}_{at}$ be the equilibrium season a price if $PP_t = 0$ and PR_{it} be the procurement in season i of year t. Then equilibrium in the wheat market is characterized by the following conditons:

(1) $D(P_{at}) = h_t + X_{at} + S_{b,t-1} - S_{at} - PR_{at}$

(2) $P_{at} = \max\{PP_t, \overline{P}_{at}\}$ where $\overline{P}_{at} = D^{-1}(h_t + X_{at} + S_{b,t-1} - S_{at})$

(3) (a) If $S_{at} > 0$, $P_{at} = \beta(1-\delta)EP_{bt}$

(b) If $S_{at} = 0$, $P_{at} > \beta(1-\delta)EP_{bt}$

(4) $D(P_{bt}) = X_{bt} + S_{at} - S_{bt} - PR_{bt}$

(5) $P_{bt} = \max\{PP_t, \overline{P}_{bt}\}$ where $\overline{P}_{bt} = D^{-1}(X_{at} + S_{at} - S_{bt})$

(6) (a) If $S_{bt} > 0$, $P_{bt} = \beta(1-\delta)EP_{a,t+1}$ or

(b) If $S_{bt} = 0$, $P_{bt} > \beta(1-\delta)EP_{a,t+1}$

where β is the rate of discount and δ the rate of physical depreciation of a unit of stock. $\beta(1-\delta) < 1$ which means that there are real costs of storage. For simplicity, other costs of storage are ignored.

The first condition describes market equilibrium in season a. The second equilibrium condition says that (i) procurement price is not the season a market price unless it is greater than $\overline{P}_{at}$ and (ii) the procurement price is the market price whenever it is greater than $\overline{P}_{at}$. (i) follows from the fact that sales to government are voluntary while (ii) reflects the assumption that PP_t is a support price. Note that (1) can be rewritten, using the definition of $\overline{P}_{at}$, as $PR_{at} = h_t + X_{at} + S_{b,t-1} - S_{at} - D(P_{at}) = D(\overline{P}_{at}) - D(P_{at})$. Hence

(7) $$(a) \quad PR_{at} = 0 \text{ if } P_{at} = \overline{P}_{at}, \text{ i.e., when } PP_t \leq \overline{P}_{at} \text{ and}$$

$$(b) \quad PR_{at} > 0 \text{ if } P_{at} = PP_t, \text{ i.e., when } PP_t > \overline{P}_{at}$$

The third condition is a no-arbitrage condition between seasons *a* and *b*. If storage is profitable, it is carried upto the point that season a price is equal to the discounted expected season b price. If storage is unprofitable, season *a* price at the zero level of storage is greater than the discounted expected season *b* price. The fourth condition describes market equilibrium in season *b*. Equation (5) is similar to (2). The market price in season *b* is the maximum of the procurement price and $\overline{P}_{bt}$ which is the price that equates supply and demand in the absence of procurement. Just as (7) follows from (1) and (2), (4) and (5) imply

(8) $$(a) \quad PR_{bt} = 0 \text{ if } P_{bt} = \overline{P}_{bt}, \text{ i.e., when } PP_t \leq \overline{P}_{bt} \text{ and}$$

$$(b) \quad PR_{bt} > 0 \text{ if } P_{bt} = PP_t, \text{ i.e., when } PP_t > \overline{P}_{bt}$$

Finally, (6) is a no-arbitrage condition between season *b* of year *t* and season a of year $t+1$.

From the no-arbitrage conditions, it is clear that S_{bt}, i.e., the storage of grain from the second season to the first season of a new year, is profitable only if prices in the new year are expected to be higher than the prices in the second season of the previous year. With a stable demand, this can happen only if supplies in the first season of the new year are expected to be smaller than the supplies in the second season of the previous year. Since supplies in the first season of a year include the new harvest, it is not clear whether such inter-year private storage could be profitable. As noted earlier, the ex-post profitability of inter-year private storage of wheat is negative for virtually all of the 1970s and the 1980s. This suggests strongly that the ex-ante expected profitability is likely to have been negative as well and motivates our assumption that $S_{bt} = 0$ for all t. The equilibrium conditions then become.

(9) $$D(P_{at}) = h_t + X_{at} - S_{at} - PR_{at}$$

(10) $$P_{at} = \max\{PP_t, \overline{P}_{at}\} \text{ where } \overline{P}_{at} = D^{-1}(h_t + X_{at} - S_{at})$$

(11) (a) If $S_{at} > 0,\ P_{at} = \beta(1-\delta)EP_{bt}$

(b) If $S_{at} = 0,\ P_{at} > \beta(1-\delta)EP_{bt}$

(12) $D(P_{bt}) = X_{bt} + S_{at} - PR_{bt}$

(13) $P_{bt} = \max\{PP_t, \bar{P}_{bt}\}$ where $\bar{P}_{bt} = D^{-1}(X_{at} + S_{at})$

Private carryover, from season a to b, i.e., S_{at} depends on traders expectations of the level of public distribution sales in season b. Let $F(X_{bt} \mid I_t)$ be the cumulative density which represents the expectations of traders in season a about public distribution sales in season b.[13] The probability distribution is conditioned on an information set I_t. I_t may include statements of intentions from policy authorities about the level of PDS releases. But the weight attached to such pronouncements may very well depend on other variables in the information set (e.g., size of harvest, stocks with government, the economy wide inflation rate, world price). Since the distribution of the second season price is truncated below at PP_t, EP_{bt} can be written (from (9)) as

(14) $EP_{bt} = g(PP_t, S_{at}, \hat{X}_{bt}, \Phi)$

where g is a function, $\hat{X}_{bt}$ is a point forecast and Φ is a vector of other variables including other parameters of the density F as well as parameters of the distribution of the other variables which are predicted in season a (e.g., demand shifters).

If private storage and first season procurement are positive, the equilibrium conditions collapse into reduced form equations determining first and second season procurement. (10), (11) and (14) combine to yield

(15) $PP_t = \beta(1-\delta)\, g(PP_t, S_{at}, \hat{X}_{bt}, \Phi)$

which can be solved to yield a storage function

(16) $S_{at} = S_{at}(PP_t, \hat{X}_{bt}, \Phi)$

Substituting in (9), after using (10),

$D(PP_t) = h_t + X_{at} - S_{at}(PP_t, \hat{X}_{bt}, \Phi) - PR_{at}$ or

(17) $PR_{at} = h_t + X_{at} - S_{at}(PP_t, \hat{X}_{bt}, \Phi) - D(PP_t)$

which is the procurement equation, the derivation of which has used all the conditions of equilibrium except (12). (12) determines second season procurement which could also be written in a reduced form similar to (17).

There are two features of equation (17) which deserve attention. First, commodity market models usually derive a reduced form price equation (e.g. Gilbert and Palaskas, 1990; Ravallion, 1985). The difference here is that the price is set by the government

13. Public distribution sales are assumed to take place at market prices. Modeling the subsidy on these sales is not essential for our purpose.

and therefore what the market determines is the quantity procured by the government. Secondly, while storage theory suggests that storage depends on expected future price the reduced form equation contains X_{bt} rather than P_{bt} as the expectational variable. As the derivation here suggests, the equilibrium expected future price is endogenous and determined by the no-arbitrage condition. This leads speculators to forecast future supply-demand imbalances measured here by X_{bt}. The argument that reduced form equations should contain expected quantity variables rather than expected price variables has also been made by Gilbert and Palaskas.

Comparative Statics

To obtain comparative static results, some structure has to be imposed on the model. In particular, we need to be explicit about the process of expectation formation and the variables that enter the information set. We make the following assumptions: (*i*) traders need to forecast only PDS grain releases (*ii*) the consumption demand curve is linear (*iii*) the information set I_t includes GS_{at} and a vector Γ_t of other variables, where GS_{at} is the level of government stocks at the end of season a and (*iv*) Γ_t does not include h_t, X_{at}, PP_t.

To the above assumptions, we add the following identities governing the evolution of government stocks:

$$GS_{at} = GS_{b,t-1} + PR_{at} - X_{at} \tag{18}$$

$$GS_{bt} = GS_{at} + PR_{bt} - X_{bt} + M_t \tag{19}$$

where M_t is the volume of net imports of foodgrains. The above identities are self-explanatory except for the treatment of grain imports (by government) which is assumed to occur only in the second season. Imports are primarily used to compensate poor procurement and hence contracted in the second season after evaluating stock levels at the end of first season.

Assumptions (*i*) and (*ii*) simplify the analysis by reducing the elements of the Φ vector. To see this, let $F(\,.\mid I_t)$ be the cumulative density of X_{bt} on support $[X_1, X_2]$, where $0 < X_1 < X_2 < \lim_{p \to 0} D(p)$. Then

$$EP_{bt} = PP_t(1 - F(X_{mt} \mid I_t)) + \int_{X_1}^{X_{mt}} (d_0 - d_1(S_{at} + X_{bt})\, dF(X_{bt} \mid I_t)$$

where d_0 and d_1 are parameters of a linear demand curve and X_{mt} solves $PP_t = D^{-1}(S_{at} + X_{mt}) = d_0 - d_1(S_{at} + X_{mt})$. $(1 - F(X_{mt}))$ is the probability that season b PDS releases exceed X_{mt} which is also the probability that season b price settles at the level of procurement price. On the other hand, season b price is higher than the procurement price if PDS grain releases are less than X_{mt}.

Let $\hat{X}_{bt}(X_{mt}, I_t) = \int_{x_1}^{x_{mt}} X_{bt}\, dF(X_{bt} \mid I_t)$

The expression for expected price can be rewritten as

(20) $$EP_{bt} = PP_t(1 - F(X_{mt} \mid I_t)) + (d_0 - d_1 S_a) F(X_{mt} \mid I_t) - d_1 \hat{X}_{bt}(X_{mt}, I_t)$$

Thus the calculation of EP_{bt} involves the point forecast $\hat{X}_{bt}$ and the cumulative probability $F(X_{mt})$. X_{mt} itself depends only on PP_t and S_{at} and is not conditioned on the information set.

The force of assumption (iii) is to allow for the possibility that public distribution sales are constrained by the level of supplies with the government, measured by GS_a. We assume that a change in GS_a affects expectations in a manner such that $\partial \hat{X}_{bt} / \partial GS_a \geq 0$ and $\partial F(X_{mt}) / \partial GS_a \leq 0$, i.e. a higher level of government stocks revises upward the point forecast of PDS grain releases and also makes it more likely that season *b* price will be at the floor level of procurement price.[14] As noted earlier, speculative threats to the government's procurement efforts arise from a change in speculative expectations. Assumption (iii) allows us to examine the effect on procurement of speculative attacks induced by changes in the level of government stocks. Assumption (iv) rules out an independent influence of h_t, X_{at} and PP_t on $\hat{X}_{bt}$ except through GS_{at}. All these variables influence GS_{at} through PR_{at}. In addition, X_{at} affects GS_{at} directly.

We now derive the comparative statics of season a procurement and private storage when both are non-zero. For this to happen (i.e., a non-zero solution), two conditions must be satisfied. Firstly, private storage must be non-zero in the absence of procurement. This is because if private storage is zero even in the absence of procurement, then it would surely continue to be unprofitable when procurement is positive. Secondly, the procurement price must neither be "too high" or "too low" in a sense made precise below. If the procurement price is "too high", private storage will be driven to zero and if "too low", procurement will not take place. The satisfaction of these conditions depends on the state variables of the model which are h_t, PP_t, $GS_{b,t-1}$, X_{at} and Γ_t. This is stated in the following lemmas, the proofs of which are omitted here but are available from the authors.

Lemma 1: In the absence of procurement, the profitability of private storage depends on the harvest h_t, first season public distribution grain sales X_{at}, and on the elements of the information set, $GS_{b,t-1}$ and Γ_t.

14. It might seem more economical to assume that an increase in GS_a shifts the distribution of $\tilde{X}$ in the sense of first order stochastic dominance. While this guarantees $\partial F(X_{mt}) / \partial GS_a \leq 0$, it does not unfortunately ensure $\partial X_{bt} / \partial GS_a \geq 0$.

Lemma 2: (i) $\bar{P}_{at}$, the season a equilibrium price in the absence of procurement, is a function of the state variables h_t, X_{at}, $GS_{b,t-1}$ and Γ_t. (ii) If private storage is profitable in the absence of a policy of procurement (i.e., when $PP_t = 0$), there exists a P^* such that $\bar{P}_{at} < P^*$ and

(a) $PR_{at} = 0$ if $PP_t \leq \bar{P}_{at}$

(b) $PR_{at} > 0$ and $S_{at} > 0$ if $\bar{P}_{at} < PP_t < P^*$

(c) $S_{at} = 0$ if $PP_t \geq P^*$

In the comparative statics that follow, we therefore assume that private storage is positive in the absence of procurement. Without loss of generality, and for ease of exposition, the propositions are proved here for the special case when the probability that season b price falls to the level of procurement price is zero, i.e., $X_{mt} > X_2$ and $1 - F(X_{mt}) = 0$. The expression for expected season b price reduces to $EP_{bt} = d_0 - d_1 (S_{at} + \hat{X}_{bt}) = D^{-1}(S_{at} + \hat{X}_{bt})$ where $\hat{X}_{bt} = \int_{x_1}^{x_2} X_{bt}\, dF(X_{bt} \mid I_t)$ is the mean of the distribution of X_{bt}. The propositions remain valid in the general case when $1 - F(X_{mt}) > 0$.[15]

Proposition 1: If procurement price lies in the interval $(\bar{P}_{at}, P^*)$, an increase in harvest increases first season procurement and decreases private storage.

Proof : Consider a small increment in h_t. By the no-arbitrage condition of private storage, $EP_{bt} = PP_t/\beta(1-\delta)$. Procurement prices remaining unchanged, EP_{bt} remains unchanged. But the equilibrium distribution of P_{bt} is such that it satisfies $EP_{bt} = D^{-1}(S_{at} + \hat{X}_{bt})$. This means $(S_{at} + \hat{X}_{bt})$, the expected supplies in season b does not change. $\hat{X}_{bt}$ does not change since it does not depend on h. Hence the increment in h_t is not absorbed by private storage either. But equilibrium in season a requires

$$PR_{at} = h_t + X_{at} - S_{at} - D(PP_t)$$

The additional output must then be procured by the government, since nothing has happened to alter either season a demand or season a PDS grain supplies. Thus, procurement increases by the increment in output and private storage remains at previous levels. This is the first round effect. The increase in procurement leads to an equivalent increase in government stocks in season *a*. A second round of effects begins as traders expect the increase in government stocks to increase second

15. The proofs can be obtained from the authors, on request.

season PDS releases by $\partial \hat{X}_{bt} / \partial GS_a$. To keep season *b* expected supplies constant, private storage decreases by an equivalent amount which, since it cannot be absorbed anywhere else, is procured by the government. The resulting increase in public stocks leads to a third round of decrease in private storage equal to $(\partial \hat{X}_{bt} / \partial GS_a)^2$ which again ends up being procured by the government. Continuing this way, the cumulative sum of the changes in procurement and private storage are

$$(21) \qquad \partial S_{at} / \partial h_t = 0 - \partial \hat{X}_{bt} / \partial GS_a - (\partial \hat{X}_{bt} / \partial GS_a)^2 - (\partial \hat{X}_{bt} / \partial GS_a)^3 + \ldots\ldots$$

$$= \frac{-\partial \hat{X}_{bt} / \partial GS_a}{1 - \partial \hat{X}_{bt} / \partial GS_a} < 0$$

$$(22) \qquad \partial PR_{at} / \partial h_t = 1 + \partial \hat{X}_{bt} / \partial GS_a + (\partial \hat{X}_{bt} / \partial GS_a)^2 + (\partial \hat{X}_{bt} / \partial GS_a)^3 + \ldots\ldots$$

$$= 1 \frac{+\partial \hat{X}_{bt} / \partial GS_a}{1 - \partial \hat{X}_{bt} / \partial GS_a} > 0$$

If $\partial \hat{X}_{bt} / \partial GS_a < 1$. the stability condition is not satisfied, all private stocks will be sold to the government. Since $\partial \hat{X}_{bt} / \partial GS_a \geq 0$, a unit change in harvest causes, at least, a unit change in procurement in the same direction.

Proposition 2. If procurement price lies in the interval $(\bar{P}_{at}, P^*)$, an increase in procurement price decreases private storage and increases first season procurement.

Proof : The proof is similar to that of Proposition 1. A small increase in procurement price increases EP_{bt} by $1 / \beta (1 - \delta)$. But $EP_{bt} = D^{-1} (S_a + \hat{X}_{bt}) = d_0 - d_1 (S_{at} + \hat{X}_{bt})$. The expected level of PDS supplies remaining unchanged, private storage decreases by $(1 / d_1 \beta (1 - \delta))$. Since

$$PR_{at} = h_t + X_{at} - S_{at} - D(PP_t)$$

procurement increases due to the decrease in private storage and decrease in first season consumption. The resulting increase in procurement is $[(1 / d_1 (\beta (1 - \delta)) + 1 / d_1]$. This is the first round effect. In the second round, the change in procurement causes expected PDS supplies to increase by $(\partial \hat{X}_{bt} / \partial GS_a) [(1 / d_1 (\beta (1 - \delta)) + 1 / d_1]$. To keep EP_{bt} constant, private storage declines by an equivalent amount which is consequently absorbed by procurement. A third round of contractions in private storage and increases in procurement begins because of the increase in expected PDS supplies by $(\partial \hat{X}_{bt}/\partial GS_a)^2 [(1/d_1(\beta(1-\delta)) + 1/d_1]$. Continuing this way, the cumulative sums of the changes in private storage and procurement are

$$\text{(23)} \quad \partial S_{at}/\partial PP = -(1/d_1 \beta(1-\delta)) - (\partial \hat{X}_{bt}/\partial GS_a)[(1/d_1(\beta(1-\delta))+1/d_1] -$$

$$(\partial \hat{X}_{bt}/\partial GS_a)^2 [(1/d_1(\beta(1-\delta)) + 1/d_1] - \ldots\ldots$$

$$= -(1/d_1 \beta(1-\delta)) - \frac{(\partial \hat{X}_{bt}/\partial GS_a)[(1/d_1(\beta(1-\delta)) + 1/d_1]}{1 - \partial \hat{X}_{bt}/\partial GS_a}$$

$$= -(1/d_1 \beta(1-\delta)) \left[\frac{1}{1 - \partial \hat{X}_{bt}/\partial GS_a}\right] - (1/d_1)\left[\frac{(\partial \hat{X}_{bt}/\partial GS_a)}{1 - \partial \hat{X}_{bt}/\partial GS_a}\right]$$

$$= \frac{-[1 + \beta(1-\delta)(\partial \hat{X}_{bt}/\partial GS_a)]}{\beta(1-\delta) d_1 [1 - (\partial \hat{x}_{bt}/\partial GS_a)]} < 0$$

$$\text{(24)} \quad \partial PR_{at}/\partial PP = [(1/d_1(\beta(1-\delta))+1/d_1] + (\partial \hat{X}_{bt}/\partial GS_a)[(1/d_1 \beta(1-\delta))+1/d_1]$$

$$+ (\partial \hat{X}_{bt}/\partial GS_a^2)[(1/d_1(\beta(1-\delta)) + 1/d_1] + \ldots\ldots$$

$$= (1/d_1) + [(1/d_1(\beta(1-\delta)) + (\partial \hat{X}_{bt}/\partial GS_a)[1/d_1(\beta(1-\delta))$$

$$+ 1/d_1] + (\partial \hat{X}_{bt}/\partial GS_a^2)[(1/d_1(\beta(1-\delta)) + 1/d_1] + \ldots\ldots$$

$$= (1/d_1) - \partial S_{at}/\partial PP_1$$

$$= (1/d_1) + \frac{[1 + \beta(1-\delta)(\partial \hat{X}_{bt}/\partial GS_a)]}{\beta(1-\delta) d_1 [1 - (\partial \hat{X}_{bt}/\partial GS_a)]} > 0$$

provided the stability condition $1 - \partial \hat{X}_{bt}/\partial GS_a > 0$ is satisfied. The comparative statics establish the point that market responses to exogenous shocks are not independent statics establish the point that market responses to exogenous shocks are not independent of market receptions of the policy regime. The larger is $\partial X_{bt} / \partial GS_a$, the larger is the magnitude, in absolute terms, of market responses.[16]

4. AN EMPIRICAL MODEL

Model and Estimation Method

Under the assumption of linear demand and that traders forecast only X_{bt}, the equilibrium expected season *b* price is

$$EP_{bt} \mid I_t = PP_t (1 - F(X_{mt} \mid I_t)) + (d_0 - d_1 S_a) F(X_{mt} \mid I_t) - d_1 \hat{X}_{bt}(X_{mt}, I_t)$$

where $X_{mt} = (d_0 - PP_t)/d_1 - S_{at}$ and $\hat{X}_{bt}(X_{mt}, I_t) = \int_{x_1}^{x_{mt}} X_{bt} \, dF(X_{bt} \mid I_t)$

In the empirical model, we additionally assume $F(X_{mt}) = 1$. The assumption is strongly supported by data where procurement has been negligible in periods other than the first quarter of a marketing year (*season a*). It is very unlikely that traders assign any positive probability to the event that prices never rise above the procurement price. With this simplification, $EP_{bt} \mid I_t = d_0 - d_1 (S_{at} + \hat{X}_{bt}(I_t)) = D^{-1}(S_{at} + \hat{X}_{bt}(I_t))$ where $\hat{X}_{bt}(I_t)$ is the expected level of PDS releases conditional on the available information. Substituting into the no-arbitrage condition, $PP_t = \beta(1 - \delta) D^{-1}(S_{at} + \hat{X}_{bt}(I_t))$ from which S_{at} can be solved as a function of PP_t, $\hat{X}_{bt}$ and demand shifters represented by the vector Θ. Substituting the storage function into the equilibrium condition for season a, we have a reduced form procurement equation:

$$PR_{at} = h_t + X_{at} - S_{at}(PP_t, \hat{X}_{bt}(I_t), \Theta) - D(PP_t) \qquad (25)$$

which is the empirical version of equation (17).

Although the complete model consists of (25) and a forecasting equation for $\hat{X}_{bt}$, we estimate only (25) using the instrument variable technique of estimating single-equation models with expectational variables (McCallum, 1976). In this procedure, the expectational variable in the equation is replaced by its actual value and the equation estimated using appropriate instruments. The advantage of this procedure, besides its simplicity, is that it obviates the necessity to specify the forecasting equation. The disadvantage is that the procedure is not efficient although it yields consistent estimates. Note, however, that even if speculators were blessed with perfect foresight with respect to X_{bt}, the instrument variables method or some other simultaneous equations method of estimation would be necessary to avoid possible simultaneous equation bias. This can arise, for instance, when $\hat{X}_{bt}$, is indeed conditioned on

16. The comparative statics with respect to the other exogenous variables are not presented here but are available from the authors.

GS_{at}. Since shocks to procurement affect GS_{at}, the error term in the procurement equation would not be independent of $\hat{X}_{bt}$.

Data

The data set consists of time series observations from marketing year 1970/71 to 1990/91. For earlier years, seasonal data (particularly on PDS releases) is not available in published form. It may also be noted that the public distribution system during those years was heavily import dependent. and the competition with private trade relatively slight. So even if the data were available in appropriate form, there may be good reasons for excluding it. The data were obtained from various issues of the following Government of India publications: Bulletin of Food Statistics (Annual), Economic Survey (Annual), and the Statistical Panorama (1990) of the Food Corporation of India.

As noted earlier, the wheat marketing year in India runs from April to March. In the empirical implementation, we assume that season a consists of the months April, May and June. Season *b* consists of the months from July to March. In the theoretical model, season *a* is identified by two features. Firstly, the new harvest arrives in season a. Secondly, the market price in season *a* is equal to the procurement price whenever procurement is positive. These characteristics are displayed by our division of the wheat marketing year where we have defined the first quarter of the marketing year to be season a. The close correspondence between first quarter wheat prices and procurement prices has been noted earlier in Figure 4.[17]

For the dependent variable, however, we do not construct the series PR_{at} since virtually all procurement is in season a. Instead, we consider the dependent variable to be PR_t which is the time series of aggregate wheat procurement. The seasonal disaggregation is used to construct the series X_{bt}. In all results reported here, X_{bt} is the per capita sales of wheat from the public distribution system during season b.[18] The procurement price series PP_t was obtained by deflating the nominal value by a season *a* wholesale price index of all commodities. h_t in the empirical model is identified with wheat output in that marketing year although marketed output might be the more appropriate variable. Finally, the regressions include lagged per capita income (Y_{t-1}) and lagged annual inflation rate as demand side variables.[19] Y_{t-1} would be expected to have a negative effect on procurement because it increases consumption demand in both seasons and therefore increases private storage. If

17. Naturally, the close correspondence would also be displayed by time periods ending before June. The first quarter of April-June is typically the longest period of time for which the procurement price is the market price.

18. The results were not altered any respect when per capita sales were replaced by aggregate PDS sales.

19. The inflation rate is computed from the wholesale price index of all commodities between April of year t and April of year $t-1$.

commodities are a hedge against inflation, inflation would also increase private storage and reduce procurement.

Results

In order to check the time series properties of the variables involved, we tested the logarithm of each time series for non-stationarity. Using the Dickey-Fuller test (Fuller) and allowing for deterministic linear trends in h_t, PP_t and Y_{t-1}, we found that the null of a unit root is not rejected at the 5% level by any of the series, except for X_{bt}[20] and the inflation rate.

Since these results suggest that a regression in levels is inappropriate, we adopted the two step procedure of Engle and Granger (1987). Here the first step is to test for cointegration between the non-stationary variables which are of the same order of integration. The result of the hypothesized cointegrating regression was as follows:

$$PR_t = -10.85 + 2.52h_t + 1.44PP_t - 1.10Y_{t-1} \tag{26}$$

$$DW = 2.37, \quad R^2 = .88$$

where all variables are in logs and the *t*-radios, being biased, are not reported.

The variables in (26) are said to be cointegrated if the estimated residuals are stationary i.e., if the null of a unit root in the residuals is rejected. The augmented Dickey-Fuller statistic (with 2 lags) was -5.15 which allows us to reject the null of unit root even at the 1% level. Thus, PR_t, h_t, PP_t and Y_{t-1} can be accepted to be cointegrated pointing to the existence of a long run equilibrium relationship between these variables.

The second step in the procedure of Engle and Granger consists of estimating (26) in first differences adding as additional variables an error correction term (the lagged residual from the first regression) as well as X_{bt} and the lagged inflation rate. The error correction is usually interpreted as representing adjustments to the equilibrium error that occurred in the last period (Granger, 1986). While X_{bt} and the inflation rate are omitted from the first regression, they are included in the second regression as the other variables are first differenced to induce stationarity. The results of the second stage regression are displayed in Table 2.

The two columns report instrument variable and ordinary least squares estimates of the model. In the instrumental variable estimation, $\Delta GS_{b,t-1}$ (change in year end stocks) and X_{bt-1} as well as the other exogenous variables in the regression are used as instruments for X_{bt}. The elasticity of procurement with respect to X_{bt}, while of the expected sign, is small and insignificant. Further, use of the instrument does not make much difference to the estimates. The coefficients of the other variables

20. For X_{bt}, the null of unit root was rejected no matter whether the time series was per capita season *b* PDS sales or aggregate season *b* PDS sales.

Table 2
Estimation of the Error Correction Model

Independent Variables	Dependent Variable : Procurement	
	IV	OLS
Constant	.06 (.05)	0.14 (0.26)
Harvest	1.79 (3.15)	1.77 (3.80)
Procurement Price	1.41 (1.93)	1.39 (2.04)
Per Capita Income (lagged)	-2.74 (-2.38)	-2.75 (-2.40)
Error Correction	-1.25 (-5.90)	-1.24 (-5.93)
Inflation rate (lagged)	-1.62 (-2.41)	-1.64 (-2.69)
Public Distribution Sales (Season b)	0.06 (0.11)	0.03 (0.11)
DW-Statistic	1.88	1.87
Standard Error	0.13	0.13
R^2	----	0.90
F statistic (Degrees of freedom)	----	20.14 (6,13)
Chow test : *F* statistic (Degrees of freedom)	----	0.36 (3,12)
Normality Test $\chi^2(2)$	----	0.49

Notes : Procurement, Harvest, procurement price and per capita income are in first differences of logs while public distribution sales is in log levels. The Time period is 1971-72 to 1990-91. *t*-ratios are in parantheses. The Chow test is for a three period forecast.

are of the expected sign in all the regressions. The harvest, the error correction and the demand shifters are significant at the 5% level. The coefficient of the error correction term is negative which is consistent with its adjustment cost interpretation. Procurement price is significant at the 10% level in the first two columns and marginally significant at the 5% level in the third column. The diagnostics on OLS residuals are favourable to the model. In particular, the null of predictive stability (Chow test) is not rejected at the 5% level in either the second or third column.

The insignificance of X_{bt} suggests one of the following explanations: (a) that speculators are not forward looking or (b) that speculators are forward looking but PDS sales are not important in price formation or (c) that speculators are forward looking and PDS sales are important in price formation but the policy regime has been such that forecasts of PDS sales have not fluctated much relative to procurement. Given that government stocks GS_{at} have varied tremendously over this period, the implication of the last explanation is that $\hat{X}_{bt}$ is in fact not conditioned on GS_{at}.

Not only is it hard to believe that speculators are not forward looking, the proportion of market sales accounted by PDS is too large for PDS to be unimportant in price determination. It seems to us that the data best supports the third interpretation. Since government stocks obey a non-stationary process while X_{bt} is stationary, the issue cannot be immediately settled by regressing X_{bt} on GS_{at}. An indirect test can be found by noting that if $\hat{X}_{bt}$ is not conditioned on GS_{at}, then GS_a would be a poor predictor of X_{bt} but a good predictor of the ratio X_{bt} / GS_a. Suppose θ_t is the fraction of government stocks (at the end of season a) which is released in PDS sales the next season. Then $X_{bt} = \theta_t GS_{at}$ and $\partial X_{bt} / \partial GS_{at} = \theta_t + (\partial\theta/\partial GS_{at}) GS_{at} = \theta_t(1 + \varepsilon_t)$ where $\varepsilon_t = (\partial\theta_t / \partial GS_{at})(GS_{at}/\theta_t)$. If $\partial X_{bt} / \partial GS_{at}$ is zero, the elasticity of θ with respect to GS_{at} must be -1, If this is the policy regime, the government releases a high proportion when stocks are low and a small proportion when stocks are high. To test this, the following regression was computed:

(27) $$\theta_t = 6.99 - 0.82 GS_{at}, \quad t = 1970 \ldots . 1990$$

$$DW = 2.05, \quad R^2 = .93$$

where the variables are in natural logs. The elasticity estimate of $-.82$ indicates considerable stabilization. However, since both θ and GS_a fail stationarity tests, the significance of the estimates cannot be established from (27). The residuals from (27) were, however, found to be stationary indicating cointegration between θ_t and GS_{at}. Accordingly, the following model was estimated:

(28) $$\Delta\theta_t = \underset{(-13.46)}{-0.98\,\Delta GS_{at}} - \underset{(-5.48)}{1.14\hat{U}_{t-1}}$$

$$DW = 2.18, \quad R^2 = .91, \quad F(2.18) = 94.1, \quad \text{Chow Test } F(3,15) = .12$$

where $\hat{U}_t$ is the estimated residual from the regression in (28). The stability of the estimated relationship is attested by the F statistic on the Chow test for parameter constancy. The model with error dynamics indicates an elasticity of θ very close to one which confirms the argument that speculative expectations of public distribution sales have not been conditioned on government stocks.

5. CONCLUDING REMARKS

This paper has modelled procurement within a two period seasonal model where the alternative to selling to the government is to carry the crop for sale at a later date. It is then natural to consider the effect of speculative activities on procurement. On the other hand, by neglecting the fundamental seasonal trade-offs involved in the decision to sell to the government, earlier models of procurement did not properly specify the choices open to grain sellers.

In examining the interplay between procurement and speculation, the basic presumption is that the anticipated behavior of the public authority guides price expectations of speculators. In this connection, it is often suggested that speculators look at the stocks with government to predict government grain sales. This view and its consequences have been modelled and put to test here. The results suggest that speculator's expectations of government grain sales have been stable in the Indian wheat market over the period 1970-1990. This has occured inspite of large fluctuations in the level of stocks with the government. The explanation seems to lie in the policies pursued by the government. In years of poor procurement and low stocks, the government has imported the amounts necessary to supply the public distribution system. In years of high procurement and thus large stocks, the government has preferred to carry rather than unload them in the market. The commitment to the public distribution network has been constant and credible which has helped to ward-off speculative attacks on procurement.

The Indian experience points to the useful role of imports in maintaining the credibility of a food security system based overwhelmingly on domestic supplies. In bad years, when public stocks are low, supplies to the public distribution network are affected by poor harvests as well as by speculative expectations. In such instances, a commitment to service the public distribution network, if necessary by imports, lowers the cost of domestic supplies. If such credibility is not perceived, speculative attacks may seriously affect the government's ability to maintain a steady level of supplies to the public distribution system. Thus, even in a virtually autarkic setup such as that of India, trade has played an important role in ensuring the stability of the PDS. By thwarting speculative attacks, the marginal value of the import option has exceeded the value that might be indicated by its marginal role as a source of supply to the PDS.

The importance of credibility in public interventions is illustrated by the experience of Bangladesh. The 1974 famine was marked by more than a 100% increase in the price of foodgrains (Osmani (1990)). A probable cause, according to Ravallion (1985), was exaggerated reports of crop damage which led traders to overestimate future scarcity. Furthermore, speculative expectations were unrestrained by the belief "... that the Government would be unable to implement a suitable stabilizing response to the reported damage to the future crop" (Ravallion, 1985, pp 28). However, in 1979 and again in 1984, when equally if not more severe crop losses were feared (and ultimately not realized) the extent of price rise was far less (35% and 10% respectively). Osmani (1990) attributes the change in speculative behaviour in 1979 and 1984 to greater confidence in the ability of the authorities to augment supplies through imports.

These arguments lead to the view that the credibility of public intervention is based not just on the level of public stocks but also on the government's ability to import food measured presumably by the level of foreign exchange reserves. Osmani (1990), for instance, argues that the Bangladesh public distribution gained credibility in 1979 and 1984 because of the level of foreign exchange reserves at those times. Seen in this context, the requirements of credibility have possibly worked to limit the Indian public distribution network to a level which the authorities have found possible to commit. A higher level of food imports is constrained not only by economic factors but also by political considerations.[21]

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21. Imports are politically embarrassing as they seem to negate the declared objective of self-sufficiency.

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