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Effects of pricing policy on seasonal storage of wheat in Pakistan

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ABSTRACT

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Most studies of stockholding in less developed countries have concentrated on public, interannual stocks. A recent change in Pakistan government policy for the pricing of wheat highlights the need to examine seasonal storage issues, considering explicitly the effects of policy on the behavior of private agents who hold seasonal stocks of grain. Using H. Working's supply of storage theory and a simple monthly model, implications of the policy change for fiscal cost, private storage, and government procurement are explored. Costs of the policy could be reduced dramatically by increasing marginally the gap between the procurement and release price. Expected cost to the consumer of a wider gap would be no larger than under the previous policy.

INTRODUCTION

Governments of less developed countries have a legitimate concern for the price and availability of the staple food. Periods of shortage and high price can lead to declines in real income, nutritional deprivation, and political crises. Most governments therefore are unwilling to rely exclusively on private market agents for supplying food.

The consequent government interventions frequently include procurement of the staple during surplus periods and disposal of supplies during deficit periods. Economists analyzing these issues have generally considered the surplus and deficit time periods as years, investigating efficient storage, trade, and/or price policies for countering interannual production instability. Theoretical work has questioned whether or not stabilizing prices – even if it can be done costlessly – is welfare-enhancing (Waugh, 1944; Oi, 1961;

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Massell, 1969; Samuelson, 1972; Wright and Williams, 1988). Most applied studies, noting that poor consumers are limited in their ability to balance a loss in real income in one period with a gain in another, have accepted governments' goal and examined how policies can be designed to stabilize prices efficiently (Gustafson, 1958; Reutlinger et al., 1976; Gardner, 1979; Krishna and Chhibber, 1983; Pinckney, 1988).

As valuable and pathbreaking as some of these contributions have been, however, with few exceptions (Mears, 1981; Lowry et al., 1987) applications have ignored seasonal issues. Yet seasonal stocks are typically several orders of magnitude larger than interannual stocks, and seasonal price changes frequently are larger than movements in average annual prices between years. Scarcity usually occurs during the pre-harvest period, and poor consumers, particularly children, are most at risk at that time (Sahn, 1989). So governments concerned with the price and availability of the staple food cannot ignore seasonal issues.

In addition to a concentration on interannual issues, economic research in this area has been concerned almost exclusively with government stocks since data on private stocks are virtually nonexistent. Studies of interannual pricing and storage policy may be able to argue that changes in end-year private stocks are relatively small and thus can be ignored, particularly when government is expected to intervene to stabilize prices across years. It is well known, however, that changes in private seasonal stocks are quite large. In addition, conceivably such stocks could respond dramatically to government policy if producers constitute a major component of demand and have the option of storing their own production or selling at harvest and buying back from the government at a later date. Certain types of government intervention could make such behavior rational.

Thus, governments desiring to assure reasonable supplies and prices of the staple food must be concerned with seasonal price changes; yet any policy that influences the expected pattern of seasonal prices will have an impact on private storage behavior. These changes in storage behavior could have important impacts on the efficiency cost to the economy and fiscal cost to the government of different possible interventions.

A recent policy change towards wheat pricing in Pakistan provides an opportunity to consider these issues for a particular country. After a description of the policy environment and an examination of previous seasonal price patterns, the following section estimates the size of private seasonal storage. The next section details and estimates a model of private seasonal storage based on Working's (1949) supply of storage theory. Estimates are made of the sensitivity of adjustments in private storage to expected price changes. The concluding section considers implications for policy and policy analysis.

DE-RATIONING OF WHEAT IN PAKISTAN

Early in 1987, the government of Pakistan announced that it was phasing out its ration shop system, which had been in place for over 40 years (Alderman, 1988a). Instead of providing set quantities at a highly subsidized price to a limited segment of the population, the new policy requires the government to sell all that the market will buy at a set price. [1] Thus, the government is setting a maximum market price, fundamentally altering the relationship of the Pakistan government to the wheat market. Since the government continues the policy of buying all wheat offered at a pre-announced procurement price, the difference between the government selling and buying price in effect puts a cap on the seasonal price rise in the private market.

Historically, the private wheat market has been officially sanctioned and supported by the government, unlike in many less developed countries where private markets have been tolerated but are in fact illegal. The result has been an active private market in wheat trading. In past years, prices in the private market have shown a marked seasonal pattern, with May/June harvest prices close to the government procurement price, afterwards rising to a peak in January before levelling off and falling dramatically in April. The seasonal price rise is shown in Fig. 1. Since the scale is the average ratio

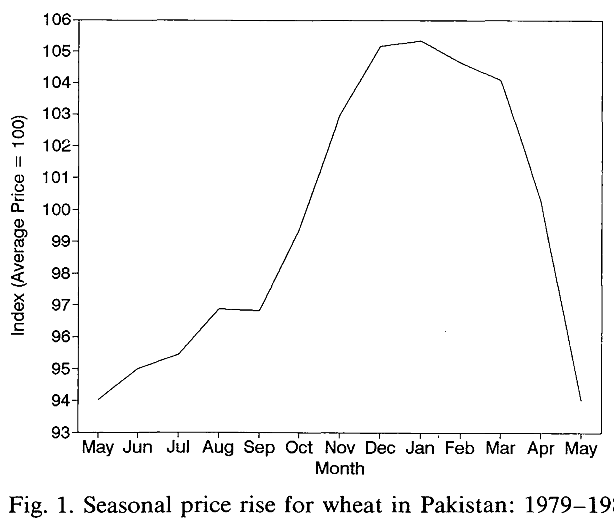

Fig. 1. Seasonal price rise for wheat in Pakistan: 1979–1987.

[1] Since most of the supplies earmarked for the ration shops did not reach the intended beneficiaries but were diverted into the open market, the change in policy was not as dramatic as it appears. See Alderman et al. (1988).

of each month's price to a 12-month moving average, the 12% rise presented in the figure is in real terms. [2] In nominal terms, the average price rise in these markets – measured as the rise from the three harvest months to the three highest-priced months – from 1978/79 to 1985/86 is 18%, with the range from 8.5% to 23.3%. [3] Considering price rises in individual markets during this time period, three-fourths of all the price rises are between 10%and 25% while price rises greater than 10% occurred 90% of the time. This contrasts sharply with the 1987/88 pricing structure, which allowed only a 4% difference between the procurement price and the release price, far less than the government handling costs. The reasonably secure 10% price rise under the old system seems to have been undermined by the new policy. Whether or not such a change in expected seasonal prices is important depends upon the size of private storage and its responsiveness to price changes.

SIZE OF PRIVATE STORAGE

The normal seasonal pattern of price rises has given the private sector, particularly surplus farmers, an incentive to store wheat from harvest until the later months in the marketing year. Knowing how much has been stored in different months in different years, however, is difficult, as there have been no national surveys of farmers, traders, and millers that collected such data.

Table 1 presents a monthly time series of minimum estimates of private storage. It was constructed with the aid of the following three assumptions:

(1) Market arrival of production is assumed to be distributed across months in the same proportion as procurement for each year.
(2) Losses of 10% are incurred at the time of market arrival.
(3) Private stocks at the end of April from the previous year's harvest are assumed to be zero.
(4) Per-capita consumption is assumed to be constant across months within a marketing year, with total consumption in the marketing year equal to production less 10%, plus offtake from government stocks, minus procurement.

[2] The index was developed by constructing a weighted average time series of wholesale prices for six markets (Multan, Faisalabad, Hyderabad, Lahore, Okara, and Sargodha) from 1979 to 1987, with the weights determined by average share in total procurement since this should reflect the extent of wheat available for storage. A seasonal index was then constructed for this weighted average series using the ratio to moving average method. Data from the Federal Bureau of Statistics were used in the analysis.

[3] The price rises in 1977/78 were considerably higher in the months following the coup and the declaration of martial law.

These last three assumptions are simplifications which bias the estimate of private stocks downwards. The estimate is thus a lower bound for private storage.

TABLE 1

Estimated private storage of wheat in Pakistan, 1983–1987

Year	month	Annual production	Market arrival of production	Procurement	Offtake	Estimated private storage
				(1000 ton)		
1983/84	May	12414	4535	1551	235	2570
	Jun		5106	1746	147	5205
	Jul		957	327	146	5106
	Aug		211	72	179	4546
	Sep		70	24	181	3894
	Oct		1	0	217	3231
	Nov				263	2610
	Dec				316	2040
	Jan				385	1537
	Feb				399	1046
	Mar				420	573
	Apr		452	105	363	388
1984/85	May	10882	7523	1747	186	5430
	Jun		1637	380	172	5937
	Jul		142	33	227	5348
	Aug		39	9	243	4693
	Sep				266	4030
	Oct				285	3383
	Nov				306	2754
	Dec				366	2184
	Jan				441	1686
	Feb				397	1141
	Mar		21	5	431	644
	Apr		1376	331	372	1114
1985/86	May	11703	7864	1892	254	6399
	Jun		1023	246	220	6452
	Jul		229	55	233	5913
	Aug		21	5	229	5210
	Sep				241	4500
	Oct				259	3806
	Nov				285	3135
	Dec				317	2494
	Jan				352	1886
	Feb				361	1284
	Mar		17	7	378	707
	Apr		701	282	345	504

TABLE 1 (continued)

Year	month	Annual production	Market arrival of production	Procurement	Offtake	Estimated private storage
				(1000 ton)		
1986/87	May	13916	7343	2952	297	4279
	Jun		3473	1396	231	5672
	Jul		853	343	247	5512
	Aug		129	52	244	4913
	Sep		7	3	255	4251
	Oct				265	3591
	Nov				276	2941
	Dec				311	2322
	Jan				351	1742
	Feb				347	1156
	Mar		6	2	432	655
	Apr		921	325	389	702

Given these assumptions, private storage at the end of any month is equal to private storage at the beginning of the month plus net production plus offtake minus procurement minus consumption:

$$\mathrm{PS}_{t+1} = \mathrm{PS}_t + Q_t + O_t - \mathrm{PC}_t - C_t \tag{1}$$

where PS_t is private storage at the beginning of month t, Q_t is production in month t, O_t is offtake from government stocks during the month, PC_t is government procurement, and C_t is consumption during the month (since the government controls all foreign trade, exports and imports only affect private stocks and consumption through procurement and offtake). The results in the last column of Table 1 show large amounts in private storage, with 5–6 million tons being held at the end of July of each year.

These private stocks are held for at least four purposes. Some traders are holding for later sale; millers are holding for later processing; farmers are holding for later sale; and farmers as well as consumers are holding for own consumption. It would be useful to know how much of this private storage is held for each of those purposes. Unfortunately, this is not possible both because of a lack of micro-level data and because the farmers themselves may shift their intended use depending on prices. The most that can be said about the breakdown is that farmers hold the vast majority of private stocks at the end of July, since a recent study reports that total storage capacity of traders and millers is only 1.1 million tons (Agroprogress, 1986).

metric ton = 1000 kg.

SUPPLY OF STORAGE MODEL

A 12-month model with no uncertainty is used here to estimate the effects of government price policy on private storage in a normal production year. Supply S_t in any month equals the opening private stocks, PS_t, plus the amount harvested during the month, Q_t, plus offtake from government stocks, Q_t:

$$S_t = \text{PS}_t + Q_t + O_t \qquad Q_t = 0 \quad \text{for} \quad 3 < t \leqslant 12 \tag{2}$$

Time t equals 1 in the largest harvest month, May. Harvested amounts Q_t are exogenous, and equal to 0 between August and March. Supply is apportioned between carry-out private stocks PS_{t+1} consumption C_t, and government procurement PC_t:

$$S_t = \text{PS}_{t+1} + C_t + \text{PC}_t \tag{3}$$

Consumption is a function of price:

$$C_t = f(P_t) \tag{4}$$

while offtake and procurement are functions of price and the release (PR) and procurement (PP) prices. Procurement is zero when the price is above the procurement price, but offtake does not go below a minimal level which is required to support the population in farflung, permanently-deficit areas:

$$\text{PC}_t = g_1(\text{PP},\ P_t) \qquad g_1 = 0 \qquad \text{for} \quad \text{PP} < P_t \tag{5}$$

$$O_t = g_2(\text{PR},\ P_t) \qquad g_2 = O_{\min} \qquad \text{for} \quad \text{PR} > P_t \tag{6}$$

The remaining equation is for the supply of storage. Since this is a certainty model, at time t the expected price for time $t+1$ equals the eventual price at time $t+1$. Therefore, the amount held in store at time t is a function of the present price and next period's price. In addition, this storage function may shift across months, particularly in an economy with a large number of subsistance producers:

$$\text{PS}_t = h_t(P_t,\ P_{t+1}) \tag{7}$$

Finally, pre-harvest prices and storage in successive years are assumed to be equal since this is a certain, normal production year model:

$$\text{PS}_0 = \text{PS}_{12} \tag{8}$$

$$P_0 = P_{12} \tag{9}$$

Setting equations (2) and (3) equal to each other and substituting yields:

$$\text{PS}_t + Q_t + g_2(\text{PR},\ P_t) = \text{PS}_{t+1} + f(P_t) + g_1(\text{PP},\ P_t) \tag{10}$$

Using Equations (7) through (10), the policy model reduces to a set of 24 non-linear equations in 24 unknowns: one balance equation and one storage equation for each month.

In applying the model, the demand function is assumed to be constant elasticity with an own-price elasticity of -0.25. This is a reasonable guess for a staple food in a poor country, although some recent estimates are considerably higher (Alderman, 1988b). Results are insensitive to the size of this parameter. Prices are calibrated in Rs. per 40 kg, a standard unit of measure in Pakistan.

The modeling for the supply of storage equation is key to producing a reasonable approximation of reality. Most analysts make a distinction between 'working' or 'pipeline' stocks and 'speculative' stocks, with the latter held sensitive to changes in expected (or futures) prices and the former not. 'Speculative' stocks are assumed to be subject to intertemporal arbitrage, and thus are held only when the expected change in price is greater than the total cost of storage, including physical costs and interest charges (or the appropriate opportunity cost of capital). This is the assumption made by Lowry et al. (1987). The implication of such an assumption for a certainty model is that whenever stocks are held, the price rise equals the cost of storage. The result carries over to models with uncertainty when expectations are rational, as in the Lowry et al article.

The intertemporal arbitrage assumption, however, is not tenable. Expected price increases equal to the full cost of storage are rarely found empirically. The seasonal price pattern for Pakistan shown in Fig. 1, which holds in the presence of large stocks, does not support such a model. Nor is support forthcoming from the large number of studies of futures markets relating the price spread between contracts to the size of stocks (Brennan, 1958; Gray and Peck, 1981).

The preferred method for modeling the supply of storage follows Working (1949) and the empirical studies. Figure 2 presents a stylized version of the supply of storage function, comparing the general shape formulated by Working and verified in the empirical studies to the shape that results from the normal intertemporal arbitrage assumption. The key difference is that in Working's formulation, there is no clear distinction between 'pipeline' stocks and 'speculative' stocks. Stockholding is an increasing function of the difference between the expected price (or futures price in most of the empirical work) and the present price, even if the difference is negative. Thus, the empirical studies show that if prices are expected to fall in the next month, market actors will hold fewer stocks than if prices are expected to

Rs., Pakistan rupees: US$1.00 = Rs.17.4 (1987).

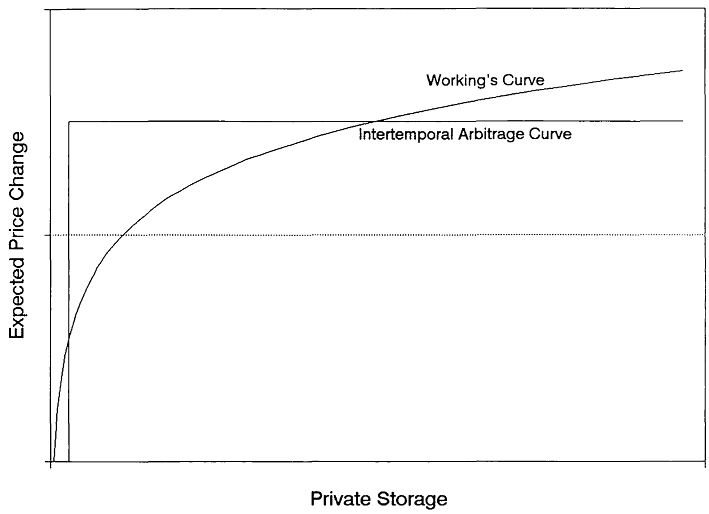

Fig. 2. Stylized supply of storage curves.

remain constant. The normal intertemporal arbitrage assumption, on the other hand, assumes that private stockholding would be the same in those two circumstances.

Working argues that stockholding is not an isolated investment, but part of a larger processing or marketing activity. Stocks have a 'convenience yield' which increases as total stocks in the economy decrease. The 'convenience yield' or 'accessibility value' has recently been elaborated on at some length by Williams (1986) and Wright and Williams (1988).

For the purposes of this paper, it is assumed that there is a convenience yield to stocks, and that the shape of the supply of storage curve follows that found in the empirical studies. The logarithmic functional form is used. Thus, equation (7) above becomes:

$$\mathrm{PS}_t = A_t \exp[B_t(P_{t+1} - P_t)] \tag{11}$$

where A_t and B_t are time-specific parameters to be estimated, and 'exp' is the exponential function. See Peck (1977/78) for another example of the use of supply of storage functions to evaluate government stock policy.

ESTIMATION OF THE MODEL

Two assumptions are necessary in order to estimate the supply of storage equation above. First, the expected price change between any two months historically is assumed to equal the average percentage price change between those two months between 1979 and 1987, as shown in Fig. 1. Second, it is necessary to assume that either the A parameter or the B parameter in equation (11) is stable across months. The latter option is chosen here, implying that a 1-rupee increase in P_{t+1} leads to the same percentage increase in PS_t, regardless of the value of t, holding P_t constant.

Consequently, there are 13 parameters to estimate from equation (11): twelve values of A (one for each month), and one value for B. It is not possible to estimate these in one step, however, because the changes in expected price for each month are constant across years, leading to a singular matrix of independent variables in the estimating equation if dummy variables are included for the months. Instead, a two-step procedure is used. First, B is estimated holding A constant; second, the value of A is computed and adjusted for population and the seasonal pattern [see Pinckney (1989) for details].

The estimating equation for B uses data for the logarithm of private storage from July to March from 1979 to 1987 as the dependent variable. April, May and June are excluded because private storage for those months is more highly variable than for the other nine months, leading to heteroskedasticity. The higher variance in these months results primarily from differences in harvesting time across years, and thus would cloud the analysis at hand. The independent variable is the expected price rise. This estimating equation produces an R^2 of 0.61 and a value for B of 0.255 with a standard error of 0.024.

This estimate of B can be interpreted as follows. A 1-rupee increase in the expected price for month $t+1$ (holding prices in month t constant) increases private storage in month t by 29%. The 1-rupee increase should be compared to the total expected seasonal price rise of about Rs.10, and the maximum price rise for any one month of about Rs.3. Even in this context, however, the responsiveness of private storage to expected price changes is large.

MODELING GOVERNMENT BEHAVIOR AND COSTS

The government sector can be modeled in a straightforward manner. Government procurement and releases are assumed to be proportional to the difference between the actual price and the procurement or release price. Thus, the functional forms for equations (5) and (6) above are:

$$g_1(\mathrm{PP}, P_t) = G(\mathrm{PP} - P_t) \quad \text{for} \quad \mathrm{PP} \geqslant P_t \qquad (12)$$
$$= 0 \quad \text{for} \quad \mathrm{PP} < P_t$$

$$g_2(\mathrm{PR}, P_t) = G(P_t - \mathrm{PR}) \quad \text{for} \quad \mathrm{PR} \leqslant P_t \qquad (13)$$
$$= R_{\min} \quad \text{for} \quad \mathrm{PR} > P_t$$

The G parameter measures the degree to which the government can defend its price ceiling and floor. It is taken to be 10 million, implying, for example, that procurement would be 2 million tons in a month when market prices are Rs.0.2 per 40 kg below the procurement price. This parameter has only a small impact on the results as long as it is large.

The minimum release parameter, $R_{\min}$ is taken to be 160 000 tons. This equals the lowest figure for offtake per capita in any one month during the last 15 years, adjusted to 1987 population figures. This amount is partly determined by the government's pan-territorial pricing. It is assumed to be insensitive to price adjustments.

Government expenditure is computed as follows. The variable costs of buying are assumed to be Rs220 per ton, while the variable costs of selling are Rs.280 per ton. The latter includes an average of Rs.200 per ton for transportation to deficit areas [see Pinckney (1989) and Agroprogress (1986) for a detailed breakdown of these costs]. Since buying prices are about Rs.2000 per ton, the gap between buying and selling prices would have to be 25% for the government to break even on handling costs. With the 1987/88 gap, the government was losing about Rs.420 per ton handled, exclusive of interest charges and physical losses.

The government also incurs interest charges on its stock-on-hand of 1.2% per month. Physical losses to stock occur at the rate of 0.7% per month, or 3.5% for a 5-month period. This figure is on the low side of studies of losses in government storage reported by Agroprogress (1986).

The final component of government cost is an adjustment for stock changes during the year. Choosing the appropriate price at which to value the stock is not straightforward, however. Since additional wheat cannot be bought or sold domestically without undermining the stated policy, prevailing domestic prices do not accurately reflect the value of the stock. Consequently, small changes in stock – less than 50 000 tons in a normal production year – are valued at a world price of US $110 per ton. Additions to stock greater than 50 000 tons are valued at the export parity price since this implies a significant increase in stocks during a normal year. This price is taken here to be US $85 per ton. Similarly, deletions from stocks of greater than 50 000 tons are valued at the import parity price of $150 per ton.

The model has been validated by inserting the values for production, procurement, and offtake for 1985/86 and 1986/87, then solving for private storage and price. The model approximates reality quite well [see Pinckney (1989) for details].

MODEL RESULTS

Table 2 presents results of different widths of the gap between procurement and release prices. With a crop of 13.4 million tons – an expected

TABLE 2

Implications of width of price band for fiscal cost and private storage

Procurement price (Rs. per kg)	Release price (Rs. per kg)	Percent different (%)	Fiscal cost (Rs. billion)	Procurement (million tons)	Private storage July (million tons)	Private storage March (million tons)	Difference (million tons)
2.00	2.00	0.0	5.4	7.1	4.2	1.7	2.4
2.00	2.05	2.5	3.9	5.3	4.8	1.5	3.3
2.00	2.08	4.0	3.5	4.9	5.0	1.4	3.7
2.00	2.10	5.0	3.2	4.7	5.2	1.3	3.9
2.00	2.15	7.5	2.6	4.1	5.6	1.0	4.5
2.00	2.20	10.0	2.0	3.6	5.9	0.8	5.0
2.00	2.25	12.5	1.6	3.2	6.1	0.7	5.5
2.00	2.30	15.0	1.3	2.8	6.4	0.6	5.8
2.00	2.40	20.0	0.8	2.2	6.8	0.4	6.4

'normal' year for Pakistan – the 1987/88 policy of buying wheat at Rs.2.00 per kg and selling it at Rs.2.08 per kg is expected to cost the government Rs.3.5 billion per year (US \$200 million). Private storage at the end of July is 5.0 million tons. Total procurement under these circumstances is 4.9 million tons, an increase of over a million tons compared to expected procurement under the previous policy. Prices reach their maximum in November and remain flat until a small decline in April. Thus, there is a marked change in the seasonal price pattern.

The Rs.3.5 billion loss can be broken down into component parts as follows: physical storage losses of 220 000 tons, worth Rs.0.6 billion (valued at import parity since on the margin the policy sells more than it buys domestically); interest charges of Rs.0.8 billion; costs of purchasing wheat of Rs.1.1 billion; and costs of selling wheat of Rs.1.4 billion. The 8 paisa (1 paisa = Rs.0.01) per kg difference between buying and selling price brings the government Rs.0.4 billion, thus yielding the Rs.3.5 billion cost.

One policy under consideration at the time of derationing was to both buy and sell at Rs.2.00 per kg. Had this policy been put into effect the estimated annual cost would have been Rs.5.4 billion per year, with procurement rising to 7.1 million tons and private storage in July falling to 4.2 million tons. On the other hand, a policy with a 15% gap – less than the historical average seasonal price rise – is estimated to cost only Rs.1.3 billion annually, with government procurement of 2.8 million tons and private storage in July of 5.8 million tons.

billion (US) = 10^9.

Two questions arise from these results. First, why are the cost savings so dramatic? Second, what (if any) are the benefits to the economy of widening the price gap?

In order to address the first question, consider the results for the 1987/88 policy with a 4% gap versus those of a policy with a 15% gap. If the government increased the price gap from 4% to 15% and if private storage did *not* respond to the increased gap, procurement would remain the same (4.9 million tons). Assuming for simplicity that the government sells all that it procures, the decreased fiscal cost would equal the difference in selling price – Rs220 per ton – times the amount procured, or almost Rs.1.1 billion. This is only one-half of the Rs.2.2 billion difference in cost in the table.

But private storage does respond to the increased gap. This is seen in the last column of Table 2, which presents the amount of the harvest absorbed into private storage. With a 4% gap between procurement and release prices, private storage increases by only 3.7 million tons between March and July; with a 15% gap, private storage absorbs 5.8 million tons, consequently reducing government procurement by 2.1 million tons. The reduction in volume handled by the government leads to a large reduction in government costs. With government handling costs of about Rs.500 per ton, the reduction in procurement/sales saves the government about Rs.1.05 billion. The increased revenue from the higher selling price is somewhat smaller than the calculation in the previous paragraph because of reduced volume, falling to just over Rs.0.6 billion. The remaining Rs.0.45 billion of the Rs.2.1 billion difference results from lower physical storage losses and interest charges.

Thus, the cost savings result from the double impact of the increase in selling price and the reduction in volume. Since the government loses money on every ton handled, the reduction in volume saves a large amount of money.

These cost savings are substantial, and of interest to a government faced with the need to reduce its budget deficit. The second question raised above, concerning economic gains to the country, is of additional importance. To what extent are these cost savings simply transfers within the economy? How much, if any, of these savings represent increases in national income?

The answers to these questions depend on assumptions about alternative flows of wheat under the two policies, and relative storage, transportation, and handling costs between the government and the private sector. It is helpful to consider the breakdown presented above of the Rs.2.1 billion difference in cost between the policies with 4% and 15% price gaps. The Rs.0.6 billion savings from charging a higher selling price is a pure transfer, and thus of no economic benefit. The Rs.0.45 billion savings on storage losses and interest charges most likely is also a transfer; storage losses on average are not much different in the private and public sector (Experience

Inc., 1986), and the change in the seasonal pattern of stocks between the policies is not great enough to have much impact on losses.

A considerable proportion of the remaining Rs.1.05 billion savings in transport and handling charges, however, is likely to be an economic savings. Farmers have an incentive to sell at harvest and buy back from the government for own consumption later in the year when the difference between government buying and selling prices is less than storage costs minus the transactions costs. Clearly a gap of 4% will make such behavior profitable for farmers with relatively low transactions costs. In such cases, the handling costs to the government and the transactions costs of the farmers are economic losses. In addition, if under the 30% gap the farmer is selling directly to individuals and institutions, there is likely to be some economic savings compared to the case of the farmer selling to the government and the government selling to the institution.

A sensitivity analysis has been conducted with respect to the specification of the demand curve and the size of parameter B, the responsiveness of private storage to the expected price change. Results change only slightly with these different specifications (Pinckney, 1989).

Consequently, these results are considered to be robust. Actual costs in any particular year, however, could vary significantly from those reported here, because of deviations from normal production and adjustments in interannual stockholding. Finally, as in any econometric exercise using estimated parameters, the further one moves from the policy under which the estimation took place, the less reliable are the results. Thus, results for price changes on the order of 10–20% should be considered more reliable than those with virtually no price change.

CONCLUSIONS

The implications of this analysis for policy are clear. Significant savings in fiscal cost could result from increasing the gap between government buying and selling prices for wheat. Economic gains, while less than the fiscal savings, are likely to be substantial.

There is a trade-off, however, between these gains and a loss to the consumer from the higher level of seasonal price variability. But the costs to the consumer of raising the release price to 15% above the buying price are moderate. If the government were to release wheat at Rs.2.30 per kg rather than 2.08, that price would be effective only during the months of December, January and February according to the model because private traders would undersell the government prior to December. Harvest time prices would be unchanged. Thus the increase in the average annual price of wheat would be only about 6% rather than the 11% increase from 2.08 to 2.30. [4]

The average consumer spends about eight percent of annual household income on wheat and wheat products. Thus, the real income loss associated with a 6% price rise is less than one-half of one percent. The poorest consumers, who spend about 12% of income on wheat and wheat products, would suffer an income loss for the year of less than three-fourths of one percent.

Nevertheless, the income loss is not spread out evenly over the months, and for the 3 months in which the maximum price is in effect, the real income loss for the poorest consumers is (0.11 * 0.12) or 1.3%. If the income elasticity for calorie consumption is 0.5, this would imply a reduction in calorie consumption during those months of 0.6–0.7%, or about 15 Cal per day. Although reducing the income of the poorest group is undesirable, it is clear that a program costing Rs.2.3 billion annually to raise calorie consumption of the poorest groups by only 15 Cal per day for 3 months per year is inefficient. A more efficient policy calls for government intervention in extreme circumstances, thus averting disastrous price rises (such as the 40–60% rise that occurred in 1977/78) but allowing for private marketing at most other times.

Another way to view the loss to consumers is to compare costs under a 15% change in official prices to those under the old system. As shown above, the average price rise under the old system was 15–20%, with some years substantially higher. Although the ration shop price was constant throughout the year, very little was actually being sold at the subsidized price (Alderman et al., 1988). Consequently, under a policy with a 15% price cap, the consumer would be no worse off than under the old system, and in some years substantially better off.

For policy modeling, this article has three conclusions. First, private stocks in less developed countries can be large and sensitive to changes in expected price, particularly within crop years. One approach for estimating a lower bound for such stocks is presented here. Second, it is important to consider within-year stocks in any analysis of storage policy. A separate analysis of Pakistan's interannual storage policy suggests that major changes could save the country Rs.100 to 200 million per year (Pinckney, 1989). This number is dwarfed by possible savings from even minor changes in seasonal

[4] The 6% figure is calculated by taking the average of the percentage increases by month as estimated by the model, weighting each month equally. Since one would expect higher consumption of wheat in low price months, this estimate of the average price increase is on the high side. Graphs of single years of data in the Agroprogress report indicate that the price rise is similar for retail flour and wholesale wheat.

Cal, food calorie = 1 $kcal_{15} \approx 4.1855$ kJ.

pricing. Finally, estimating a supply of storage curve directly yields seasonal price changes and private stock behavior equations which are much closer to reality than those that result from the normal intertemporal arbitrage assumption. Such an approximation to reality is vital if the model is to be applied to any real policy analysis.

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