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RICE PRICE FLUCTUATION AND AN APPROACH TO PRICE STABILIZATION IN BANGLADESH

Raisuddin Ahmed
Andrew Bernard

February 1989

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FOREWORD

Correction of the distorted structure of relative prices and prevention of wide fluctuations in the level of commodity prices constitute twin challenges in agricultural price policies. While macroeconomic instruments are commonly used in changing relative prices, the task of price stabilization requires comprehensive sectoral analysis of price relations, stock requirements, market integration, and various other factors that destabilize supply and demand.

IFPRI's initial analyses of price stabilization were limited to the issue of optimal stock of foodgrains. Thomas Pinckney's work on stock policies in Kenya and Pakistan and Raj Krishna and Ajay Chhibber's research on India have demonstrated how optimal stock policies can save scarce public resources so urgently required for economic development.

This research report by Raisuddin Ahmed and Andrew Bernard focuses less on optimal stock and more on a consistent framework and operational rules for stabilization of prices. It examines the factors that cause fluctuation in prices and develops a framework for containing annual and seasonal variation of prices within a bound. Although the research is conducted in the context of Bangladesh, the approach is applicable to other countries. IFPRI is currently involved in extending this research by applying it in Bangladesh through a collaborative arrangement with the Bangladesh Ministry of Food. Such a link between research and application will bring IFPRI's research directly to bear on the policy needs of developing countries, improving both current policy and future research.

John W. Mellor

Washington, D.C.
February 1989

ACKNOWLEDGMENTS

This study was initiated to examine fluctuations in rice prices of Bangladesh, where policymakers have regularly experienced frustration with the management of prices of this critical commodity. The repeated shifts from a position where they fought to contain upward price movement to another where they confronted the task of stemming the downward dash of prices have puzzled them. The absorbing nature of the task has diverted attention from issues and problems of long-run development.

Our deepest gratitude goes to all those public officials in Bangladesh who shared their experiences and understanding in unfolding the problems of price stabilization in Bangladesh. It is hoped that the study will help solve the puzzle and provide a basis for removing the frustrations.

The final version of the study reflects the assistance of many who provided access to data, commented on earlier drafts, and extended guidance in the analytics of complicated measurement. While we express our general appreciation to all those involved in such assistance, particular recognition of extremely useful help goes to Romeo Bautista, John W. Mellor, Robert Nevin (USAID, Dhaka), Mahabub Hossain (BIDS, Dhaka), R. R. Piggot (Australia), Stephen Vosti, Mustapha Rechache, and a number of anonymous reviewers.

Raisuddin Ahmed
Andrew Bernard

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SUMMARY

Traditional welfare economists often conclude that commodity price stabilization schemes are economically wasteful. Nevertheless, most contemporary developing countries use some type of stabilization policy to address price instability arising from shocks in the domestic supply of foodgrains. They do so because the assumption that consumers can save enough in times of low prices to pay for higher prices later on is unrealistic in economies with widespread poverty and imperfect capital markets. The positive and comprehensive dimensions of stable prices are considered in this report.

This report examines the sources and extent of rice price variability in Bangladesh and provides a complete framework for the implementation of a simple yet effective mechanism for limiting that variability in the future. Although the framework is developed in the context of Bangladesh, the general approach should be applicable for most developing countries.

Annual price fluctuations in the postindependence or posttechnology period in Bangladesh have increased, and supply and demand forces in the rice market no longer move together to stabilize prices. In addition, imports that are controlled by the government have taken on a new, more important role in helping to stabilize prices. These developments will significantly affect the actual implementation of a price-targeted program in Bangladesh. If, as is indicated, supply shocks are becoming more important than demand shifts as a source of price variability, then government action on the supply side has to diminish rather than augment price variability. To do this, a timely mechanism to respond to any dramatic shortfall in production (for example, crop loss from natural calamity) should be developed and put into action. The coordination of imports with a national stocking policy is a critical element in any rice price program in Bangladesh. Imports can provide long-term access to sufficient amounts of foodgrains, whereas the stocks on hand offer shorter-term and location-specific responses to foodgrain deficits.

While the structure of the overall economy of Bangladesh has been changing, so too has the rice market itself undergone dramatic shifts in recent years. New high-yielding varieties of rice have increased overall production and have changed the intrayear pattern of production and prices. Where once the aman crop dominated the annual production of rice, now the large boro and aus crops, especially the high-yielding varieties, cause prices to fall back almost to their December (aman) levels. This new pattern of seasonality has implications for the government's role in the procurement and distribution of foodgrains. A second procurement season in the regions growing rice in the boro and aus seasons is likely to be required if a price-based program of stabilization is adopted.

Although most of this study focuses on temporal aspects of prices in the rice market, spatial relationships should not be overlooked. The analysis of market integration shows that, although transmission of prices does occur to some degree in all markets at certain times in specific locations, the integration of markets is not complete. This implies that particular attention should be paid to those markets that are not well linked to the overall rice economy, and procurement and sales procedures should be adjusted accordingly. Special attention should be given to the districts of Patuakhali, Barisal, Dinajpur, Rajshahi, and Rangpur in procuring the aman crop. Similarly, Chittagong, Kushtia, and Jessore should get special attention during the aus season.

The framework for price stabilization implies a planning shift from a quantity-targeted to a price-targeted approach in the management of the public food system. The model developed specifies a price band in annual prices and links this band to the seasonal prices, keeping in view both cost and price stability. The price band in effect eliminates both super- and subnormal profits from private trade operations in foodgrains. The results indicate that a successful price stabilization program will substantially reduce pressure on the rationing system, and the process can be even more effective if pricing of rationed foodgrains, particularly ration prices for priority groups, is coordinated with market prices. A simulation exercise shows that if the proposed mode of stabilization had been operative during 1976-84, the fluctuation in annual prices would have varied from 3.4 to 23.1 percent, compared with variations of −17.3 to 41.3 percent under the existing system. Seasonal prices vary by a stable 15 percent every year under the proposed model, compared with actual prices, which varied from a low of 13.8 percent in 1980/81 to a high of 37.8 percent in the following year.

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INTRODUCTION

Stabilization of prices, particularly of major foodgrains, is a serious concern of most developing countries. There are two types of temporal variations in prices: interyear and intrayear. The intrayear variation is generally called the seasonality of prices. The distinction between the two types is important in the context of policy instruments that are brought to bear on prices in order to contain extreme fluctuations. Public procurement in the harvest season and sales in the peak-price season are well-known policy instruments for combating seasonal fluctuations in foodgrain prices. Similarly, buffer stocks and export and import policies in foodgrains are commonly used to manage interyear variations in food prices and supply. Many developing countries spend a substantial share of their budgetary and administrative resources in controlling these temporal variations in prices. Therefore, issues and relations underlying price fluctuations need to be properly understood before formulating and implementing such costly policies.

The understanding of price stabilization problems and their potential solutions requires the following information. First, it is necessary to identify and examine conceptual issues involved in the assessment of benefits and costs and the underlying analytic approach of price stabilization. Second, the extent and nature of instability in prices of a commodity have to be quantitatively estimated, disentangling the real from nominal effects. Third, the underlying causes of unstable prices have to be identified in order to determine the influence of random elements as opposed to systematic factors. Fourth, before formulating any public stabilization policy, it is essential to know whether markets where private traders operate are integrated. If markets are not integrated, then many assumptions of aggregate analysis (for example, estimates of supply and demand parameters from aggregate relations) are violated. Finally, to make this information useful for practical operation, it is desirable to formulate an approach to price stabilization appropriate within a specific context. These are the objectives of this study for Bangladesh.

Price stabilization is essentially a short-run problem. Therefore, the policy instruments chosen should reflect the contemporary situation and pragmatic considerations. But probing into the dynamics of current situations by examining the historical behavior of prices in relation to structural changes in the economy is virtually unavoidable. Thus it is necessary to look backward as well as forward. Three particular aspects of Bangladesh's history receive specific analytic attention here. The first relates to the transition from a predominantly subsistence economy to a moderately commercialized one and the implications of that for variability in prices. The second relates to the effect of modern high-yielding varieties (HYVs) of rice on seasonality of prices. The third concerns data as well as behavior of price regimes before and after Bangladesh achieved independence in 1971.

Serious problems exist in pursuing price analysis covering the period 1971 through 1974, years of extraordinary social and economic disruptions in Bangladesh. Similarly, statistics such as personal income, imports, and money supply for the 1960s, when Bangladesh was a part of Pakistan, are suspect. Because of these problems, the analysis may seem unbalanced to readers who are not conversant with Bangladesh, but they are real issues that deserve to be explicitly recognized.

Methodology

To achieve the objectives of the study, four main methodological steps are necessary. First, nominal prices are decomposed into trend, seasonal, and irregular components. Second, causes of price movements are analyzed. Third, the degree of market integration is measured, and fourth, target annual average prices are predicted, and the annual average is linked with the seasonal factors to arrive at seasonal target prices for stabilization. These methods are explained in the sections where each task is discussed.

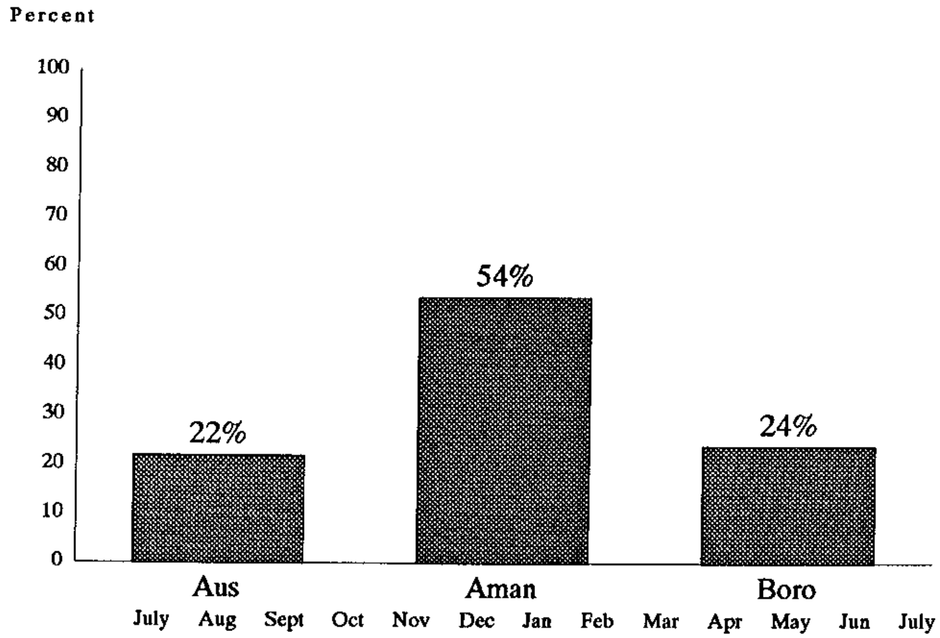
Data

The data used in the analyses are the wholesale monthly prices of coarse varieties of rice collected by the Department of Agricultural Marketing of the government of Bangladesh. Government price data include prices for three qualities of rice: fine, medium, and coarse. With the adoption of HYVs of rice, which are all coarse quality, the share of coarse rice in the total rice supply has increased. Currently coarse rice has the largest share, and coarse and medium rice together compose more than 90 percent of rice supply in the market. The use of coarse rice prices here should not invalidate the conclusions on the behavior of rice prices in general. The prices of various qualities of rice are closely correlated. The simple correlation coefficient between prices of coarse and medium-quality rice during 1975-84 is 0.9986 and highly significant. However, in a rising phase of rice prices, the price of coarse rice rises slightly faster than the price of medium. Similarly, in a falling phase, the price of coarse rice declines faster than the price of medium rice. As prices change, consumers in the middle-income bracket who shift back and forth between the two qualities of rice cause this phenomenon.

The national average price of any given quality is based on prices of about 350 markets spread throughout Bangladesh. However, the average is not weighted to reflect the size of the share of each market. Nor does the average explicitly reflect the various types of rice that are produced and marketed in various seasons. There are three seasons for rice harvests—aus, aman, and boro. The span of harvest time and the share of production for each of the three types of rice are shown in Figure 1.

The share of harvest for each season is shown as a flat figure even though arrival at market or actual harvest is concentrated in certain months, depending on the location. Generally, the aus harvest is concentrated in July-August, aman in December-January, and boro in May-June. Most rice grown in the aus season is coarse rice. Moreover, rice harvested in this season generally has a high moisture content; therefore, prices quoted in the market could vary widely due to varying degrees of moisture. Local varieties of rice harvested in aman and boro seasons consist of fine, medium, and coarse varieties.

Figure 1—Time spans of harvest seasons of rice and shares of aus, aman, and boro season harvests in total rice harvest, averages for 1982-84



Source: Computed from data in Bangladesh, Bureau of Statistics, *Statistical Yearbook 1985/86* (Dhaka: BBS, 1986).

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PRICE STABILIZATION ISSUES

Whether price stabilization is economically rational or not is a fundamental issue. Economists approach this issue by comparing economic benefits from a stabilization program with its cost. But in fact most low-income, developing countries, including Bangladesh, operate some sort of stabilization program, particularly in foodgrains, even if such programs are frequently wasteful. To ask them to dismantle the programs has not been effective in the past and is not expected to be so in the near future. This is partly because unstable prices have political consequences and partly because policy-makers are concerned about the effects of periodic food scarcity, which can result in starvation and serious malnutrition. In addition, occasional sharply falling prices during harvest season can undermine the confidence in markets of producers and policymakers. Therefore, logic dictates a need for a stabilization mechanism that would minimize economic waste but preserve the elements that address food security and price support concerns arising from severe price instability. This is the approach taken in this study on rice price stabilization in Bangladesh. Until empirically tested alternatives to price stabilization are available, the emphasis on improvement of the operation of stabilization programs seems valid.

Even though this approach has been adopted here, the standard analysis of benefits and costs of stabilization is not irrelevant. The theoretical framework used historically in most empirical investigations of commodity price stabilization is the simple Marshallian partial equilibrium analysis of a closed economy developed by Waugh (1944) and Oi (1961) and synthesized by Massell (1969, 1970). Such a simple model is often inadequate for empirical application in dynamic circumstances, but it captures elemental effects of stabilization. However, some economists have raised serious doubts about the use of this approach in empirical investigations. Cochrane (1980) argues that "welfare analysis based upon the concepts of consumer and producer surplus has not in the past made, and will not in the future make, any recognizable contribution to the making of decisions by the United States, other developed countries, the less-developed nations, or the international agencies either to initiate commodity stabilization programs or to reject them." The use of the concepts, however, persists in economic analyses because neat alternatives are absent.

The assumption of a closed economy in the application of the concept is not considered a serious constraint. Most developing countries, Bangladesh in particular, do not allow open external trade in foodgrains even though they depend on public imports or exports to cushion the stocks of foodgrains. This control of foodgrain trade by the public sector makes the closed-economy model relevant. A brief exposition of the partial-equilibrium model is presented below.

Figures 2-5 indicate the income and welfare effects of price stabilization. Figure 2 shows a standard linear supply-demand relationship with two equally probable supply curves— S_1 and S_2. The third curve, S_3, represents an average of the other two. With supply fluctuating between the two extremes over time and without price stabilization, producers' average revenue is $(OP_2 \cdot OQ_2 + OP_1OQ_3)/2$. Upon intervening, the government or buffer stock agency would buy Q_0Q_4 in the period of high supply (S_1) to maintain price at P_0, whereas it would sell Q_0Q_1 during a poor harvest (S_2). In this

Figure 2—Welfare effects with linear supply-demand relations

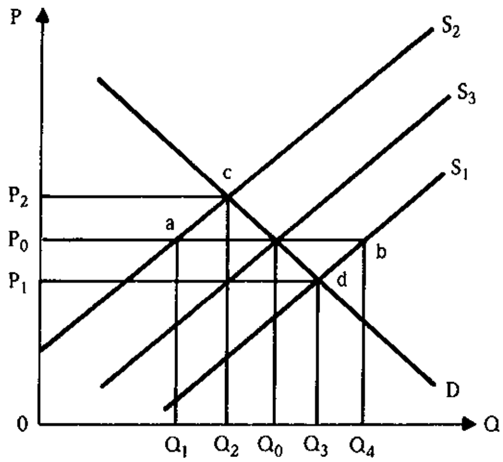


Figure 3—Welfare effects with shifting supply curve

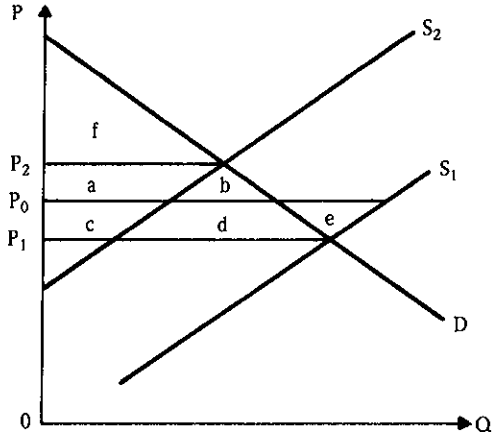


Figure 4—Welfare effects with shifting demand curve

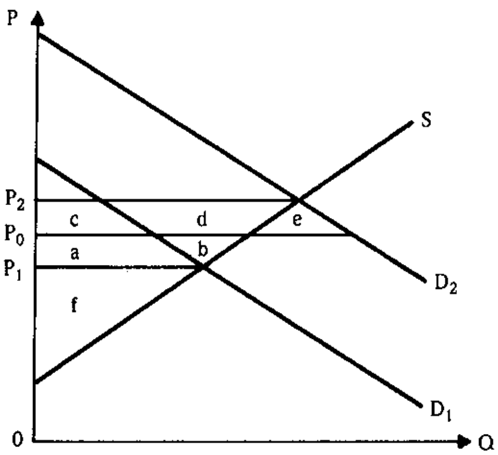
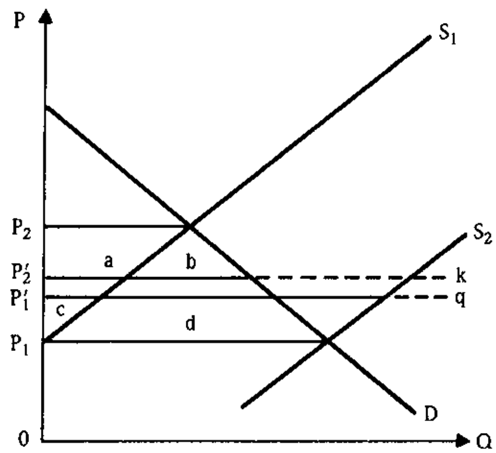


Figure 5—Welfare effects including cost of buffer stock agency



case price stabilization raises the variability of gross revenue while at the same time increasing its mean. Following this static framework, Waugh's 1944 seminal work established that consumers having a negatively sloped demand curve gain from price variation and lose from price stabilization. He focused only on consumers. Following Waugh's line of reasoning, Oi (1961) demonstrated that with a positively sloped supply curve producers also benefit from price instability and lose from stabilization. He focused only on producers. Massell (1969) combined both producers' and consumers' welfare and illustrated that the distribution of welfare changes is determined by the origin of the random price fluctuation, and that price stabilization produces a net gain to the society (producers and consumers taken together).

Massell uses the linear model with prices fluctuating from shifts in either supply or demand or both, with stabilization being implemented through a buffer stock. Figure

3 shows the case of shifting supply, with supply curves S_1 and S_2 each occurring 50 percent of the time. The price P_0 is a price that can be achieved with costless storage activity, that is, P_0 is the buying and selling price of the buffer stock agency (this unrealistic assumption of costless storage is relaxed below). By preventing the price from falling to P_1, producers gain revenue (c + d + e), while consumers lose (c + d), so that there is a net gain in the system of e. Preventing the price from rising to P_2 benefits consumers by a + b and costs producers only a in forgone revenue, and there is a net gain of b. Hence stabilization gives producers a net gain of c + d + e − a and consumers a net loss of c + d − a − b. Therefore the total net gain by producers and consumers together is e + b. Massell (1969) notes the welfare problems associated with this type of abstraction but remarks that "...producers are able to compensate consumers so as to leave both groups better off."

Figure 4 shows price fluctuations resulting from demand shifts from D_1 to D_2 (again each curve is equally likely). Mirroring the supply movement, the net gain to consumers is c + d + e − a, and the net loss to producers is c + d − a − b, so that the overall gain equals e + b. The model incorporates positive storage costs (Figure 5) when the buffer stock agency operates to stabilize prices within a range of P_1P_2 so that it earns a profit of $P_2 - P_1$ on each unit bought or sold. These profits can be used to offset storage, interest, insurance, and other costs of maintaining stocks. In Figure 5, $P_2' = k$ and $P_1' = q$ are costs per unit when the level of stabilization is set at P_2' and P_1', respectively. Since costs exist, partial price stabilization will be closer to optimal than absolute price stabilization within the context of this model.

Turnovsky (1974) points out that the Waugh-Oi-Massell analysis assumes that demand and supply depend upon actual prices and deal with "a situation of price variability rather than price uncertainty, since an important aspect of this latter case is the fact that some decisions must be made on the basis of imperfect information." Turnovsky examined the Waugh-Oi-Massell approach under the more realistic assumption that producers' decisions were based on expected prices, and he considered two different processes by which producers anticipate prices—rational expectations and adaptive expectations. He found that whether or not the Oi results continue to hold depends on the price expectation mechanism as well as the autoregressive properties of the stochastic disturbances, while the Waugh and Massell results hold under both expectation hypotheses.

Although a number of researchers have pointed out various shortcomings of the static model, Newbery and Stiglitz (1981) provide a more comprehensive framework for examining welfare issues related to commodity price stabilization. Some important issues that they focus on will be examined here in the context of Bangladesh and the implications of economic models. In general, Newbery and Stiglitz are against public stabilization policies even though they find occasional positive gains.

Does Price Stabilization Destabilize Income?

Income from the crop is the product of its price times the quantity, PQ. Generally price and quantity are inversely related; price rises when production falls, and price falls when production rises. This relation is apparent in annual data of Bangladesh. Assuming a constant elasticity of demand, ε, the relation between variability of income (Y) and price is var (log Y) = $(1 - 1/\varepsilon)^2$ var (log Q). When price is absolutely stabilized, the only source of variability in income is production. Whether price stabilization reduces or increases variance in income depends on whether price elasticity of demand is greater or less than 0.5 in absolute terms and on the extent of marketed surplus.

When price elasticity of demand is 1.0, the variance in income is zero. When price elasticity of demand is less than 1.0 but greater than 0.5 and supply fluctuation is the source of price fluctuation, then stabilization of prices increases instability in income from the particular crop. Of course, supply is generally the source of variability in prices of rice in Bangladesh (that is, variability of imports and domestic production), and the price elasticity of demand for rice ranges from 0.4 to 0.6 (Pitt 1983, Ahmed 1981). This suggests that price stabilization in rice may increase instability in income from rice. But such a conclusion could be quite misleading in a dynamic sense.

The effects of rice price instability on jute prices and other sources of income are not zero for Bangladesh. The positive relations between the rice price and nominal wage rates, as well as various other prices, have been recorded in other studies (Ahmed 1981). These relations indicate that variability in nominal income from rice may rise with stabilization, but variability of real income as well as total household income is likely to be smaller with rice price stabilization than without it. Perhaps these dynamic factors led Newbery and Stiglitz (1981) to conclude that "the benefits of pure price stabilization schemes are likely to be relatively more important for small countries and likely to be greater in total, the more widespread is the production of the commodity." Rice is clearly a dominant crop in the agriculture of Bangladesh.

Farm Structure and Implications for Price Stabilization

The structure of farms in Bangladesh is such that 40 percent are deficit farms cultivating less than 1.0 acre each. They are deficit in the sense that they are net buyers of rice even in good harvest years. Another 30 percent, cultivating an area between 1.0 and 2.5 acres per household, are marginally self-sufficient in that, as a group, in good years they produce a small marketable surplus (see Table 1), but they may have to buy rice in bad harvest years. The remaining 30 percent of farms are surplus producers of rice in good years as well as bad. About 91 percent of the marketable surplus of rice is produced by this group, which fits the conventional definition of "producers" in the neoclassical framework of price analysis.

On the basis of farm size data for 1973/74 through 1977/78 from a study by Ahmed (1981), the relation of marketable surplus to gross production and prices is as follows. With a 1.00 percent change in rice production, the marketable surplus changes

Table 1—Share of farm groups in the total number of farms, in total area cultivated, and in marketable surplus

Farm Group	Share of Total Farm Households, 1983	Share of Total Land Area, 1983	Share of Marketable Surplus in Total Production, 1978
		(percent)	
Deficit farms (less than 1.0 acre)	40.4	7.8	0.0
Marginally self-sufficient (1.0 to 2.5 acres)	29.9	21.2	8.3
Surplus (more than 2.5 acres)	29.7	71.0	91.7

Source: Computed from Bangladesh Bureau of Statistics, *National Report on the 1983/84 Census of Agriculture and Livestock* (Dhaka: BBS, 1986).

in the same direction by 2.20 percent in the marginally self-sufficient group and by 1.50 percent in the surplus farm group. The overall elasticity is 1.56. With a 1.00 percent change in the rice price, the marketable surplus changes by 0.02 percent in the same direction, but only in the surplus farm group. In the marginally self-sufficient group, the price effect is not significant; even the direction is negative. This implies that such self-sufficient farms may have a backward-bending but weak supply curve. Such farmers can fulfill their cash obligations by selling a smaller quantity of rice when the price is high rather than a larger amount when the price is low.

On the basis of the foregoing relations and assuming a price elasticity of demand for rice of −0.5 and 1983/84 production, price, and marketing rates, the estimated benefits from price stabilization, following the short-run static framework, are shown in Table 2. The source of price change is entirely the random supply instability.

The estimates are based on a gross production level of 16.0 million tons of rice in 1983/84 and 4.6 million tons of marketable surplus. The price assumed is 260 taka (Tk) per maund.[1] This is the base from which changes are measured. Note that the magnitude of change is the main concern and the parameters of change are important in these measurements. The base-year statistics are of secondary importance.

The effects are drawn from short-run relations but the lessons derived from this simple exercise go far beyond the ones indicated by the economists mentioned earlier.

Effects on Consumers

The analysis in Table 2 and similar past analyses show that price stabilization is bad for consumers because consumers bear a net loss (Tk 26.1 million in Table 2). But the experiences of developing countries indicate that it is the consumer who demands price stabilization. Why this gap between reality and economic analysis? The source of this conflict between economic analysis and empirical experience may be found in the averaging of good and bad seasons. The economic analysis implies that a rational consumer, who saves when prices are low, enabling him to purchase when prices are high, is on average better off with price instability. In reality this does not happen where the level of poverty is high and capital markets are imperfect. An unsatiated consumer cannot hold back on consumption sufficiently during a low price season to save enough to help him avoid starvation in a high price season. He cannot plan with a time horizon that includes the two price situations, and therefore an average of the two situations is not applicable to him. The process of adjustment to a high price-low income situation in a country with widespread poverty may have further implications for future growth. A study by Jodha (1978), based on the Rajasthan drought, indicates that the affected population first reduces consumption, then defers committed obligations and reschedules current production activities. As the shock becomes more severe, they deplete inventories, livestock, and utensils; mortgage or sell land; and finally migrate to urban centers or other areas. Replacement of assets in good years becomes difficult not only because they can save little in good years but also because they have to sell cheap and buy dear. A study in Bangladesh records a similar process of adjustment by the poor (Ahmed 1981).

Price instability, therefore, has the potential for accelerating the process of pauperization. Price stabilization schemes, if implemented effectively, can reduce the effect of this process. In essence, such schemes impose discipline upon the consumer so that he consumes less when prices fall. Such schemes also prevent consumption from falling

[1] One maund equals 37.32 kilograms. At the 1984/85 official rate of exchange, US$1.00 = Tk 30.

Table 2—Estimated short-run gains to producers and consumers from price stabilization, 1983/84

Types of Consumers and Producers	Low-Price Season[a]	High-Price Season[a]	Net Loss or Gain Over Two Seasons
		(Tk million)	
Consumers	−349.40	323.27	−26.13
Producers	403.88	−270.93	132.95
Deficit farms[b]	0.00	0.00	. . .
Marginally self-sufficient farms	35.36	−20.49	14.87
Surplus farms	368.52	−250.44	118.08

Sources: Estimated on the basis of parameters in Table 2, and production data from Bangladesh, Bureau of Statistics, *Statistical Yearbook of Bangladesh 1985* (Dhaka: BBS, 1985).
Note: Minus sign indicates a loss.
[a] The low price season is when production increases by 10 percent without a change in demand, and the high price season is when production falls by 10 percent.
[b] Deficit farms are net buyers, so the effect of price stabilization on this group is included in the consumer category.

precariously when prices rise. Because of an adverse economic environment, a poor consumer will fail to follow the same rational consumption path as that implied in price stabilization if left alone to face market forces.

Effects on Producers

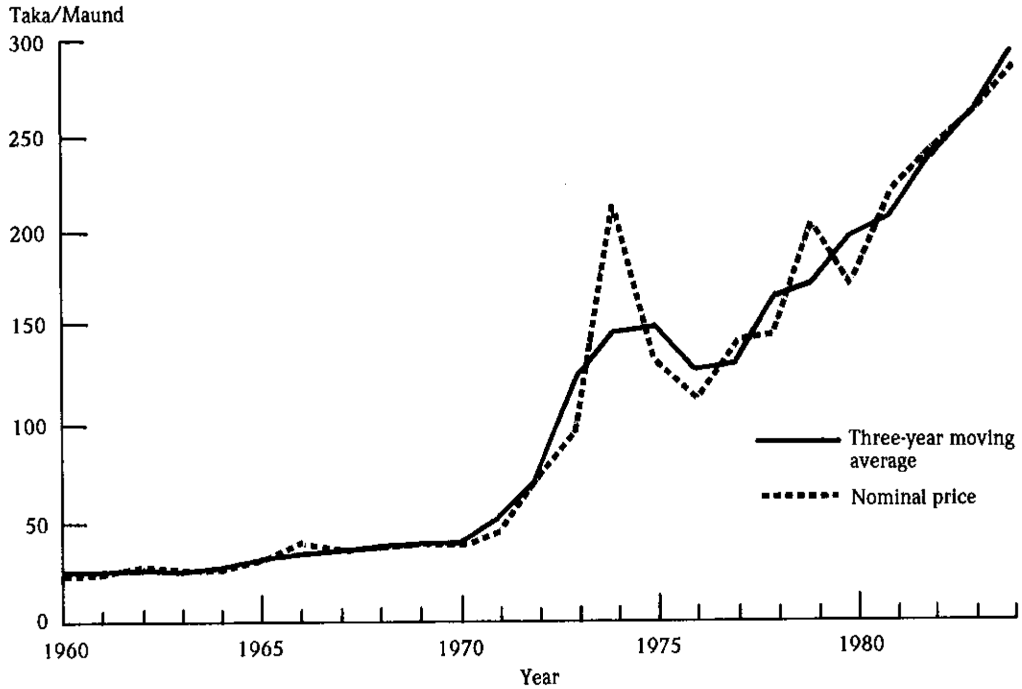
Table 2 reveals some interesting facets of price stabilization relevant to producers. Again, the average of good and bad harvest seasons masks a significant effect of price stabilization. It is clear from the numbers that the deleterious effect on producers of a price slump in a good harvest season is much larger than the beneficial effect when the harvest is poor and prices are high. This adverse effect in a falling price regime, in the absence of a stabilization scheme, is about 47 percent larger than the positive effect for surplus farmers during a rising price regime. For marginally self-sufficient farmers the deleterious effect of low prices is 75 percent larger than the positive effect of the high price scenario. In Bangladesh, when agricultural technology is progressing vigorously, the downward fluctuations tend to be more numerous, albeit less severe, than upward fluctuations, as will be shown later. This makes the case for stabilization much more convincing for a technologically oriented growth strategy than for traditional agriculture. Therefore, price stabilization, particularly price supports when harvests are good, should be a critical concern of producers with a marketable surplus.

Finally, the assumption that all farmers are net surplus producers of rice is not correct for Bangladesh. It is wrong to assume that the effect on deficit farmers is the same as that on consumers. These deficit farmers in practice sell some rice just after harvest at low postharvest prices to meet urgent cash obligations. They then must buy more during other seasons when prices are higher. They have little access to the formal credit market to avoid this situation (see Ahmed and Hossain 1988).

Rice Price Stabilization and Jute Production

One important issue raised by Newbery and Stiglitz (1981, 27) concerns the effect of price stabilization in one crop on production of and income from other crops. In the context of Bangladesh, the effect of rice prices on jute production deserves particular attention.

Figure 6—Nominal annual rice prices compared with three-year moving averages, 1968-84



Source: Based on data from Bangladesh Bureau of Statistics, *National Report on the 1983/84 Census of Agriculture and Livestock* (Dhaka: BBS, 1986).

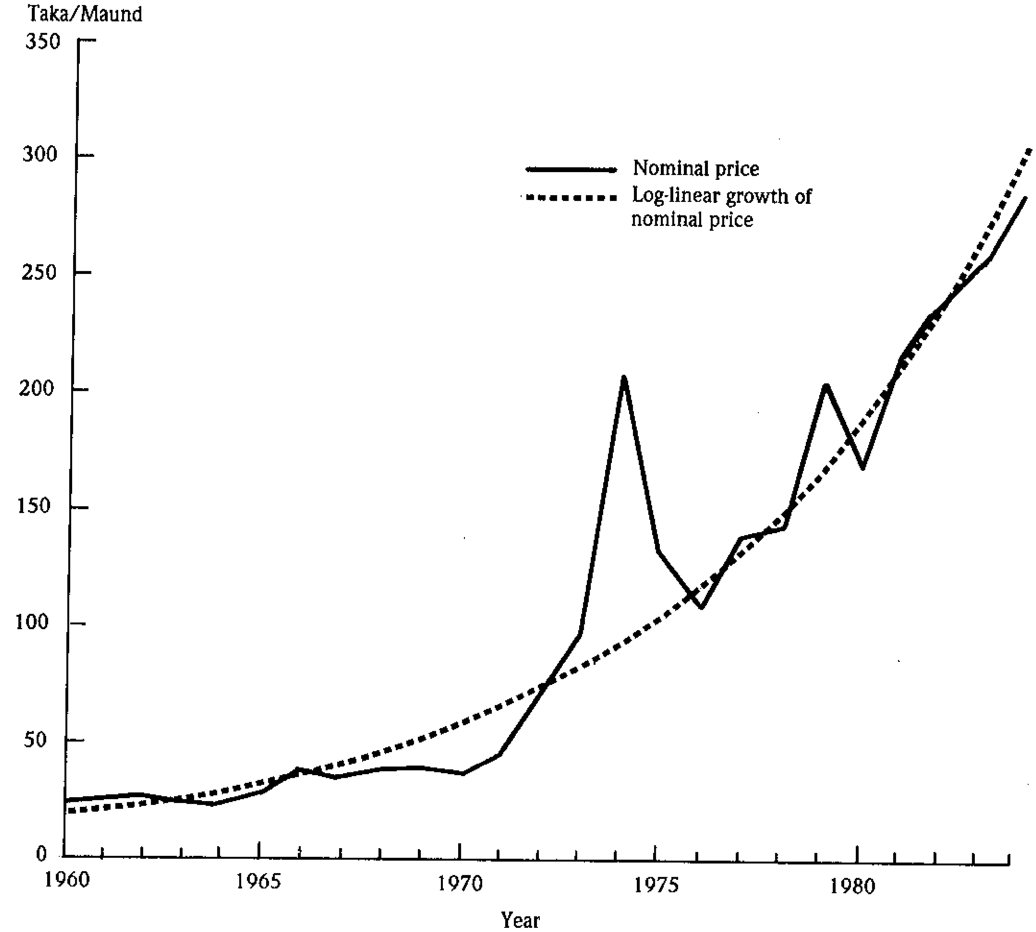
monthly price indexes. The monthly price indexes are based, for every year, on the January price (January equals 100). The second indicator is the coefficient of variation, which is defined as the standard deviation of monthly prices in a year, deflated by the average price. This indicator is more comprehensive than the first and can be interpreted as a measure of fluctuation expressed as a percentage of average price. The following conclusions can be derived from information in Table 4.

1. As indicated by the first indicator, monthly price fluctuations exceeded 35 percentage points in only 2 years out of 10 (that is, once every 5 years) during the period 1960-70. In the period 1971-75, the years of civil war and postwar turmoil and famine in Bangladesh, monthly nominal prices fluctuated more than 35 percentage points in all of these years. During the period 1976-84, fluctuations in monthly nominal prices exceeded 35 points in 2 out of 9 years.

2. December-January, particularly January, is the period when rice prices are low in Bangladesh. Exceptions to this rule have occurred only three times in a period of 24 years. These exceptions can be traced to the beginnings or ends of abnormal price movements and the consequent adjustment process. The low-price period of December-January clearly coincides with the harvest of the main rice crop, the aman rice.

3. Unlike the distribution of low-price points, the high-price points are not distributed so consistently over specific months. High-price points in rice prices generally occurred in the months of July and October-November during the 1960s. During the

Figure 7—Nominal annual rice prices compared with log-linear annual growth, 1968-84

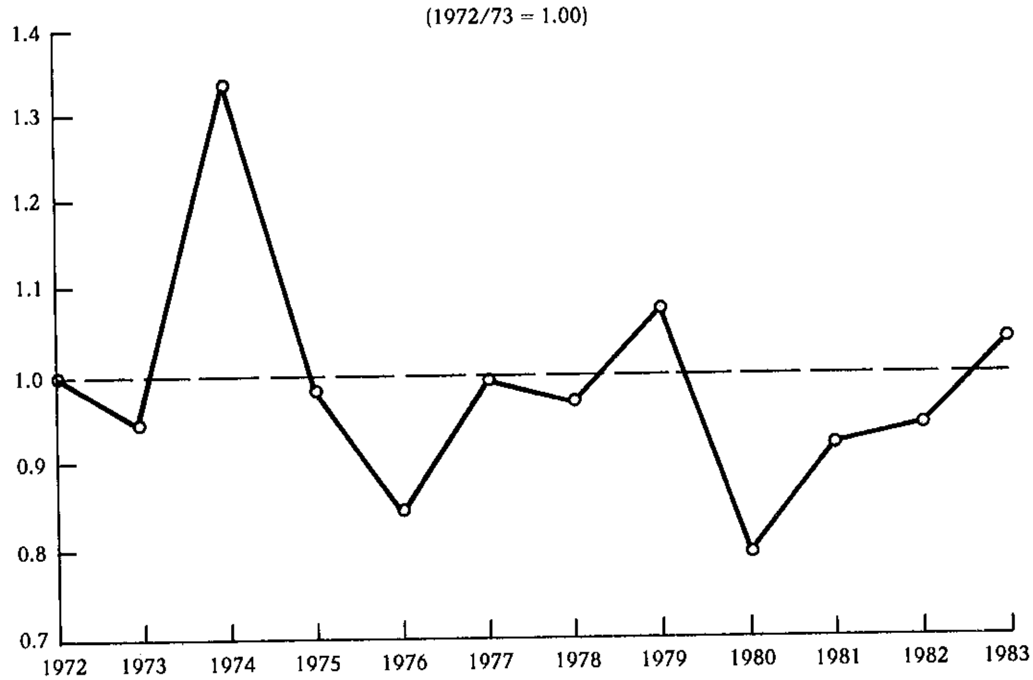


Source: Based on data from Bangladesh Bureau of Statistics, *National Report on the 1983/84 Census of Agriculture and Livestock* (Dhaka: BBS, 1986).

late 1970s and early 1980s, high-price points occurred more frequently in May and August than in other months. The incidence of high prices in October-November thus appears to have diminished in the 1976-84 period compared with 1960-70.

Another way of looking at the variations in monthly nominal prices is to consider prices at particular months over a number of years (say January prices of 1960-70) and to measure the coefficient of variation around a simple time trend (Table 5). The statistics in Table 5 indicate that the extent of variation in monthly prices was higher in 1971-75 compared with either 1960-70 or 1976-84. The early years show a relatively constant coefficient of variation across months, whereas the latter two periods exhibit a wide range from month to month. For 1976-84 the high coefficients from July to October raise a question as to whether production with new technology, most of which is harvested during July to October, has caused this phenomenon. In general, there has been little change from the 1960s to the recent period.

Figure 8—Ratio of the rice index to the manufactured goods index, 1972-83



Source: Computed from Bangladesh Bureau of Statistics, *Statistical Yearbook 1985/86* (Dhaka: BBS, 1986).

Decomposition of Nominal Prices

There are numerous methods for seasonally adjusting economic time series, all of which are based on the premise that seasonal fluctuations can be measured in an original nominal series and separated from trend, cyclical, and irregular fluctuations. The seasonal component is defined as the intrayear pattern of variation, which is repeated constantly or evolves from year to year. The trend-cycle component includes the long-term trend and business cycle, if any. The irregular component is composed of residual variations, such as the sudden impact of political events, the effect of abnormal weather conditions, and reporting and sampling errors. The series adjusted for the seasonality factor consists of trend-cycle and irregular components. Similarly, the series adjusted for trend-cycle and irregular factors consists of the pure seasonal component.

The method for decomposition of the original price series into trend-cycle, seasonal, and irregular factors in this study is based on the X-11 procedure developed by the U.S. Bureau of the Census for adjusting economic series for seasonality (U.S. Department of Commerce 1976). Among the various approaches considered, the X-11 proved the most flexible and appropriate for this price series. The procedure has the advantage of relatively precise measurements of the components and enormous flexibility in application for various types of time series. A brief description of the technical ingredients of the X-11 procedure is presented in Appendix 1 of this study.

In summary, the moving-average technique is the central element of the procedure, and iterative steps of moving averages are constructed to arrive at final results. A choice

Table 4—Extent of fluctuation in monthly nominal prices of rice, 1960-84

Year	Fluctuation[a]	Coefficient of Variation[b]	Month of Lowest Price Point	Month of Highest Price Point
	(percent)			
1960	39.9	0.113	January	July
1961	23.4	0.055	January	November
1962	19.3	0.062	January	July
1963	16.4	0.054	December	July
1964	23.9	0.073	April	October
1965	30.3	0.087	January	October
1966	58.9	0.167	January	October
1967	20.4	0.062	January	July
1968	31.3	0.105	February	November
1969	26.7	0.073	January	October
1970	21.4	0.074	December	July
1971	36.3	0.102	January	November
1972	84.0	0.213	January	October
1973	44.7	0.108	January	June
1974	154.5	0.362	January	October
1975	84.0	0.244	December	April
1976	10.8	0.033	July	February
1977	52.9	0.138	January	August
1978	17.6	0.046	January	May
1979	70.4	0.191	January	August
1980	22.9	0.093	December	May
1981	33.9	0.088	January	December
1982	29.2	0.107	January	May
1983	19.2	0.048	January	November
1984	26.7	0.071	January	October

Source: Computed from price data provided by Bangladesh, Ministry of Agriculture, Department of Agricultural Marketing, Dhaka.

[a] Price fluctuation is measured as the difference between the highest and lowest index numbers; the index number of a month is based on the January price as 100 and constructed separately for months in a year.

[b] The coefficient of variation is the standard deviation divided by the mean.

Table 5—Coefficients of variation of monthly rice prices in 1960-70, 1971-75, and 1976-84

Month	Coefficient of Variation		
	1960-70	1971-75	1976-84
January	0.104	0.429	0.089
February	0.133	0.464	0.100
March	0.134	0.487	0.107
April	0.149	0.450	0.098
May	0.142	0.310	0.108
June	0.139	0.208	0.068
July	0.125	0.205	0.131
August	0.124	0.219	0.162
September	0.102	0.251	0.155
October	0.106	0.352	0.141
November	0.103	0.525	0.105
December	0.101	0.481	0.100

Source: Computed from price data in Table 4, which were provided by Bangladesh, Ministry of Agriculture, Department of Agricultural Marketing, Dhaka.

Note: The coefficients of variation are computed around a simple time trend.

of several moving averages is available in X-11 for estimating the trend-cycle component. The selection of the appropriate moving average for estimating the trend-cycle component is made on the basis of a preliminary analysis of the data, using the technique provided in the X-11 procedure. The extreme values of irregular components thus derived are replaced by neighboring values if the irregular values fall beyond 2.5 σ (two standard deviations). Because of this smoothing adjustment in extreme values, the procedure may underestimate the irregular component, but it produces a consistent picture of seasonality.

Trend Cycle

When nominal prices are decomposed into trend, seasonal, and irregular components, the trend component of rice price is nonlinear and inclusive of cyclical elements. The trend price of rice was reasonably stable during the 1960s (1960-70), but rose sharply during the 1970s and early 1980s (1971-84), with occasional upward bursts in cyclical fashion. Even eliminating the cyclic component, the pure trend is not linear, but closely resembles an exponential growth curve and is consistent with the trend of inflation.

Seasonal Factors

The purely seasonal factors in rice prices are shown in Tables 6 and 7 and Figure 9. The following conclusions emerge clearly from the tables and graphs.

First, comparing 1960-70 and 1976-84 in Figure 9, it can be seen that in the first period the band of seasonality (breadth of the lowest and highest seasonality factors)

Table 6—Index of pure seasonality in monthly rice prices, 1960-84

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1960	90.7	93.9	95.1	98.7	101.5	104.7	107.8	104.5	100.6	100.4	102.9	99.2
1961	90.9	93.9	95.1	98.6	101.3	104.5	107.7	104.3	100.9	100.8	103.1	99.3
1962	91.2	93.5	95.2	98.3	101.3	103.8	107.2	104.2	101.7	101.7	103.5	99.7
1963	91.3	92.7	95.2	97.8	101.1	103.1	106.7	104.3	102.5	102.8	104.0	99.7
1964	91.1	91.9	95.4	97.5	100.8	102.5	106.2	104.7	102.9	104.0	104.5	99.9
1965	90.4	91.3	95.4	97.1	100.5	102.2	106.1	105.5	103.1	104.7	104.9	99.7
1966	89.5	90.9	95.4	97.0	100.6	102.2	106.2	106.0	102.9	105.3	105.2	99.5
1967	88.5	90.5	95.0	97.3	101.0	102.7	106.7	106.5	102.4	105.3	105.2	99.0
1968	87.8	90.4	94.4	97.8	101.9	103.8	106.9	106.4	101.5	105.1	105.2	98.6
1969	87.4	90.2	93.6	98.5	103.0	105.0	107.1	105.9	100.9	104.8	104.9	97.8
1970	87.2	90.2	93.1	99.2	104.6	106.3	106.9	104.7	100.5	104.6	104.7	97.0
1971	87.2	90.1	92.7	100.3	106.2	107.0	106.2	103.9	100.3	104.6	104.3	95.9
1972	87.3	90.2	93.3	100.9	107.7	107.4	104.9	103.2	100.1	104.7	103.7	95.1
1973	87.7	90.3	94.4	101.5	108.5	107.0	103.6	103.0	100.1	104.6	103.1	94.7
1974	88.2	90.6	96.1	101.7	108.8	106.1	102.7	103.1	100.3	104.4	102.6	94.6
1975	88.6	91.0	97.2	101.9	108.7	104.9	102.1	103.6	100.5	104.2	102.3	94.6
1976	89.1	91.5	97.8	101.6	108.3	103.9	101.9	104.0	100.8	103.7	102.1	94.5
1977	89.5	92.4	98.0	101.6	108.0	103.4	102.0	103.6	101.0	103.2	101.8	94.8
1978	89.9	93.3	98.1	101.8	108.1	103.3	101.9	102.9	100.5	102.3	101.6	94.9
1979	90.2	94.4	98.7	102.8	108.5	103.4	101.1	101.2	99.2	101.6	101.6	95.5
1980	90.8	95.5	99.9	104.0	108.7	103.6	99.8	99.4	97.6	101.1	101.6	95.8
1981	91.6	96.9	101.3	105.4	108.6	103.5	98.3	97.7	95.9	100.9	101.7	96.6
1982	92.4	98.1	102.4	106.4	108.2	103.1	97.0	96.7	94.7	100.9	102.0	97.4
1983	93.0	98.9	103.0	107.1	107.6	102.6	96.1	96.1	93.9	101.3	102.2	98.1
1984	93.3	99.2	103.2	107.4	107.2	102.3	95.6	95.8	93.6	101.7	102.5	98.1

Note: The procedure for computing the index is described in Appendix 1.

Table 7—Dispersion of the index of pure seasonality in rice prices, with low and high price months, 1960-84

Year	Range	Minimum	Maximum	Low Month	High Month
1960	17.14	90.68	107.82	January	July
1961	16.76	90.89	107.65	January	July
1962	16.00	91.17	107.17	January	July
1963	15.40	91.28	106.68	January	July
1964	15.12	91.07	106.19	January	July
1965	15.71	90.42	106.13	January	July
1966	16.76	89.46	106.22	January	July
1967	18.11	88.55	106.66	January	July
1968	19.12	87.79	106.91	January	July
1969	19.75	87.40	106.91	January	July
1970	19.66	87.19	106.85	January	July
1971	19.85	87.19	107.04	January	June
1972	20.38	87.28	107.66	January	May
1973	20.77	87.71	108.48	January	May
1974	20.59	88.17	108.76	January	May
1975	20.01	88.65	108.66	January	May
1976	19.18	89.14	108.32	January	May
1977	18.53	89.49	108.02	January	May
1978	18.20	89.85	108.05	January	May
1979	18.29	90.23	108.52	January	May
1980	17.88	90.81	108.69	January	May
1981	17.02	91.55	108.57	January	May
1982	15.73	92.44	108.17	January	May
1983	14.63	93.01	107.64	January	May
1984	14.12	93.29	107.41	January	April

Source: This index is based on the seasonality index in Table 6.

gradually widened. The opposite pattern (a gradual narrowing) can be discerned in the latter period (1976-84). However, the downward fluctuations were increasingly smaller during 1976-84 compared with the first period. The difference in upward fluctuation between the two periods is not so sharp.

Second, as far as the seasonality factor is concerned, the lowest factor price has occurred in the month of January in all periods, although a new strong second low is evident in the 1976-84 years. The highest seasonal price was always in July during the first period, but it moved back to April and May in the later years.

A dramatic overall change in the pattern of price seasonality occurred over the 24-year period from 1960-84. This movement is best brought out by comparing the average seasonality factors of the first three years, 1960-62, with those of the last three, 1982-84 (Figure 10). The large shifts in the shares of the three rice crops due to the advent of HYVs are visibly reflected in the patterns of seasonality factors in the two periods. In the earlier period, prices started at their lowest in January (the aman season) and rose steadily through July, before retreating with the arrival of the smaller aus and boro crops in August and September.

In recent years, the lowest month has still been January (aman), but the earlier and larger arrivals of aus and boro rice during June-August have caused prices to drop close to their January levels. The direct result for any price stabilization scheme is that careful attention must be paid to both harvest seasons. In addition, the shifts of seasonality are ongoing and require periodic reassessment for policymakers to keep up with their evolution.

Figure 9—Seasonal index, 1960-70 and 1976-84

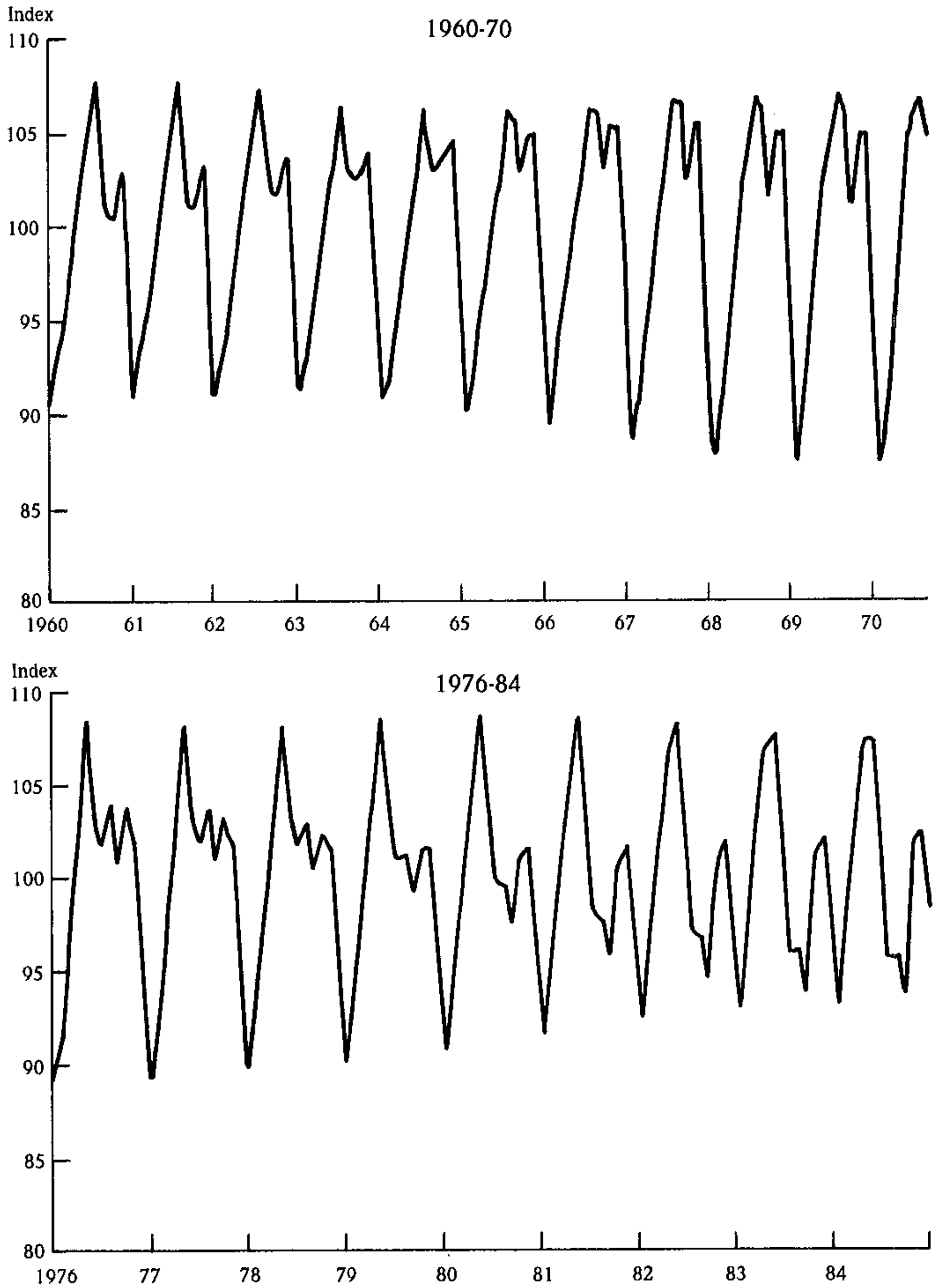
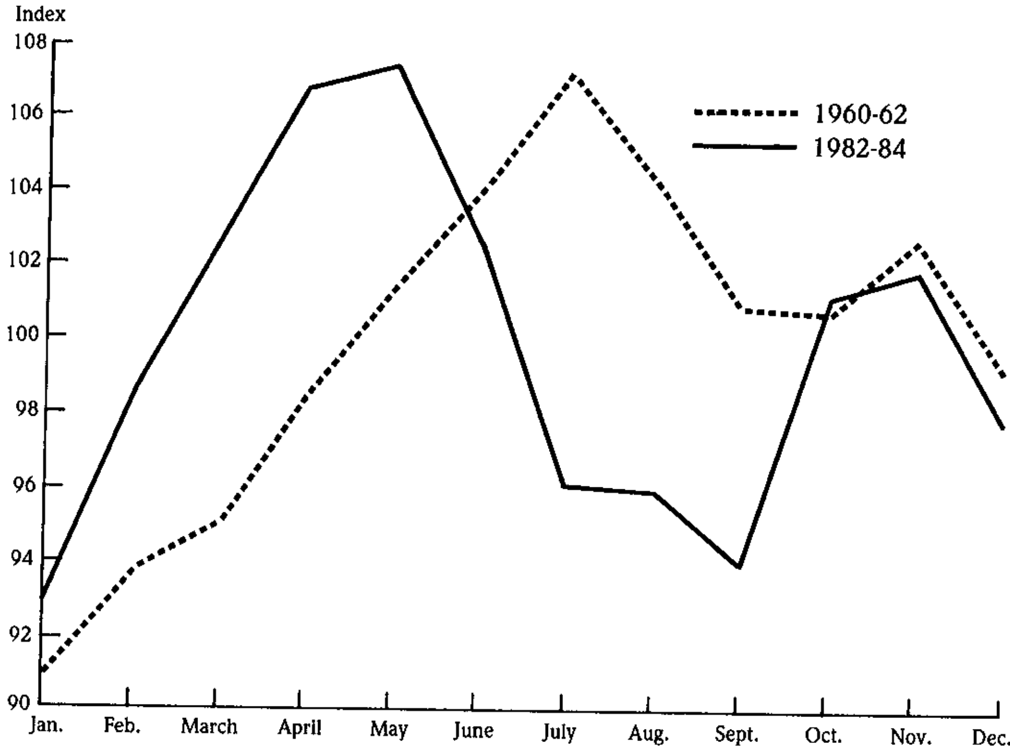


Figure 10—Seasonal factors in rice prices based on three-year averages, 1960-62 and 1982-84



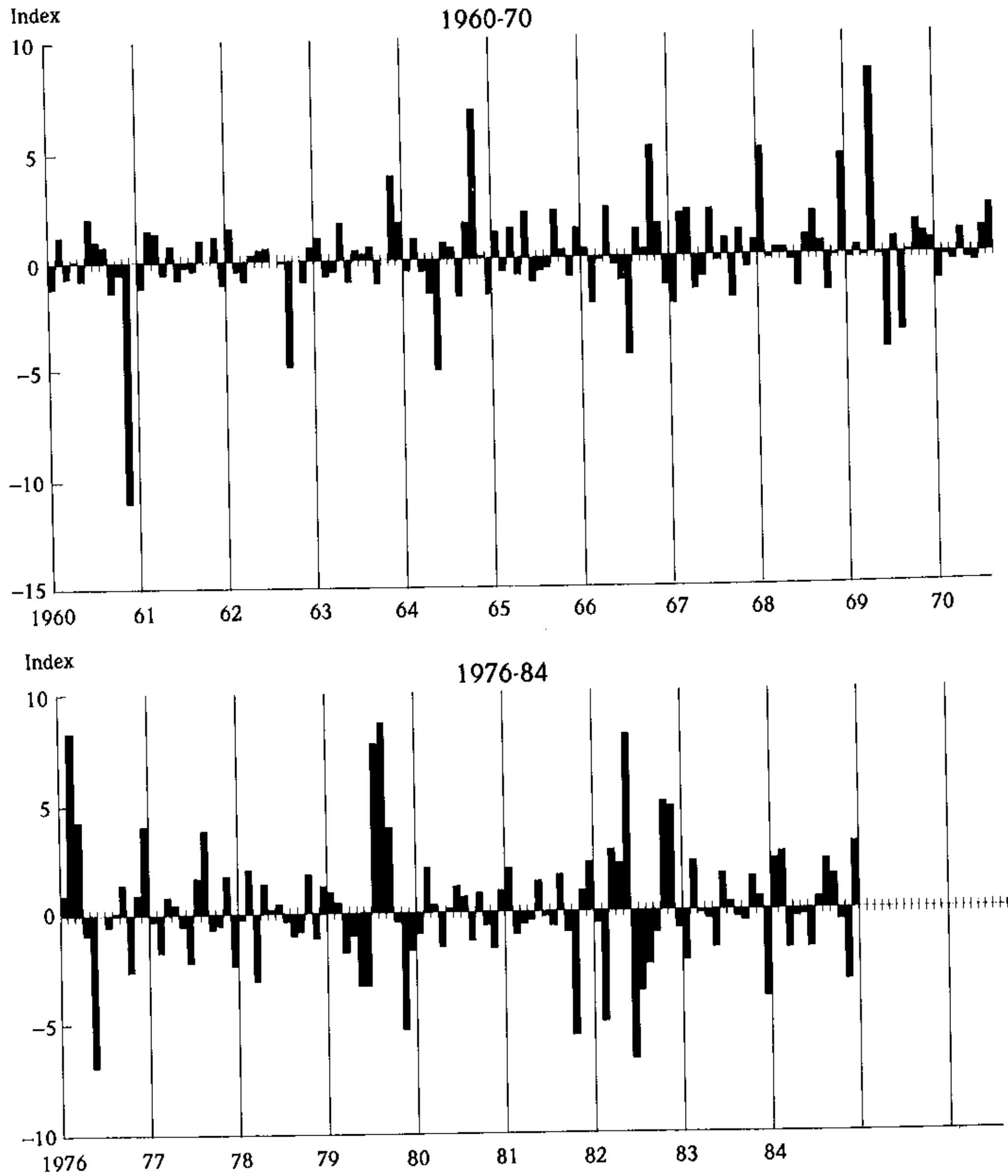
Irregular Factors

Irregular factors represent random effects on prices, generally arising from weather variations but not exclusive of other random phenomena like availability of food aid, war, or erratic public actions. The measurements of irregular factors in the monthly rice prices during 1960-70 and 1976-84 are shown in Figure 11. Comparison of these figures clearly demonstrates that the frequencies as well as amplitudes of irregular factors were much larger during the period 1971-75 relative to either 1960-70 or 1976-84. However, the differences between 1960-70 and 1976-84, the periods of particular interest, are not so obvious. In terms of the number of times when positive or negative deviations of irregular factors exceeded five points, the period 1976-84 appears to be somewhat more volatile than 1960-70. During 1960-70 such deviations occurred in 4 out of 10 years (0.40 per year) compared with 7 in 9 years (0.78 per year) during 1976-84. The 1960s appear to have been relatively blessed compared with either the 1970s or early 1980s.

Integration of Factors

Once the nominal prices have been decomposed into trend, seasonal, and irregular factors, it should be obvious that these can also be integrated to result in the nominal price. This procedure is simple. Trend factors are measured in taka per unit (maund) of rice, whereas seasonal and irregular factors are index numbers based at 100. A multiplicative relation produces this integration as shown in equation (1).

Figure 11—Irregular factors, 1960-70 and 1976-84



Note: The procedure for computing the index is described in Appendix 1.

$$NP = TR \cdot SF \cdot IF, \tag{1}$$

where

NP = nominal price,
TR = trend factor,
SF = seasonal factor, and
IF = irregular factor.

(See Appendix 2, Table 22, for estimates of these components in 1960 and 1984.)

Perhaps it is appropriate to point out that the pure seasonality pattern as shown earlier is somewhat different from the pattern obtained with the nominal prices. The overall difference, as indicated by the pattern of rising and falling phases of prices, is not, however, so significant as the difference at particular months or phases.

Contribution of Components to Variance in Nominal Prices

The variance and the share contributed by each component—trend, seasonal, and irregular factors—will differ depending on whether one takes the monthly prices, the average of a number of months, or the annual average price. The span of months is therefore a critical factor determining the contribution of the components to the total variance in original data. The shares are presented in Table 8 by time spans in months.

It is clear from the table that in monthly price variations in the original series, the seasonal irregular factors play the dominant role. In the 1960-70 series, the contributions of trend, seasonal, and irregular components to variance of monthly prices are 15, 60, and 23 percent, respectively. These shares in trimonthly prices for the same series are 32, 61, and 7 percent. With the 1976-84 series, the shares of trend, seasonal, and irregular components to variance of monthly prices are 21, 52, and 28 percent. For trimonthly (quarterly) prices these shares change to 47, 44, and 9 percent, respectively, for the 1976-84 series. The significant difference between the two series is reflected in the contribution of the trend-cycle factor in monthly and trimonthly price variations.

Table 8—Relative contribution of components of variance in original series, 1960-70 and 1976-84

Period/ Span in Months	Trend Cycle	Seasonal	Irregular
		(percent)	
1960-70			
1	15.05	59.56	23.39
2	22.53	67.00	10.47
3	31.49	61.31	7.20
4	36.19	59.61	4.20
5	40.53	55.42	4.05
6	46.32	50.74	2.93
7	53.44	44.08	2.48
9	70.06	27.08	2.86
11	90.87	7.15	1.98
12	97.18	0.06	2.76
1976-84			
1	20.49	52.01	27.50
2	33.66	48.24	18.11
3	46.87	43.91	9.22
4	60.02	33.84	6.14
5	70.61	23.84	5.56
6	77.35	18.72	3.94
7	81.32	15.40	3.27
9	85.31	12.06	2.64
11	95.12	3.12	1.76
12	97.40	0.12	2.50

Source: This table is computed from the decomposition analysis of prices discussed in Appendix 1.

The share of the trend-cycle factor in these variations is significantly higher in the 1976-84 series compared with the 1960-70 series. Obviously, the differences in inflationary forces between the two periods resulted in this increased share of the trend factor.

It may be concluded from this analysis that the fluctuations in nominal prices that are observed in contemporary rice markets of Bangladesh are the products of factors reflecting trend and cyclical influences, pure seasonal phenomena, and irregular forces. The pure seasonal factors have changed dramatically with the shift of the peak price month from July in the 1960s to May in the 1980s. Although January remains the lowest price month, a new, second low-price period during August-September has emerged in the posttechnology period (1976-84). This change in pure seasonal factors is frequently masked by the trend and irregular factors that influence nominal prices. The inflationary trend factor together with the irregular factors accentuated the fluctuations in nominal prices during 1976-84 compared with 1960-70. On the other hand, the pure seasonality factors contributed to more stability in prices during the latter period. A cyclical rise and fall in rice prices about every other year became the pattern of the trend-cycle component during 1976-84, whereas there was almost no cyclical movement during 1960-70.

5

CAUSES OF FLUCTUATIONS IN ANNUAL AND SEASONAL PRICES

The price of rice, like that of any other commodity at a given time and a given market, is determined by the interaction of forces of supply and demand, and the expectations of market actors concerning future prices. The question of time is taken into account by analyzing fluctuations of both annual and seasonal prices. Because there are many markets and because aggregate prices are considered here, it is important to determine whether markets are integrated. This is covered in the next section. Changes in expectations and their effects on price fluctuations are not analyzed in this report (see Ravallion 1985 for such an analysis).

Decomposition Analysis of Annual Price Fluctuations

Domestic production and imports exert supply-side influences, and domestic demand and exports constitute demand-side influences on the price of rice. Foodgrains have rarely been exported from Bangladesh, so domestic consumption is the only demand force. If supply and demand move in the same direction in any year, rice prices will tend to stabilize. If supply and demand move in opposite directions in a given year, rice prices will tend to destabilize. The nature of the interaction of supply and demand forces is therefore considered critical in determining price fluctuations. The Bangladesh economy of the early and mid-1960s was mainly agricultural; the share of agriculture in gross domestic product (GDP) was about 70 percent. The urban population was only about 5 percent of the total. Agricultural income largely represented the basis for demand, and agricultural production largely represented supply. An economic structure of this type implies that supply and demand are jointly determined and move in the same direction, resulting in increased price stability. However, by the early 1980s the supply and demand forces had become more independent. Agriculture contributed only 48.5 percent to total GDP; urban and rural nonfarm populations had increased to more than one-fourth of the total population. These structural changes may have contributed to increased price instability, while government policies on foodgrain imports may have mitigated any deleterious effects from the separation of demand and supply. To examine these hypotheses, the following formal model is used.

The Model

The methodology in this exercise uses a simple supply and demand equilibrium model to decompose price variance. The formal version is as follows:

$$Qd = a - bPt, \tag{2}$$

$$Qs = c + dPt, \tag{3}$$

$$Qi = e, \text{ and} \tag{4}$$

$$Qd = Qs + Qi, \tag{5}$$

where a is the demand intercept, c is the supply intercept, e is the import intercept, and b and d are the slope parameters. Imports are determined independently of domestic price, so equation (4) has no slope parameters. Attempts to fit an equation of imports on domestic and world prices show no significant relations. Whereas policy may use an expected price in deciding about imports, delays in arrivals or other aid-related factors obscure relations in past data. It should be noted here that while many exogenous factors (income, wealth, and so forth) influence prices and quantities in this system, the model conveniently reduces them to net intercept terms in order to greatly reduce data and computational needs. Given the objectives of examining the effect on price variance of broad forces of supply and demand, such a simplified model is appropriate.

This structural model, which was employed first by Piggot (1978, 1986), is then loosened somewhat by equating the slope parameters with the elasticities evaluated at the means (following Myers and Runge 1985), resulting in

$$b = \varepsilon_d \cdot (q/p), \text{ and} \tag{6}$$

$$d = \varepsilon_s \cdot (q/p), \tag{7}$$

where ε_d is the elasticity of demand and ε_s is the elasticity of supply.

The constants are finally derived as

$$a = Qd + bPt, \tag{8}$$

$$c = Qs - dPt, \text{ and} \tag{9}$$

$$e = Qi. \tag{10}$$

In matrix notation the system of equations (2) through (5) can be written:

$$AY = C, \tag{11}$$

where A is a matrix of coefficients associated with the endogenous variables (price and quantity), Y is a matrix of endogenous variables, and C is a matrix of net intercepts.

The variance-covariance matrix of the endogenous variables is

$$T = xvx', \tag{12}$$

where

T = the desired variance-covariance matrix,
x = A^{-1},
v = the variance-covariance matrix of the net intercepts, and
x' = the inverse of x.

From this form the composite elements of variance directly attributable to demand, supply, and import intercepts and their interactions can be easily identified. The contributions of demand for and imports of domestic products and their interactions with the variance of prices are measured for the 1961-70 and 1975-84 periods. The price elasticity of demand is assumed to be −0.4, and the price elasticity of supply is allowed to vary from 0.2 to 0.4, particularly to accommodate the situation in the second period. Most cross-section and time series estimates of price elasticity of demand center around −0.4 (Ahmed 1981, Pitt 1983).

Results

The contributions to the total price variance of the six components—demand, production, imports, interaction of demand and production, interaction of demand and imports, and interaction of production and imports—are shown in Table 9. These contributions change dramatically between the first and second time periods. The first decade is characterized by large, positive, direct effects of domestic production and demand and a comparably large, negative interaction term. Over the range of results, imports play a small role. As Myers and Runge (1985) found in their analysis of the U.S. maize market, this large interaction term is the result of the simultaneous shifting

Table 9—Decomposition of price variability, 1961-70 and 1974-83

Variable	Percent of Price Variance Explained		Ratio of Demand/Net Supply Effects	
	1961-70	1974-83	1961-70	1974-83
	(percent)			
$\varepsilon_s = 0.20$				
Demand	305	60	1.05	1.17
Demand/supply interaction	−486	35		
Demand/import interaction	−1	−35		
Supply	289	44		
Supply/import interaction	−9	−10		
Imports	2	7		
Total	100	100		
$\varepsilon_s = 0.25$				
Demand	261	51	1.02	0.98
Demand/supply interaction	−406	38		
Demand/import interaction	−1	−30		
Supply	253	46		
Supply/import interaction	−8	−11		
Imports	2	6		
Total	100	100		
$\varepsilon_s = 0.30$				
Demand	225	45	0.99	0.85
Demand/supply interaction	−343	40		
Demand/import interaction	−1	−26		
Supply	225	48		
Supply/import interaction	−8	−11		
Imports	2	5		
Total	100	100		
$\varepsilon_s = 0.35$				
Demand	196	39	0.96	0.74
Demand/supply interaction	−293	41		
Demand/import interaction	−1	−23		
Supply	203	49		
Supply/import interaction	−7	−11		
Imports	2	4		
Total	100	100		
$\varepsilon_s = 0.40$				
Demand	173	35	0.93	0.64
Demand/supply interaction	−252	42		
Demand/import interaction	−1	−20		
Supply	185	51		
Supply/import interaction	−6	−12		
Imports	1	4		
Total	100	100		

Note: Numbers may not add to total because of rounding. The demand elasticity is $\varepsilon_d = -0.4$, and the supply elasticities (ε_s) are given in the table.

of supply and demand curves, hypothesized earlier in this section. This study suggests that the shifts are outward movements of both curves.

The characteristics of the second time period are quite different. The direct demand and domestic production components are remarkably smaller, and more important, their interaction terms have switched signs. No longer are the curves shifting in the same direction, and no longer is the price being stabilized by the interaction of supply and demand. The hypothesis that supply and demand forces have become more independent in the second time period is reinforced by these results.

The effect of imports has increased strongly in the later decade. The demand-import covariances are always negative, as are those of domestic production and imports, and they largely offset the positive production-demand covariances. Thus a fundamental shift in the overall structure of price variability has occurred between the two periods. In the latter time period, at almost every level of supply elasticity, the contribution of supply variability to price variability is higher than that of demand. More important, if the supply elasticity increases between periods (as is hypothesized for the advent of the new rice technology), then the shift is more dramatic. During the 1960s the contributions of supply and demand forces were almost equal to price variation. In the late 1970s and early 1980s supply variability became the dominant force behind price fluctuations.

Even though changes in supply elasticity make a difference in the results, they do not influence the conclusions concerning imports. At all levels of elasticity, imports became more important in overall price variance in the second period. Especially noteworthy are the large negative covariances: imports helped to offset shortfalls in supply and increases in demand.

The foregoing conclusions are important to the analysis of contemporary policies in price stabilization. In attempting to derive lessons for current policy purposes, a straightforward comparison of policies in the 1960s and those practiced now may be hazardous unless this structural change in demand-supply relations is kept in view. On the domestic front, the major sources of price instability are the weather factors that affect production. Forecasting domestic production under the influence of randomly occurring weather disturbances has assumed an added importance in a structural situation where demand and supply forces are becoming more and more independent. In this context, a brief analysis of the effects of flood and drought on variability of production is quite revealing.

Random Effects of Flood and Drought

Earlier it was shown that extremely irregular fluctuations in prices were more frequent in 1976-84 than in 1960-70. Government efforts to stabilize prices were more intensive in the later than in the earlier period. During 1976-84, domestic procurement of foodgrains as a price support measure reached half a million tons (equivalent to 25 to 40 percent of marketed surplus) in good production years. Open market sales from public stock during poor harvest years were also introduced during this period. Neither procurement for price support nor open market sales were effectively employed to stabilize prices in 1960-70. However, erratic behavior of public purchases, imports, and sales may aggravate rather than pacify instability in prices. This happens primarily because of the misreading of the effects of natural calamity when the government responds vigorously to counteract the effects of floods, droughts, and cyclones with excessive or inadequate imports of foodgrains.

An accurate assessment of crop damages from natural disasters is therefore crucial for combating erratic movements in foodgrain prices. The government has an established procedure and mechanism for assessing crop damages from natural calamities.[2] Table 10 gives a picture of the size of the loss in production of rice crops due to flood and cyclone. Although these statistics are less reliable than crop production estimates, the relative intensity of the adverse effects of flood and cyclone in various years is reflected. The estimates of crop loss from drought are not available. It is difficult to assess loss from drought because such damages are often intricately enmeshed with land productivity and various factors that influence this productivity. Unlike flood damage, drought loss cannot be easily identified and measured, except when farmers fail to sow or plant because of drought. Nevertheless, loss from drought is likely to be more severe than that from flood in Bangladesh.

The data in Table 10 show that flood damage is more frequent than cyclone damage, and aus and aman rice crops are more vulnerable to flood than boro. However, as more areas are sown with HYVs, the proportion of HYV crop loss due to flood appears to be larger than the overall proportion of HYVs in total rice-cropped area. While the share of HYVs in total rice-cropped area ranged from 19 to 24 percent during 1979/80-1983/84, the share of the HYV crop lost to flood appears to range from 31 to 50 percent of total rice losses in the same period. The capacity of HYVs to overcome short-duration flooding and drought is generally much weaker than that of local varieties. The interaction of HYVs and natural calamity thus increases instability in production and prices. The estimates of loss of production from flooding, as presented in Table 10, are in

Table 10—Loss of rice production from floods and cyclones, 1969-84

Calendar Year	Total Loss	Share of Aus in Total Loss	Share of Aman in Total Loss	Share of Boro in Total Loss	Share of HYVs in Total Loss	Share Lost from Floods	Share Lost from Cyclones
	(1,000 metric tons)	(percent)					
1969	218.08	15.2	83.7	1.1	0.9	100.0	0.0
1970	1,411.95	13.8	86.0	0.1	0.1	47.1	52.9
1971	305.27	18.0	82.0	0.0	6.0	100.0	0.0
1972	244.82	30.0	70.0	0.0	0.2	100.0	0.0
1973	895.15	22.2	77.8	0.0	13.0	67.8	32.2
1974	535.41	43.5	56.5	0.0	13.3	100.0	0.0
1975	279.57	24.2	9.0	66.8	25.6	100.0	0.0
1976	681.85	51.5	38.7	9.8	31.7	100.0	0.0
1977	402.33	3.6	14.3	82.1	27.5	17.8	82.2
1978	131.12	49.7	24.6	25.7	39.8	99.7	0.3
1979	60.47	22.3	77.7	0.0	12.2	100.0	0.0
1980	285.05	10.4	88.1	1.5	40.5	100.0	0.0
1981	158.90	33.8	13.0	53.2	47.3	100.0	0.0
1982	175.22	25.2	53.8	21.0	42.2	100.0	0.0
1983	540.15	28.1	46.9	25.0	50.3	100.0	0.0
1984	1,949.17	16.2	64.7	19.1	30.5	100.0	0.0

Sources: Computed from Bangladesh, Bureau of Statistics, *Agricultural Yearbook 1979-80* (Dhaka: BBS, 1981); and Bangladesh, Bureau of Statistics, *Statistical Yearbook of Bangladesh, 1985* (Dhaka: BBS, 1986).

[2] In the event of a natural calamity, the government's agriculture extension workers and statistical assistants at the *upazila* and *union* administrative levels are asked to assess the extent of damages in planted areas and yields of various crops in the afflicted zones. This information is examined and aggregated at various levels before final aggregation at the national levels.

calendar years. These estimates are rearranged into fiscal years to compare them with the annual official statistics of rice production, which are available in fiscal years in Table 11. Some interesting lessons on relative adverse effects of flooding and droughts clearly emerge from this data. First, in almost all years with moderate to severe flooding (crop loss of more than 300,000 tons)[3] but with no severe drought, actual production of rice has remained above trend production. This supports the hypothesis that location-specific flood losses do not lead to an aggregate loss of crop production by the same amount. Flooding causes locational income and employment problems, but it does not adversely affect, and may even improve aggregate supply and hence average prices.[4] Flooding is caused by excessive rainfall, which may cause crop damage in low-lying areas but at the same time improves soil moisture and crop yields in highland rice crops. In most flood years, the average actual yields are higher than trend yields. Montgomery (1985) arrived at similar conclusions in his analysis of the effects of flooding in Bangladesh.

Second, the impact on aggregate production becomes most serious when severe floods and droughts occur in the same year. Third, a severe drought, even without a severe or moderate flood, is often found to cause actual aggregate production to fall below trend production. Thus, drought is more menacing than flood in Bangladesh as far as aggregate production is concerned.

Causal Analysis of Seasonal Price Fluctuations

In analyzing the factors that explain the pattern of seasonality in prices, particular emphasis is placed on new technology and on storage costs.

Storage Costs and Seasonal Prices

If traders in a competitive market always knew in advance what the peak price would be in the upcoming season, and if they did not have any capital constraint, then they would purchase and store as much rice in the harvest season as they would be able to sell in the peak price season to maximize total profit. This would be possible only if the storage cost, including a normal profit, is accommodated within the price gap between harvest and peak seasons. In this situation the seasonal factor—that is, the price spread between the two seasons—would be equal to the storage cost. But the reality will certainly be different. The peak price cannot be foreseen with certainty; only a speculative guess based on current information is possible. The market may not be competitive, particularly if capital is constrained. Therefore, in any particular trading period, seasonal price spreads are likely to deviate from the storage cost. But over a number of trading periods, the average price spread would tend to be equal to the storage cost, implying that excess profits in some periods compensate for losses in others.

In the context of developing market economies, the storage cost is something that cannot be identified with the prevailing interest rates in the organized financial markets. In such countries the storage function is performed by farmers, full-time traders, and government. Farmers in Bangladesh store about a quarter of the marketable surplus of rice, although precise estimates are hard to find (Bangladesh, Bureau of Statistics 1968).

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[3] All tons in this report are metric tons.

[4] The classic case was the 1976/77 cyclone and flood damage, which was largely limited to the district of Sylhet, where the government had to take special measures to support income and employment of the poor even though the national average price in that year was lower than the previous year.

Table 11—Relative adverse effects of flood and drought on production of rice, 1969/70 to 1983/84

Fiscal Years[a]	Flood Loss	Deviation of Production from Trend	Deviation of Yield Rate from Trend	Deviation of Area Planted from Trend	Recorded Drought Status
	(1,000 metric tons)		(ton/acre)	(1,000 acres)	
1969/70	218.14	1,488.60	0.0313	1,531.73	...
1970/71	1,409.58	375.40	0.0070	402.99	...
1971/72[b]	305.27	−1,082.80	−0.0218	−1,302.75	...
1972/73	244.82	−1,191.00	−0.0388	−568.50	Severe
1973/74	895.15	333.80	0.0161	−91.24	...
1974/75	722.26	−543.40	−0.0129	440.98	Severe
1975/76	159.63	643.40	0.0121	750.28	...
1976/77	945.58	−615.80	−0.0142	−492.47	Moderate
1977/78	109.54	316.00	0.0193	−270.21	...
1978/79	97.45	−67.20	0.0021	−192.95	...
1979/80	64.60	−439.40	−0.0123	−215.70	Severe
1980/81	365.44	419.40	0.0166	16.56	...
1981/82	95.37	−93.80	−0.0086	250.82	Severe
1982/83	180.11	217.00	−0.0007	427.07	...
1983/84	590.02	239.80	0.0043	195.33	...

Sources: Computed from flood loss statistics in Bangladesh, Bureau of Statistics, *Statistical Yearbook* (Dhaka: BBS, 1986) and Bangladesh, Bureau of Statistics, *Agricultural Yearbook 1979/80* (Dhaka: BBS, 1981).

[a] When crop losses are rearranged from crop years to fiscal years, the following adjustments are made: the figures for aus and aman rice in crop year 1969 and those for boro in crop year 1970 constitute the total for the fiscal year 1969/70.

[b] This is the year of civil war in Bangladesh when about 3 million people died, resulting in large-scale failure to plant or sow rice crops.

The storage cost and possible benefit at the farm level is dependent on a host of factors including conditions in the informal credit market and food security considerations. The informal credit market is highly fragmented and restricted in scope, and the implicit interest rate in these markets is often quite high. An interest rate in excess of 50 percent per year is not uncommon. But this does not mean that everybody can lend money at that rate. In fact, a large majority of farmers with surplus financial resources cannot find opportunities for investment in informal credit markets. Therefore, the market is limited to friends and relatives and to those who can ensure a credit discipline and loan security of various forms (such as a land mortgage or sales contract for commodities or assets). Some farmers also hold stock for reasons of food security. They delay sale of surplus stock from the current harvest until it becomes clear that the next harvest is going to provide an adequate supply for the next consumption period. Of course, distress sales occasionally override this food security consideration, but such sales are generally a small fraction of total sales.[5]

Theoretically, organized commercial banks in rural areas can provide an alternative opportunity to surplus farmers for investment, and the interest rate in these banks can serve as a basis for estimating the storage cost of farm stockholders. In fact, establishment of commercial banking has progressed in Bangladesh so that almost all *upazilas* (administrative units of about 100 villages) do have a bank. But corruption, illiteracy, lack of

[5] Part of the distress sale figure may also be the result of inadequate physical storage facilities on farms, particularly among small farmers with poor housing.

banking tradition, and interest rate policies of these banks have kept the effective use of these institutions from spreading among the majority of farmers.

The second category of rice stockholder, the government, purchases rice from farmers, generally in the aman season. This rice and imported grains constitute the two sources of government stock. Storage cost plays a small role in the decisions of the government in fixing the harvest-season procurement price and the peak-season sale price. The government's share in the total marketable surplus varies tremendously across years. In several years of the period 1970-84 this share was as high as 30-40 percent, while in most years it ranged from 2-10 percent of marketable surplus.[6]

The third category, the full-time traders in rice, are the stockholders in the free market who share the remaining portion of marketable surplus. Their storage costs might be approximated by the interest rate in the organized financial markets, but most of the traders conduct trade based on their own capital, which may have a different opportunity cost than the market interest rate. The interest rate in commercial banks for short-term borrowing was about 4 percent during 1964/65 when the general rate of inflation was also about 4 percent. In 1983/84, similar borrowing from banks cost an interest rate of about 15-16 percent with an inflation rate of about 14 percent. The real rate of interest in commercial banks therefore does not appear to have changed much. On the face of it, one would expect that real storage costs and resulting seasonality in prices would also be stable during the early 1960s and the early 1980s. But the storage cost between the two periods could be different even if the real interest rate were the same because of the difference in the length of storage brought about by new technology.

New Technology, Rice Production, and Seasonal Prices

The new rice varieties (HYVs) have had a significant effect on growth in foodgrain production in Bangladesh. The trend growth rates were not significantly different between the periods 1960-70, 3.1 percent a year, and 1971-84, 2.9 percent a year. The growth rate was faster (about 3.6 percent) during 1975-84 than in any other period. However, the sources of growth between the 1960s and the post-1970 period were remarkably different.

The increase in acreage was the main source of growth during 1960-70, whereas improvement in productivity of land was the primary source during 1971-84. The share of acreage in the incremental production of rice during 1960-70 was 57.4 percent, and the share of yield was 31.6 percent. This pattern changed drastically so that the share of acreage was only 14.3 percent and that of yield was 69.2 percent during 1971-84 (Hossain 1984). That new technology in agriculture brought about this phenomenal change is supported by information in Table 12 and related to statistics on the use of modern inputs in agriculture (Table 13). The most striking feature of the changing pattern of rice production in Bangladesh is the increase in the average share of HYVs, which has risen from zero in 1960-62 to about 42 percent in 1982-84.

Three consequences of this technological progress in rice production are important for the seasonal pattern of rice prices. First, assuming that aus, aman, and boro rice come to the market within a certain time period after harvest, and this timing has not been changed by technology, one would expect the increased production and hence

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[6] These estimates are based on the quantities procured by the government in various years and on the estimates of gross marketable surplus determined by relating such surplus to gross production, as formulated in Ahmed (1981).

Table 12—Changes in the shares of different rice crops in total rice output, 1960-62, 1969-70, and 1982-84

Rice Crops	1960-62	1969-70	1982-84
		(percent)	
Aus local	25.42	24.63	15.13
Aus HYV	0.00	0.70	6.77
Aus total	25.42	25.33	21.90
Aman local	69.67	55.78	39.75
Aman HYV	0.00	1.08	14.37
Aman total	69.67	56.86	54.12
Boro local	4.91	8.91	3.60
Boro HYV	0.00	8.90	20.38
Boro total	4.91	17.81	23.98
All rice	100.00	100.00	100.00
All HYVs	0.00	10.68	41.52

Sources: Bangladesh, Bureau of Statistics, *Statistical Abstract of East Pakistan* (Dhaka: BBS, 1966); and Bangladesh, Bureau of Statistics, *Statistical Yearbook of Bangladesh, 1985* (Dhaka: BBS, 1986).

market supply to generate different degrees of downward pressure on market prices at different seasons, all else being the same. This is so because the effects of technology are quite different in different types (or seasons) of rice, as is clearly shown in Table 12. In comparing the shares of various types of rice in total rice output between 1960-62 and 1982-84, the table demonstrates that the share of boro rice has risen from about 5 percent to 24 percent, the share of aus rice has fallen moderately from 25 to 22 percent, but the share of aman rice has declined sharply from about 70 percent to 54 percent. Moreover, the production of early-harvested broadcast aman has dwindled, shortening the length of the aman harvest period. Of the 24 percent share of boro rice in 1982-84, a little more than 20 percent was HYV boro. HYV aus accounted for only 7 percent, and HYV aman accounted for 14 percent of total rice production in 1982-84.

Table 13—Trend in the use of modern agricultural inputs, 1960/61-1983/84

Years	Area Irrigated by Modern Methods	HYV Area	Use of Chemical Fertilizers
	(percent of net cultivated area)	(percent of cropped area)	(nutrient pounds/cropped area)[a]
1960/61	0.3	. . .	2
1965/66	0.9	. . .	4
1969/70	2.6	2.1	9
1975/76	7.7	13.0	15
1977/78	9.4	13.4	24
1979/80	12.8	18.8	28
1980/81	13.6	21.0	28
1982/83	19.2	22.9	31
1983/84	20.3	23.6	36

Source: Mahabub Hossain, "Agricultural Development in Bangladesh: A Historical Perspective," *Bangladesh Development Studies* 12 (No. 4, 1984): p. 12.
Note: The ellipses indicate a nil or negligible amount.
[a] The trend in the use of absolute quantities of fertilizers rises much faster than the use per cropped acre because of increased cropping intensity.

Second, the technological progress in rice cultivation has brought in its wake changes in the timing of planting, average growth period, and harvest of various rice crops. Therefore, the timing of market arrivals of harvested crops has also changed, with consequent effects on seasonality of prices. The time of harvest varies slightly among districts due to agroclimatic conditions; the average harvest time is that time when the major portion of the crop is harvested. The average harvest times of various rice types during 1960-62 and 1982-84 in the country as a whole are shown in Table 14.

Since market arrivals begin only two to four weeks after harvest, it is not difficult to unravel the source of shift in seasonal prices of rice, as shown in Figure 10. As a result of the new technology the second-lowest price level now occurs in September because the boro and aus harvests overlap somewhat during the month of August. This overlapping occurs because of the staggering of the boro harvests over two months. The delayed planting of the irrigation-based boro crop, which is sown on new land at higher elevations, is partly the cause. Moreover, the growth period of the new HYVs is about 30-40 days longer than that of the local varieties (Bangladesh Agricultural Research Council 1983, 1982). As the harvests of boro and aus have moved forward by about two months without any substantial change in the harvest period of aman, the peak price season has become the month of May in the posttechnology period compared with a peak price period around July during the pretechnology era. During the earlier period, boro was a much smaller crop than now, which is also reflected in the July peak.

Third, and closely related, is the question of storability of different types of rice, and the effect of storability on the seasonal pattern of prices. Aus rice is harvested in wet months, and its moisture content is generally high. Farmers find it difficult to dry aus rice sufficiently. The same can be said but to a lesser degree of HYV boro. The storability of local boro is moderately good to excellent. Because aman varieties are harvested in dry stalks, they have excellent storability. For this reason, as well as taste, farmers with a surplus tend to sell their HYV and aus rice and to keep the aman rice for home consumption and for sale in a later month when prices are higher. These factors also contribute to the peak price situation around the month of May and a second low price period just after harvest of aus and boro.

Relation Between Seasonality in Prices and Production

The discussion of seasonality of prices and its causal factors has been predominantly descriptive. To understand the process better and to appreciate the weights of various

Table 14—Harvest months for various types of rice, 1960-62 and 1982-84

Type of Rice	1960-62	1982-84
Local aus	July-August	July-August
HYV aus	...	August-September
Local transplanted aman	December-January	December-January
HYV aman	...	January-February
Broadcast aman	November-December	November-December
Local boro	April-May	April-May
HYV boro	...	June-July

Sources: The information for 1960-62 is based on Bangladesh, Bureau of Statistics, *Surplus Labour in Paddy Cultivation in East Pakistan, 1964/65* (Dhaka: BBS, 1965). The information for 1982-84 is based on various sample surveys for crop estimates of the Bureau of Statistics and on field surveys by the Bangladesh Rice Research Institute.

causal factors that may have potential as policy instruments, it would be desirable to translate the descriptive points to objective measures. Unfortunately, lack of appropriate, season-specific data frustrates attempts to make a comprehensive objective analysis of seasonality.

A theoretically consistent approach to conducting a causal analysis of seasonality would require data on both demand and supply determinants by seasons, including some variables or specifications that could account for traders' expectation of prices. However, season-specific information on income, procurement, public distribution, prices of substitutes, and market arrivals from domestic production is not available. The only available season-specific data expected to have an important influence on seasonality of prices are for production. Thus, aman, aus, and boro rice harvests may be treated as proxies of seasonal supply. A regression model relating the measure of fluctuation in seasonal prices with seasonal production is undoubtedly an underspecification of the causal relation. Nevertheless, an estimate of this relation is provided here in order to reinforce the common understanding that the pattern of seasonal production significantly influences seasonality in prices. The estimate of the equation is

$$\begin{aligned} \log S &= \underset{(1.23)}{24.67} - \underset{(-1.06)}{2.65}\log AMN + \underset{(0.76)}{0.73}\log BORAS; \quad (13) \\ \bar{R}^2 &= 0.12, \end{aligned}$$

where S is the measure of seasonal fluctuations. S is measured by the difference of peak and trough seasonal prices after nominal prices are adjusted for the trend-cycle component. Therefore, it represents the band or amplitude of the pure seasonal and irregular factors of prices. AMN is the aman harvest and BORAS is the sum of boro and aus harvests, which have overlapped for a short time in recent years. The t-values are in parentheses. The analysis covers 1976-84.

Although the explanatory power of the influence is weak ($\bar{R}^2 = 0.12$), and the level of significance of the coefficients is also poor, the direction of the relation may be of some value. On this basis, it can be concluded that an increase in aman production in any year reduces the band of seasonal prices, and the increase in the combined boro and aus production widens the band of seasonal prices. This result seems consistent with the earlier finding that the effects of seasonality were accentuated in 1976-84 compared with 1960-70. During 1976-84, the share of aman declined and the share of aus plus boro increased compared with their respective shares in 1960-70.

Quantitative analysis of factors causing seasonal variation in prices and measurement of the weights of each of these factors on seasonality remains an underexploited area of investigation. Systematic development of seasonal information will be a first requirement for conduct of such analyses in the future.

In summary, the relative independence of supply and demand factors, accompanied by inelastic supply and demand elasticities, has increased annual price variability during recent years. Supply factors and their interactions with imports have become more dominant in explaining fluctuation in annual prices. These developments imply that an accurate forecast of domestic production is a critical requirement for planning price stabilization measures, including the need for imports. New technology has not accentuated the underlying pure seasonality of prices, although random fluctuation in seasonal prices has increased in recent years. All these factors dictate that price stabilization should be organized on a more systematic basis than in the past.

6

INTERMARKET LINKS AND REGIONAL PRICES

As mentioned in the introduction, an examination of the strength of integration among the many spatially distributed markets that constitute the basis of aggregate price analysis may identify weaker links in the chain of markets, which then can be kept under special purview when price stabilization measures are implemented. Segmentation of markets, that is, a complete lack of integration, implies that a market with excess demand does not get feedback from another market with excess supply. Therefore, the transmission of prices between such markets is absent. Markets may not be segmented, however, but the degree of integration or the rapidity and extent of transmission of prices among markets may still be weak for technical and economic reasons (for example, monsoons, political strikes, or high transaction costs in trade). Market integration does not mean that prices across geographical regions should be the same. Intermarket price differences will exist because of differences in transportation costs. These differences should not impair the transmission of price signals and trade among markets. In this chapter most regional rice markets in Bangladesh are shown to be integrated. Therefore, the adoption of an aggregate approach in modeling the price stabilization program is appropriate. But, even though the overall integration of markets is evident, there are occasions and locations where market integration is weaker than normal.

Regional Price Differentials

The trade flow in rice generally follows the pattern of supply from the hinterlands to the main industrial and urban centers of Dhaka, Chittagong, and Khulna. In addition, deficit districts receive supplies from nearby surplus districts. On the basis of this pattern of trade flow, the price differentials between markets, reflecting the marketing margins in interregional trade, are estimated for aus and aman rice. The price differential is calculated as

$$(P_1 - P_2)/P_1, \tag{14}$$

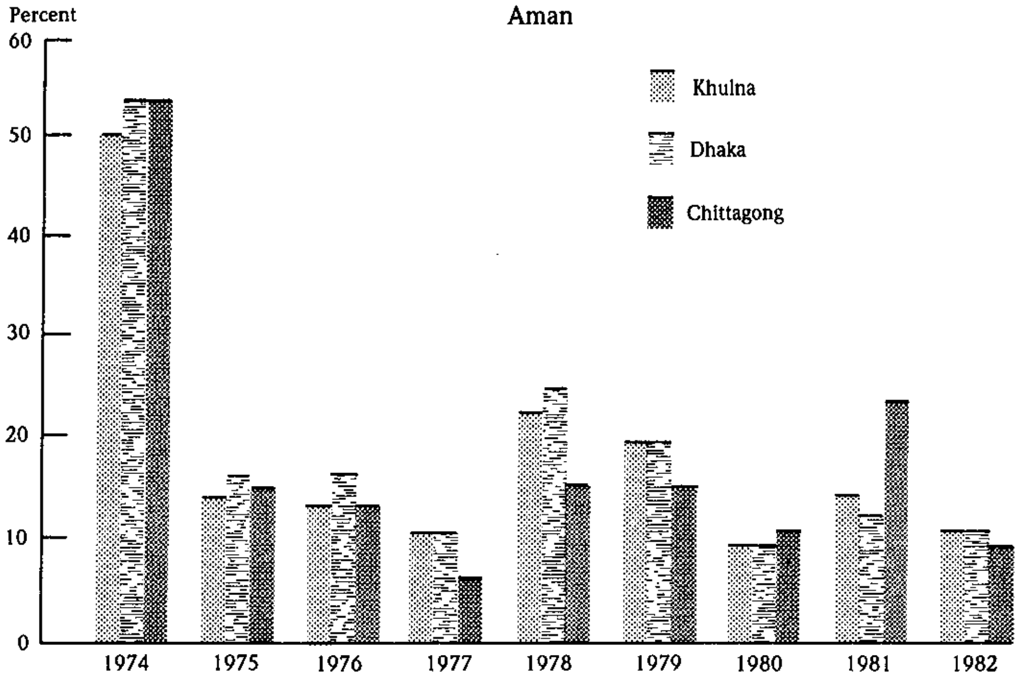
where P_1 is the price at the first market in a given year, and P_2 is the price at the second market in the same year.

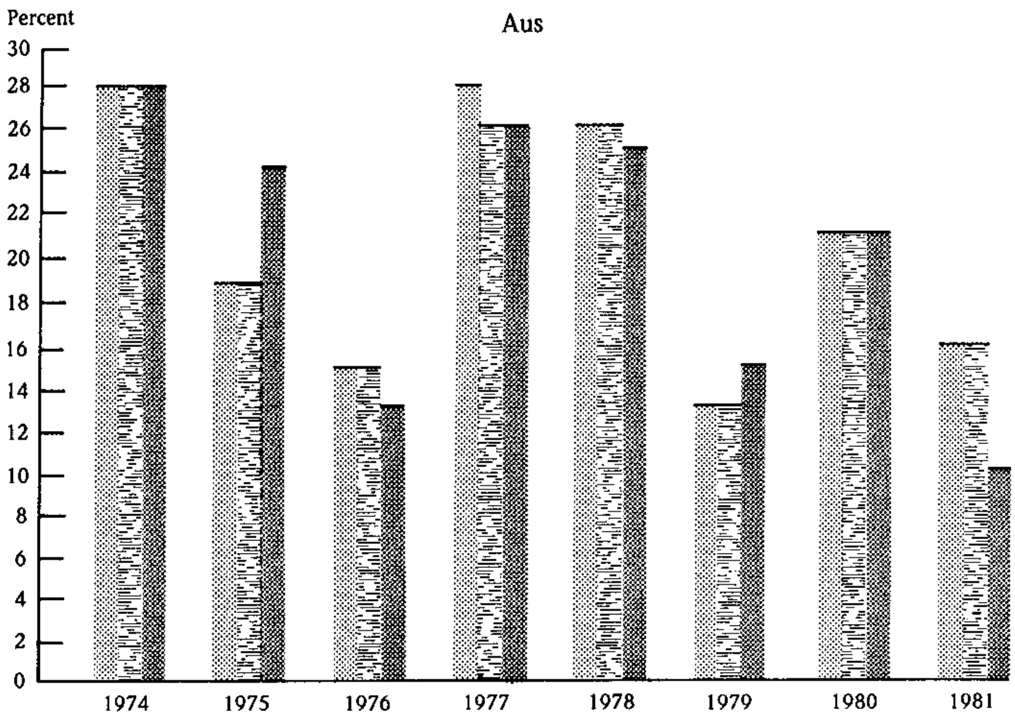
The estimates of price spreads or spatial marketing margins vary considerably by region and by time. However, there is no guarantee that the pairs of markets with high marketing margins necessarily constitute trade channels with any substantial volume of trade. For example, the Dinajpur-Noakhali channel exhibits an average price differential of 22 percent with a standard deviation of 33 percent, but trade in this channel is infrequent and small.

This information is summarized graphically in Figure 12. The graph shows the difference between highest and lowest prices in the Dhaka, Khulna, and Chittagong divisions, expressed as a percentage of the highest price. A number of conclusions can be derived from this information.

Spatial price differences average about 15 percent in aman rice and 18 percent in aus rice, but this average proportion varies in different years. In 1974, the proportion

Figure 12—Intraregional price spreads for aman and aus rice in Khulna, Dhaka, and Chittagong divisions, 1974-82





Source: Computed from price data in Bangladesh Bureau of Statistics, *Statistical Yearbook, 1983/84* (Dhaka: BBS, 1985); and Bangladesh Bureau of Statistics, *Statistical Yearbook, 1985/86* (Dhaka: BBS, 1987).

rose to about 50 percent in aman and 28 percent in aus rice. Prices rose abnormally in 1974, particularly in the aman season. Recovery from disruptions in the market related to the civil war of 1972, particularly those involving movement of market functionaries, did not come about until that year. Even excluding 1974, spatial price margins appear to rise proportionately faster in years of rising prices.

This last point, that the proportion of the marketing margin rises with the rise in price levels, implies that either marketing costs increase with the rise in prices or traders reap an above-normal profit during such times. Perhaps the latter explanation is more realistic, and this may be the reason why policymakers distrust traders during periods of rising prices. However, such a phenomenon may not be irrational or an act of exploitation by traders if the relation between the marketing margin and level of prices is symmetrical. In that event, traders would make subnormal profits during a phase of falling prices, offset by above-normal profits during a phase of rising prices.

Methodological approaches to investigate the extent of market integration were initially limited to simple price correlations between markets. That such correlations are not always a proper indicator for market integration is evident from studies by Jones (1976), Harriss (1979), and Timmer (1974). Common factors like inflation, seasonality, and consistent price setting by public agencies may generate high correlation coefficients among market prices even though the underlying conditions are not congenial to an integrated market. Nevertheless, the correlation coefficients are not entirely meaningless. If the correlation coefficient between one pair of markets is higher than that for another pair, both operating under the same set of factors, obviously the former pair is more integrated than the latter. Therefore, the nature of integration in rice markets in Bangladesh is examined first through simple correlations and then through a somewhat more sophisticated approach suggested in recent literature (Ravallion 1986, Heytens 1986).

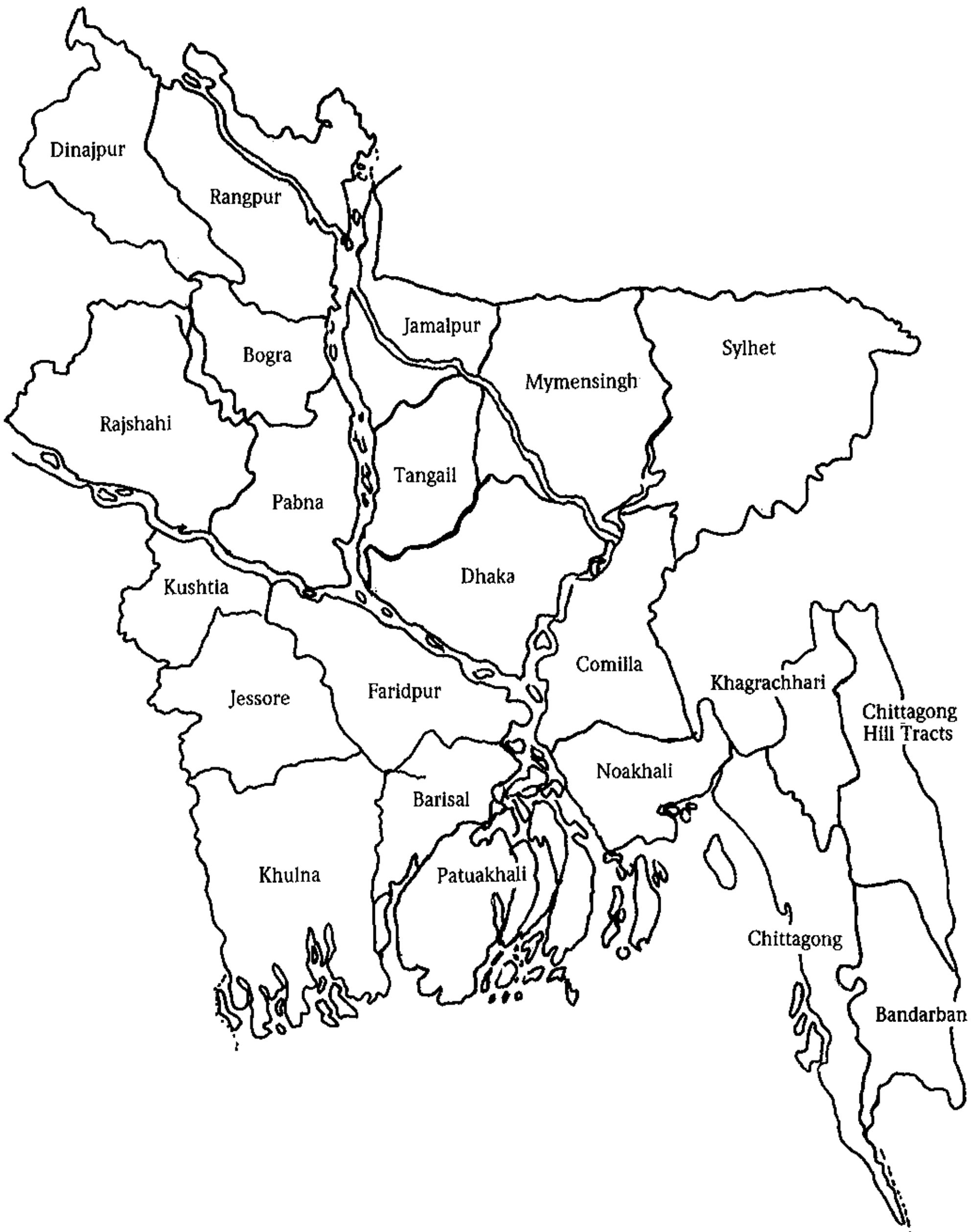
Interdistrict Correlations of Monthly Rice Prices

The paired correlation coefficients between district average prices of aman and aus rice are shown in Appendix 2, Tables 23 and 24. Price correlations during a period of rapidly changing prices could be different from those during a period of relatively stable prices. For this reason the correlation coefficients in stable and unstable years are worked out separately. In general, there is no difference in the number of significant coefficients between the stable and unstable years (years with less than or more than a 10 percent change in prices). However, the absolute magnitudes of correlation coefficients are slightly higher in unstable years. Only the coefficients for unstable years are presented in the tables. The locations of districts are shown in the map of Bangladesh (Figure 13).

The immediate observation that emerges from the correlation coefficients is that, measured by this indicator, aus rice markets are well integrated. Only 48 out of 190 pairs of correlations (about 25 percent) are statistically insignificant; all remaining coefficients are highly significant. Of the 48 insignificant coefficients, 18 relate Chittagong to other districts in the northern and southern parts of Bangladesh. Chittagong is one of the largest aus-growing districts. However, its transportation connections with districts in northern and southern Bangladesh are not well developed, inhibiting rice flows and perhaps causing insignificant correlations. Chittagong aus prices may need special monitoring during implementation of any stabilization scheme.

In the case of the aman price, there are 63 out of 190 pairs of correlations that are statistically insignificant. On this score, aman rice markets may appear to be less

Figure 13—Map of Bangladesh



integrated than aus. However, 51 out of the 63 insignificant correlations in aman prices pertain to Barisal, Patuakhali, Dinajpur, and Bogra. The first three are extremely backward in infrastructural development. Moreover, these districts again have larger shares of aman production than other districts. Therefore, concentration of production and backward infrastructure may be associated with disharmony in price movements between these three and the other rice markets of Bangladesh.

Application of an Advanced Test of Market Integration

Methodological developments for studying market integration are quite sparse. Ravallion (1986) developed a general approach to modeling market integration that can estimate the extent to which local prices are influenced by prices elsewhere. He employed this model with rice prices in Bangladesh just prior to and during the 1974 famine. His test of segmentation in rice markets rejected the hypothesis of segmented markets, but the test on short-run integration of markets was inconclusive. It must be noted that Ravallion's inquiry covered not only a period when a famine was raging in Bangladesh, but also a period just following a civil war when the country was still trying to recover from the infrastructural destruction wrought by that war. Ravallion's model has also been empirically applied by Heytens (1986) on Nigerian data. Timmer (1974) proposed a further use of the parameters from Ravallion's model to construct some indicators that will be explained later.

The Model

The estimating equation that was derived from Ravallion's general approach and used for the present study closely follows Heytens' discussion.

$$(P_{it} - P_{it-1}) = (\alpha_i - 1)(P_{it-1} - \bar{P}_{t-1}) + \beta_{i0}(\bar{P}_t - \bar{P}_{t-1}) + (\alpha_i + \beta_{i0} + \beta_{i1} - 1)\bar{P}_{t-1} + \gamma_i X + \mu_{it}, \qquad (15)$$

where

P_{it} = price in local market at time period t, i runs from 1 to n markets;

$\bar{P}_t$ = price in the central or reference market (Dhaka in the present study);

X = other factors used as dummies for dry or monsoon seasons;

α, β, and γ = parameters of the model to be estimated; and

μ_{it} = the error term.

The model specifies the change in local price as a function of the change in the Dhaka market price for the same period, last period's spatial price margin, last period's Dhaka market price, and local market characteristics. In equation (15) β_{i0} measures the extent to which the local price at a given time is influenced by the change in the central market price during the same time period. It therefore reflects the extent and the rapidity of movement of information from central market functionaries to wholesalers, retailers, or farmers in the local markets so that they can act to adjust prices.

The term $(\alpha_i - 1)$ measures the extent to which last period's spatial price differential is reflected in this period's local market price change. If the margin widened in the last time period (because of a price rise in the central market) and transaction costs remained the same, traders would have an incentive to move rice away from the local market to another part of the marketing chain, thus pushing up prices in the current time period. Other forces might also influence local price changes. Periodic shortages in supply or disruption of communications by local storms or cyclones could influence local price changes and sever the links with the central market. Finally, the general level of prices in the central market may provoke price changes in the local market, as is generally considered usual in an inflationary environment. This is reflected by β_{i1}.

From equation (15) the following hypotheses can be tested:

Market Segmentation. The hypothesis that the local market is segmented from the central market means that the changes in the central market price will have no effect, immediate or lagged, on prices in local markets. In equation (15) market i is segmented if

$$\beta_{i0} = \beta_{i1} = 0. \tag{16}$$

This can be determined by testing equation (15) against the following restricted model with an F-test:

$$(P_{it} - P_{it-1}) = (\alpha_i - 1) \quad (P_{it-1} - \bar{P}_{t-1}) + \gamma_i X + \mu_{it}. \tag{17}$$

If equations (15) and (17) are equal according to the F-test, then $\beta_{i0} = \beta_{i1} = 0$ and markets are segmented.

Short-Run Integration. This hypothesis requires that changes in the central market price be immediately (within the same month in the case of monthly data) and fully reflected in the local price. In terms of equation (15) it means that

$$\beta_{i0} = 1, (\beta_{i1} = 0), \text{ and} \tag{18}$$

$$\alpha_i = 0. \tag{19}$$

If both equations (18) and (19) are satisfied, market i is integrated with the central market in the same time period. Acceptance of the hypothesis makes $\beta_{i0} = 1$ and $(\alpha_i - 1) = -1$, indicating that this period's central market price change and last period's spatial differential are fully reflected in the current local price level.

Absence of Local Characteristics. This hypothesis implies that $\gamma_i = 0$, and therefore it reduces to

$$\begin{aligned}(P_{it} - P_{it-1}) &= Y_0 + (\alpha_i - 1)(P_{it-1} - \bar{P}_{t-1}) + \beta_{i0}(\bar{P}_t - P_{t-1}) \\ &\quad + (\alpha_i + \beta_{i0} + \beta_{i1} - 1)\bar{P}_{t-1} + \mu_{it}.\end{aligned} \tag{20}$$

More generally, specifications of the X variables are limited to dummy variables defined over the same time frame as each price observation (for example, monthly price data require monthly dummy variables). Such a general specification enables the use of dummies for monsoon and winter-season months. Seasonality factors, if each market has different seasonal prices, could also be used in the form.

Equation (15) can be tested against equation (20) with an F-test in order to determine the significance of local characteristics. Equation (15) can also be manipulated to result in an indirect but more subtle and general indicator of market integration. Assuming that the central market is stable,[7] and there is no effect of local characteristics on local prices, then (α_i) and $(\beta_{i0} + \beta_{i1})$ indicate the relative contributions of past local and central market prices to the determination of the current local price.[8] If past central

[7] Stability means $(\bar{P}_t - \bar{P}_{t-1}) = 0$. It may appear unrealistic, but if one considers that the condition is devoid of seasonal and inflationary effects, it may not be so.

[8] For consistency, Ravallion's notation is used throughout.

market prices are the primary influences on local prices, the local market is well connected in that central market supply and demand factors are being transmitted to local markets and influence prices there.

Timmer constructed an index of market connection (IMC) in order to measure the relative influences of these two sets of forces. IMC is defined as the ratio of the lagged local market coefficient to the lagged central market coefficient.

$$IMC = \alpha_i/(\beta_{i0} + \beta_{i1}). \qquad (21)$$

If Ravallion's short-run integration is accepted, then $\alpha_1 = 0$ and IMC = 0 when markets are segmented, $\beta_{i0} = -\beta_{i1}$ and IMC = ∞. Given the model's specification, $(\alpha_i - 1)$ would be between 0 and −1 under normal conditions and the index would normally be positive. In general, the closer the index is to 0 the greater the degree of market integration. Timmer, allowing for the assumptions of stability in central market prices and the absence of local characteristics, considered that a value of IMC less than 1 reflected a high degree of short-run market integration.

Data for the Investigation

Data for such a sophisticated analysis have to be modestly disaggregated and accurate. For this reason, instead of using average prices at district levels, market prices at 67 Bangladesh markets were obtained from the Department of Agricultural Marketing. These were weekly prices for coarse and medium-quality rice, collected from periodic markets and aggregated to monthly averages. Preliminary examination of this data set revealed that information for certain months was missing for certain markets. The distribution of missing data, which reflects the extent of inactive markets (Figure 14), indicates that most of the missing data pertain to the months of July, August, September, and October. These are the months when rural transport and the communication system are handicapped by monsoon and postmonsoon rains and floods, and markets are occasionally disrupted by these natural hazards. Rice markets are also generally thin in September and October. This is a tentative indication that rice markets lack complete market integration, at least in the short run.

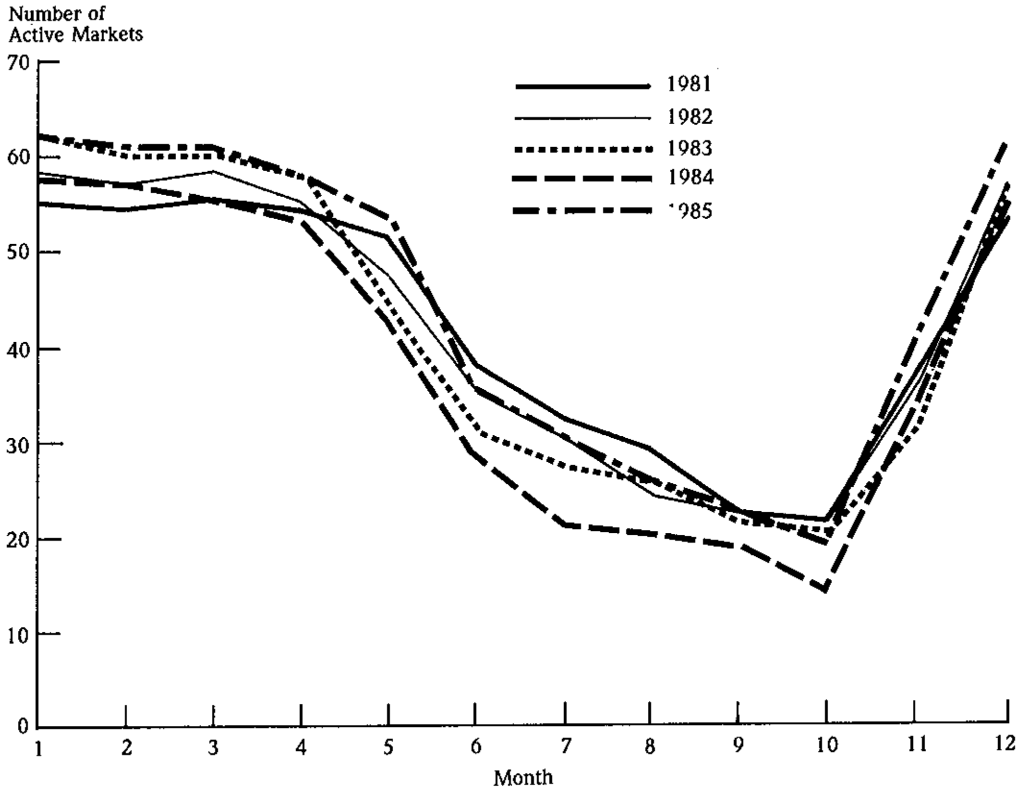
Because the analytical framework developed earlier requires that there be no missing data for any month for a market, only those markets that had price data for all months were selected. Only 19 out of 67 markets met this condition. This choice of markets may bias the results toward integration if only because the chosen markets were more active than those not selected.

Results

Segmentation of Markets. The error sum of squares (ESS) for restricted (equation 15) and unrestricted (equation 17) forms of the model and F-statistics for testing the hypothesis that markets are segmented are given in Table 15. The data cover the period 1981-85.

The hypothesis that a market is segmented—totally lacking in integration—where price changes in a local market depend only on past prices in that market is rejected at the 1 percent level of significance for every market. Most of the tested markets fall geographically within northern, western, and southern parts of Bangladesh; therefore, the conclusion is not valid for eastern and northeastern regions. Because eastern districts of Bangladesh are infrastructurally better connected with the central Dhaka market, market segmentation is less likely in these areas than in the areas covered by the tested markets (except in the Chittagong Hill Tract).

Figure 14—Average number of active rice markets, by month, 1981-85



Source: Weekly price data provided by Bangladesh, Ministry of Agriculture, Department of Agricultural Marketing, Dhaka.

Short-Run Market Integration. A lack of total segmentation of markets does not imply that markets are well integrated or integrated at all times. The degree of integration may be weak, and this may be more so at certain times. The results for the hypothesis that the monthly prices on markets are integrated even in the short run are given in Table 16.

Timmer's IMC ratio for evaluating short-run integration was less than 1 in 3 cases out of 19, and the β_{i0} coefficients were less than one standard error away from unity in 6 additional markets.[9] Thus, at first glance, only three of the markets show any short-run integration or integration within the domain of monthly prices. Six others reflect Dhaka price changes without exhibiting signs of significant short-run integration. The rest are poorly integrated with the Dhaka market. However, as mentioned earlier, weekly data collected for 67 markets throughout Bangladesh showed a significant drop in the number of markets reporting prices during monsoon months. Thus, if a dummy for the rainy season is added to acknowledge that markets may be well connected

[9] If β_{i0} is close to one but the IMC is high, short-run integration is not likely; yet reference market price changes are being passed along. In this study, that result is viewed as a sign of some integration.

Table 15—Results of a test for segmentation of markets, using the error sum of squares, 1981-85

Market	District	Error Sum of Squares		F-Statistics
		Unrestricted	Restricted	
Joypurhat	Bogra	0.1562	0.3174	28.893
Gaibandha	Rangpur	0.1559	0.3791	40.082
Rangpur	Rangpur	0.0801	0.1748	33.081
Kurigram	Rangpur	0.1359	0.2909	31.923
Rajshahi	Rajshahi	0.1016	0.2201	32.664
Nowabganj	Rajshahi	0.1141	0.2526	34.022
Natore	Rajshahi	0.0680	0.1841	47.859
Naogaon	Rajshahi	0.1010	0.2385	38.142
Dinajpur	Dinajpur	0.1483	0.2957	27.847
Thakurgaon	Dinajpur	0.0909	0.2147	38.171
Sherajganj	Pabna	0.1124	0.2759	40.716
Kushtia	Kushtia	0.0568	0.1475	44.785
Chuadanga	Kushtia	0.0509	0.1358	46.736
Jessore	Jessore	0.0919	0.2476	47.438
Khulna	Khulna	0.1003	0.2258	35.049
Barisal	Barisal	0.1276	0.3081	39.187
Jhalkati	Barisal	0.1514	0.3612	38.815
Patuakhali	Patuakhali	0.2593	0.5255	28.757
Faridpur	Faridpur	0.0507	0.1540	57.076

Table 16—Results of a test for short-run integration of markets, using the index of market connection, 1981-85

Market	Index of Market Connection			
	Dry Season	Monsoon Season	Whole Year	β_{10} Coefficient
Joypurhat	1.52	2.71	2.72	0.98
Gaibandha	0.60	1.88	1.55	1.05
Rangpur	NS	1.83	2.84	0.82
Kurigram	2.01	NS	0.87	0.79
Rajshahi	1.06	1.28	1.36	0.81
Nowabganj	0.94	1.74	1.46	0.85
Natore	0.78	NS	1.79	0.83
Naogaon	NS	2.24	1.09	0.78
Dinajpur	0.48	0.76	1.03	0.81
Thakurgaon	NS	1.24	1.31	0.79
Sherajganj	1.11	2.30	2.42	0.97
Kushtia	1.75	NS	1.44	0.77
Chuadanga	0.50	1.50	0.87	0.73
Jessore	0.70	NS	0.50	0.84
Khulna	1.35	1.71	1.78	0.85
Barisal	1.40	1.35	2.10	0.98
Jhalkati	1.46	1.40	2.54	1.09
Patuakhali	1.08	2.27	1.89	1.11
Faridpur	0.80	NS	1.54	0.81

Notes: NS means the number is nonsignificant. β_{10} measures the extent to which the local price is influenced by a change in the central market price.

during part of the year but poorly linked in other months due to adverse weather, just under half of the markets (9 out of 19) are highly integrated with the central market during the dry season (three others have β_{10} near one). Even in the dry season about 36 percent of the markets are relatively weak in intermarket linkages. During the monsoon season (July-October) about 74 percent (14 out of 19) of the markets are poorly integrated (their IMC is greater than one), and 26 percent remain highly integrated with the central market even in the monsoon months.

Policy Implications

In the context of the present study, the analysis of market integration has the following implications:

First, the absence of segmentation of markets, as evidenced by the various tests, implies that price analysis at the aggregate level is valid. If it were not, the stabilization program and its associated model would have required as many versions as there were independent segments in the market.

Second, even though the markets are not segmented, the degree of integration (the extent and rapidity of transmittal in price signals from one market to another) is weak at some market locations and at some times of the year. This implies that the government cannot be sure that, by undertaking procurement or open market sales in only a few centers, it will automatically influence prices in all markets. In the aman season, particularly for procurement, a greater than normal effort may be required for successful procurement drives in Dinajpur, Patuakhali, Barisal, Bogra, and Rajshahi. In aus season, procurement efforts should focus on Chittagong division in particular and on the Jessore-Kushtia belt in general.

Third, although the present study is geared to short-run price stabilization issues, a long-run solution also lies in development of infrastructure in the northern and southern parts of Bangladesh, which would strengthen integration of markets and facilitate the efforts of the price stabilization scheme.

7

AN APPROACH TO PRICE STABILIZATION

The extent of the price fluctuation shown in Chapter 4 raises an important question. Why has Bangladesh not been as successful as Indonesia in reducing price fluctuation, despite roughly the same amount of public expenditure on intervention in the foodgrain market? After all, the two economies do not differ greatly in population, consumption patterns, and cropping patterns. Indonesia has been able to reduce both inter- and intrayear fluctuations in rice prices from 50-60 percent in the 1960s to 10-15 percent in the second half of the 1970s (Mears 1981). The difference can be traced to the orientation of the two programs. In Indonesia, stabilization of prices through targeting of ceiling and support prices within a price band is the principal policy objective. In Bangladesh, meeting quantity targets for various public distribution conduits is the principal explicit objective, while price stabilization is a secondary and implicit objective. In this chapter a framework for price stabilization, where policy objectives are enunciated as prices rather than quantities, is outlined. Quantities, however, are derived from prices in a consistent manner. After all, quantities are unavoidable for budgetary purposes. The framework is designed to be used by the government for planning the public-sector foodgrain program before the preparation of the annual budget. The Planning, Finance, and Food ministries should all find it helpful.

The framework consists of an analysis of the costs associated with a target price-band policy. The task requires the following steps:

1. Develop a short-term model for prediction in April-May of the annual average price most likely to prevail during the following July-June financial year;
2. Link the seasonal variations in prices, as analyzed in Chapter 4, to the predicted annual prices in order to arrive at predicted seasonal prices;
3. Estimate costs associated with various price bands in order to indicate the trade-off between the degree of price stability and the cost; and
4. Establish operating rules for managing annual and seasonal prices that should be consistent with the framework.

The details of these steps will be discussed further after a brief account of the current practices in management of the foodgrain system, which is necessary to clarify the differences between these practices and the proposed changes.

Current Practices in Public Foodgrain Management

The public foodgrain system is based on a set of policies and an organizational structure designed to implement these policies. The Food Department, the primary organization, consists of a number of branches entrusted with the tasks of distribution, procurement, storage, transportation, inspection, and control. Publicly owned storage facilities have been developed to a capacity of 1.85 million tons in 1984, and these capacities are spread throughout the country. Major policy decisions are made at the highest level by the Ministers of Planning, Finance, Food, and Agriculture and the President. Initiative for changes in policies may come from any of these ministries, even though the formal processing of documents is conducted by the Food Ministry. A food policy monitoring cell assists the Secretary of Food in this process of policy formulation.

The normal exercise in short-run policy formulation begins in January or February and culminates before the preparation and finalization of the annual public budget on June 30. This budget pertains to the following financial year (for example, the budget presented on June 30, 1984, relates to July-June 1984/85). Extraordinary changes in policies may be made at any time. The budget exercise is comprehensive. It includes targets on revenue collection, foreign aid, current and capital expenditures, money supply and credit, the general inflation rate, exports, imports, production of trade-related goods, administered prices, and subsidies, and many others (see Bangladesh, Ministry of Finance 1985a and 1985b, and Bangladesh, Ministry of Planning 1985 for a sample of references).

In the context of the foodgrain system the budget exercise includes targets on how much grain is to be imported, how much is to be procured from domestic production, and how much is to be distributed through various public conduits. These targets are arrived at following procedures that do not explicitly incorporate a simultaneous and consistent price target for the market. This is what is meant by the characterization of the current policy as oriented to "quantity target rather than price target." The basis of arriving at these targets will be discussed further when quantitative relations concerning imports, procurement, and distribution are estimated. The formulation of these targets is influenced considerably by recent experience, political consideration, and most importantly, the prospect of domestic production. For example, how much foodgrain would be imported is normally estimated on the basis of a forecast of domestic production, the normal consumption requirement (generally 16 ounces per capita per day), and availability of food aid. In years not considered to be normal (politically unsettling years, election years) this rule may be violated to increase the import target. At the time of budget preparation, aus rice production is approximately known, but aman and boro rice and wheat production are only forecasts. Thus, considerable uncertainty surrounds the initial targets, but it may be possible to make corrections as information becomes more certain with the passage of time.

Government procurement from domestic production is voluntary on the part of sellers. Through its network of storage and purchasing centers, the government makes purchases at harvest time from farmers and small traders. Procurement target and procurement price are determined at the time of budget preparation. Past experience, production prospects, price trends, and stock in public godowns are some of the considerations that enter into the target determination. No formal procedure exists to check whether these targets are consistent with prospective prices.

Public distribution consists of rationing channels, open-market sales, relief grants, and food-for-work allocations. The rationing channel is divided into a number of outlets. Broadly speaking, urban consumers are subsidized through statutory rationing and rural consumers through modified rationing, though the latter channel is relatively small and irregular. Private, licensed dealers do the actual job of selling to ration card holders at regulated prices and predetermined quotas (see BECON 1986 for details). Open-market sales of foodgrains are still quite thin. These sales are the only component of the system that allows for direct action to bring down prices when the price level becomes too high. After this brief account of the current system, the main objective of developing a framework for price stabilization can be addressed.

A Model for Short-Term Price Determination

If planning for stabilization has to precede actions, it is vital that the government be able to predict price levels in the upcoming year, at least with a moderate degree of reliability. The purpose of the model is, therefore, to predict an average annual price of rice that is valid for the upcoming budget year. Two considerations bear the utmost importance in developing this model. First, the model should be simple enough for staff economists and other professionals working at the country level to be able to work with it. In particular these professionals must be able to insert new values for variables as they become more certain and then reevaluate the price. Second, though simple in structure, the model should have reasonably strong predictive power. Prediction of prices is generally a frustrating task. The experiences of international organizations in predicting prices of commodities in international markets bear testimony to this frustration (Mellor and Ahmed 1987).

A Fully Specified Model

If determination of prices is to be based on underlying supply and demand parameters, then the framework should be a fully specified structural model that will provide predicted price along with consistent estimates of supply and demand parameters. Such a structural model for rice in Bangladesh is formulated as follows:

Demand for rice:	$MDR_t = f(Y_t, PR_t, SW_t)$,	(22)
Supply of rice:	$MSR_t = QR_t - QRP_t + RDP_t$,	(23)
Public procurement:	$QRP_t = f(QR_t, PR_t, ADP_t, OS_t)$,	(24)
Public distribution of foodgrains:	$RDP_t = f(PR_t, ADPR_t, Z_t)$,	(25)
Stock available to government:	$Z_t = OS_t + MP_t$,	(26)
Opening stock:	$OS_t = OS_{t-1} + QRP_{t-1} + MP_{t-1} - RDP_{t-1}$,	(27)
Import of grains:	$MP_t = f(GAP_t, FA_t, WP_t)$, and	(28)
Demand-supply balance:	$MDR_t = MSR_t$,	(29)

where the expected signs of the partial derivatives are as follows:

$\partial MDR_t/\partial_{Y_t} > 0$	$\partial MDR_t/\partial PR_t < 0$	$\partial MDR_t/\partial RDP_t < 0$
$\partial MDR_t/\partial SW_t < 0$	$\partial QRP_t/\partial QR_t > 0$	$\partial QRP_t/\partial PR_t < 0$
$\partial QRP_t/\partial ADP_t > 0$	$\partial RDP_t/\partial PR_t > 0$	$\partial RDP_t/\partial ADPR_t < 0$
$\partial RDP_t/\partial Z_t \geqslant 0$	$\partial MP_t/\partial GAP_t > 0$	$\partial MP_t/\partial FA > 0$
$\partial MP_t/\partial WP_t < 0$,	$\partial QRP_t/\partial OS_t < 0$	

where

MDR_t = market demand for rice in tons per capita,

Y_t = per capita real income in taka,

PR_t = price of rice in real terms (nominal price deflated by the index of manufactured goods' prices),

SW_t = per capita production of wheat,

MSR_t = market supply of rice in tons per capita,

QR_t = per capita production of rice,

QRP_t = public procurement from domestic production per capita,

RDP_t = distribution of foodgrains per capita from the public rationing system,

ADP_t = administrative procurement price in real terms,

OS_t = opening stock of foodgrains per capita in government godowns,

$ADPR_t$ = administrative ration price in real terms,

Z_t = availability in government stocks,

MP_t = import of foodgrains per capita,

GAP_t = per capita gap between domestic availability of foodgrains and estimated requirements based on 16 ounces per capita per day,

FA_t = food aid per capita,

WP_t = world price of foodgrains (weighted average price), and

t = year (t = 0, 1, 2, ... n).

The supply equation (23) has been formulated without a price variable in the argument because, at the time of the prediction exercise, production estimates of two out of three rice crops—aus and boro—are already known and the first forecast of the third (aman) is available but speculative.[10]

The eight equations above can be reduced to six by substitution of equations (22) and (23) in equation (29). These six equations can provide solutions for six of the endogenous variables: PR_t, RDP_t, QRP_t, Z_t, MP_t, and OS_t.

The equations are estimated by the three-stage least square method for estimation of a simultaneous system using the analysis with the limited dependent variables (LIMDEP) computer software program. The estimated equations are presented in Appendix 2, Table 25. The difference between the predicted and actual prices from this model is quite large in most years. The direction of relationship as indicated in the estimated equation is correct in almost all cases but the reliability of the coefficients is often quite low. For example, the estimated coefficient of the income variable (equation 22) shows the expected sign, but the t-statistic of the estimate is beyond the acceptable level of significance. The coefficient of wheat output (SW) can be interpreted as the additional units of rice demanded in substitution for a unit change in wheat

[10] For the purpose of estimation of this and the other model in this study, boro rice in 1983/84 is found to be relevant for the 1984/85 market supply.

supply. This coefficient is expected to be negative but less than one in the context of the taste pattern in Bangladesh. The sign of the coefficient is correct but its absolute value is 4.2, substantially greater than one. Because the wheat price series was incomplete for the entire period, price could not be used for the supply of wheat in equation (22). Wheat is a relatively new product, which has gained substantial importance in the domestic production of grains only in recent years. Among the various equations in the system, the estimates of import equation (28) were found to be quite reliable, except for the coefficient of world price (WP).

Why this poor result with such a complete system? The following reasons may underlie the frustrating results. First, the 1960-84 (excluding 1972-75) data series had to be used to give enough degrees of freedom for reliable estimates. But the data pertaining to the 1960s are not reliable, particularly for certain variables. During this period Bangladesh (formerly East Pakistan) was a part of Pakistan and some statistics, such as per capita income and imports in certain years, were not originally available as direct measures. They were derived by various researchers for various purposes and therefore estimates vary considerably. Second, the economy of Bangladesh underwent significant structural changes after 1971, particularly for factors that affect prices. Thus, procurement from domestic production was mostly compulsory in the 1960s, while it was voluntary after 1970. The public distribution system has changed, with more administrative prices used to control offtake now than in the past. The political power structure accords higher priority to special groups and food-for-work outlets than was the case in the 1960s. Moreover, farmers now market about 30-35 percent of rice production compared with only about 10 percent in the early 1960s.

An Alternative Model

The foregoing discussions indicate that the prediction of price has to be based on a shorter data series, 1976-84, for example. Moreover, the emphasis is on prediction rather than estimation of parameters of supply and demand, even though these parameters are implicit in the price prediction model. The following price equation was the central basis for the prediction of price:

$$PR_t = f(Y_t, MSR_t, SW_t). \tag{30}$$

Price is shown in equation (30) as dependent on income, market supply of rice, and wheat production. Market supply consists of domestic production minus public procurement plus distribution from public stock. As explained earlier, domestic production, during the short period in question, is not a function of price. But public procurement and distribution are influenced by price as shown in equations (24) and (25) of the fully specified model.

Therefore, the system of equations adopted in this model consists of equations (30), (24), (25), and (23), where the expected signs of partial derivatives are $\partial PR_t/\partial Y_t > 0$, $\partial PR_t/\partial MSR_t < 0$, and $\partial PR_t/\partial SW_t < 0$. Other partial derivatives are expected to behave as indicated before.

In this system there are four endogenous variables and four equations; therefore, it is possible to find solutions for the four unknowns (PR_t, QRP_t, RDP_t, and MSR_t). Inspection of each equation further shows that the number of endogenous variables appearing on the right-hand side is less than the number of exogenous variables excluded from the relation; therefore, the parameters can be identified. The econometric estimation of the system was made by using the three-stage least square method and the LIMDEP computer software with the 1976-84 data set.

This abridged model differs from the complete one in the price equation used in place of independent supply and demand equations, the treatment of Z_t and OS_t as exogenous rather than endogenous, and the omission of the import (MPt) equation. Z, OS, and MP are interrelated. The equations for both Z and OS are identities. Therefore, treatment of MP as exogenous is implicit. Is it reasonable to assume MP as exogenous? In the very context of forecasting short-run prices when domestic production shortfalls are largely known, the treatment of MP as exogenous is not unrealistic. It is shown in Appendix 2, Table 25 that import decisions are mostly explained by the size of the gap in domestic production and the availability of foreign aid. These two variables are exogenous. Therefore, the implicit treatment of MP and the explicit use of Z and OS as exogenous are not as objectionable as it may appear. Moreover, single-equation ordinary least squares as well as simultaneous equation estimates show that OS has no influence on procurement and Z has only modest influence on public distribution. These variables are not significant.

The estimated equations of this system [equations (30), (24), and (25)] are presented in Table 17. Equation (23) is an identity. Data for the analysis are shown in Appendix 2, Table 26.

The Price Equation

The estimate of the price equation (30) is reasonable. The derived price and income elasticities of demand are −0.52 and 0.46. These are consistent with estimates made earlier by other researchers (Mahmud 1981, Ahmed 1979). The income variable is lagged by one year to accommodate the flow of the income measured from the production account of national product to expenditure streams with a time lag. The variables MSR and SW are measured in tons per 1,000 persons, Y in taka per person, and PR in taka per maund. The nominal rice price is deflated by the manufactured consumer goods prices, and GNP is deflated by the general price index. The effect of wheat supply (domestic wheat production) on rice price is statistically not significant even though the direction of effect and the size of the coefficient are consistent with intuitive judgments. An increase in production of wheat is expected to depress the rice price

Table 17—Estimated equations of the rice price system

Equations and Variables	Coefficient Estimate	t-Value	Elasticity at Mean Values
Equation (30): price			
Constant	412.95	2.04	. . .
Y_{t-1}	0.08	4.80	0.88
MSR_t	−2.28	−1.97	−1.94
SW_t	−1.13	−0.36	−0.05
Equation (24): procurement			
Constant	39.92	1.49	. . .
QR_t	−0.25	−0.32	. . .
PR_t	−0.28	−2.61	−14.65
ADP_t	0.33	2.37	10.55
OS_t	−0.04	−0.17	. . .
Equation (25): ration distribution			
Constant	18.98	12.05	. . .
PR_t	0.06	1.90	0.76
$ADPR_t$	−0.15	−3.94	−1.21
Z_t	0.12	1.13	0.21

due to the substitution effect. Wheat production is only about 8 percent of rice production in recent years. Therefore, its effect on rice price through substitution in consumption is bound to be weak.

The Procurement Equation

Earlier efforts to estimate the procurement equation (24) in a single equation model were not satisfactory, but the estimated equation in a simultaneous system proves to be quite rewarding. The effect of rice production, QR, on procurement is not significant. The market price of rice and the administered procurement price exert significant influence on procurement of rice. The direction of the relation is correct, and the elasticities of procurement for these two prices are quite high but not equal, which indicates that the effects on procurement of market price and administered price are not symmetrical. It must be remembered, however, that procurement is a seasonal activity and estimation of the equation within a framework of annual statistics may not provide a complete picture, even though the effect of prices on procurement is clearly established. Various nonprice factors (the extent of purchasing centers, financial resources at the disposal of the procurement agency, and so forth) could play important roles. These factors should not be ignored when procurement decisions are formulated in the context of the price stabilization program enunciated here.

The Ration Equation

The estimated equation for per capita ration offtake (equation 25) also gives good results. It is apparent that both the market and administered ration prices in real terms have correct signs; however, administered price has a much stronger effect on the level of offtake. These results confirm recent findings that relative prices have become more influential in determining foodgrain offtake from the public system in recent years (Montgomery 1985). Availability of government stock (Z) is only a weakly significant factor in determining the level of public distribution.

Predictive Power of the Model

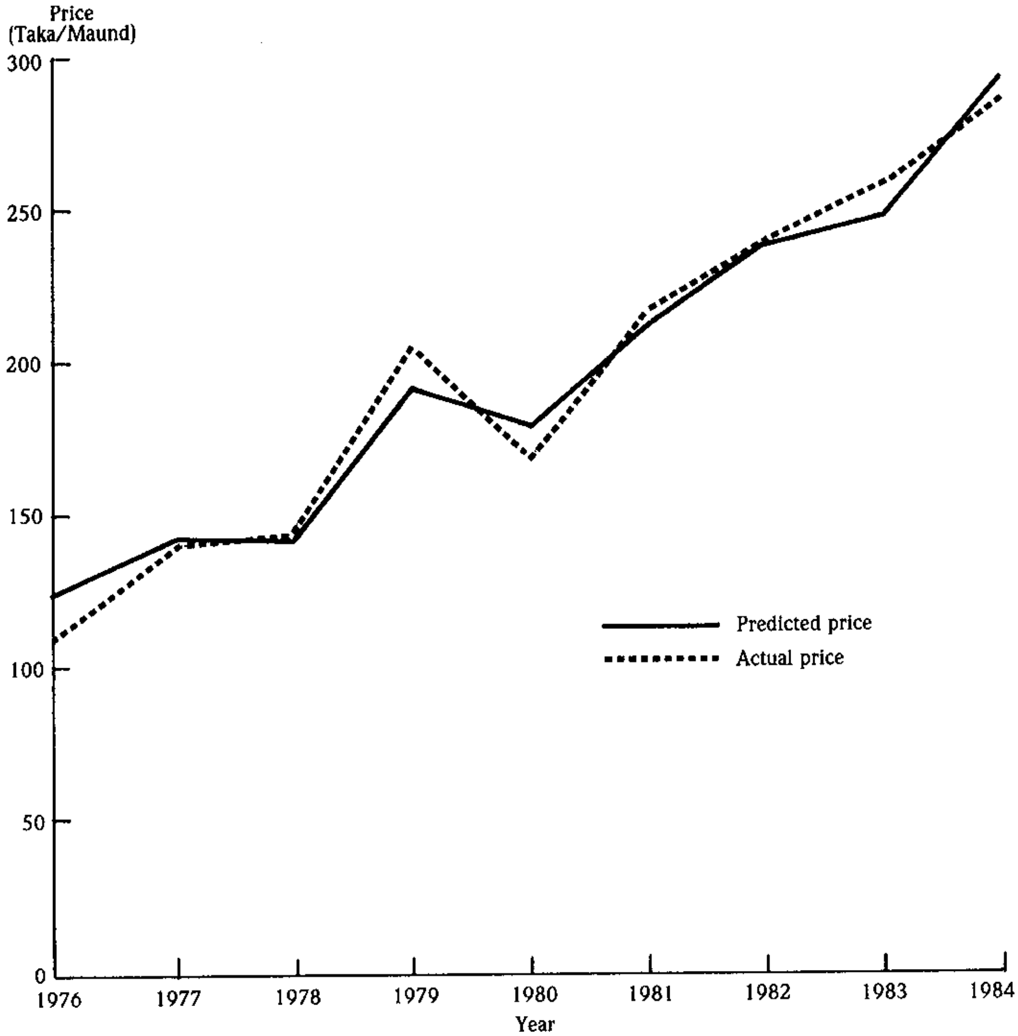
How reliable is the model in predicting rice prices in Bangladesh? One way to determine this is to see how well the predicted values fit actual past prices (see Figure 15). The predicted prices for various years are obtained by inserting the values of exogenous variables in each year in the estimated equations of the alternate model (equations 30, 23, 24, and 25) and then solving for the endogenous variables in a simultaneous manner, using a computer program. The predicted prices thus obtained are converted to nominal terms by multiplying the real prices with the deflators.

It is reassuring that the model is remarkably consistent with historical experience. However, whether it will continue to be so in the future depends partly on the capacity of users to update the model as time passes by. Moreover, users will have to keep this monitoring mechanism up-to-date to take into consideration effects of nonprice factors (such as election-year actions, booms in construction activity, and floods). Only local analysts can assess these factors and modify predictions accordingly.

Application of the Model to Price Stabilization

Using the framework developed above to stabilize prices involves several steps. In the first step, prices are predicted from the production forecast in order to select a target annual average price. According to the concept, a price band that reflects norma-

Figure 15—Predicted versus actual price of rice, 1976-84



Source: Actual prices are from data provided by Bangladesh, Ministry of Agriculture, Department of Agricultural Marketing, Dhaka.

tive as well as efficiency considerations provides the domain from which a particular price target is selected. In the second step the annual average price is linked with the seasonal pattern of prices, which provides a guideline for the seasonal activities of procurement and distribution of foodgrains that should be consistent with the average price target. The third step stipulates the operational rules for organizing domestic procurement and distribution as basic instruments for stabilization.

Price Band

Within what band of prices should a country stabilize its annual real prices of foodgrains? A narrower band costs more, whereas a wider band provides a smaller degree of stabilization but costs less. One reason costs rise as prices become more stable is because private traders react to price stabilization policies of governments. When the band is so narrow that it does not allow private traders to make a normal profit from stocking foodgrains, the government has to undertake an increasing amount of stocking and market operation to bring about the desired degree of price stability, and this implies an increasing rate of cost. On the benefit side, a higher degree of price instability not only affects producers and consumers in the ways described in Chapter 3, but it strains the limits of political tolerance to instability in foodgrain prices. It is assumed, in the context of Bangladesh, that political tolerance is the deciding criterion for selecting the degree of price stability and the price band. This assumption derives its validity from the behavior of the government in management of food policies during the past decade.

Even though political considerations play a dominant role, cost considerations are also important. The incremental quantity of foodgrains that the public system should be prepared to sell on the open market and the costs of price stabilization are shown later. Here the procedure for arriving at a price band is specified.

For operational purposes, nominal prices are relevant. The conversion of real to nominal prices and the derivation of a price band in nominal annual prices is accomplished through the following formulation. Suppose that NP_0 is the nominal normal price in the base year, NP is the nominal price in the price band in the following year, v is the annual price band in real terms (a 4 percent band, for example, implies 4 percent up and 4 percent down), and i is the rate of inflation. Then the upper bound is $NP_U = NP_0[1 + (i + v)]$ and the lower bound is $NP_L = NP_0[1 + (i - v)]$. For example, when the base-year nominal price is Tk 300 per maund, the expected inflation rate is 10 percent, and an annual price band of 4 percent is chosen, then the upper-bound nominal price is Tk 342 and the lower-bound nominal price is Tk 318. It is clear that the lower-bound nominal price can be below the price in the base year when the inflation rate is smaller than the price band as defined here. Historical price data in Bangladesh show that nominal prices in some years have fallen below the prices of previous years even when inflation rates were positive.

Linking Annual and Seasonal Prices

The crop harvest seasons and seasonality of prices that have prevailed in recent years were explained in Chapters 2 and 4. For the purpose of price stabilization three trough and peak price seasons are relevant. These are the second-lowest price season (S_1), generally prevailing in the months of July-August-September; the lowest price season (S_2), prevailing in December-January; and the peak price season (S_3), prevailing during April-May-June. Prices in other months fall in intermediate zones having little relevance for price stabilization. The relationships between these seasonal prices and the annual price can be written as follows:

$$PS_1 = PA(SF_1), \qquad (31)$$

$$PS_2 = PA(SF_2), \text{ and} \qquad (32)$$

$$PS_3 = PA(SF_3), \qquad (33)$$

where PS is the seasonal average price of rice in a particular season, PA is the annual average price of rice in a particular year, and SF is the seasonal factor (see Chapter 4). The actual price in any season of a year would be different from the estimated price on the basis of this formulation, because of these irregular factors unrelated to domestic production. Prices in the same season of different years are explained by the difference in annual prices as well as these irregular factors. Thus, annual prices capture trend or inflationary effects when year-to-year comparisons in nominal seasonal prices are attempted.

It is obvious that the average annual price picks up the inflationary factor all at once, even though a certain rate of inflation in a given year may be distributed over the seasons or months within that year in an increasing or a decreasing order. This fine-tuning of the link between annual and seasonal prices can be undertaken if distribution of inflationary forces within a year can be obtained. The analysis of the trend-cycle factor, presented earlier, indicates that in different years there are different patterns of distribution of the monthly trend-cycle factors. In years of normal inflationary force this fine-tuning may not be necessary, but in abnormal years such sequencing of inflationary factors is unavoidable.

Using the example in the previous section where the upper-bound annual average price was estimated at Tk 342 and the lower-bound price at Tk 318, the seasonal prices related to that price band can be determined. Suppose the annual target price within the Tk 342-318 range in a particularly bad crop year is Tk 342. Then the peak season or ceiling price with a seasonal factor of 8 percent (typical of Bangladesh) is Tk 369 and the S_2, the slack or harvest season price (or support level for price), is Tk 315. In a good crop year when the target price is the lower-bound annual average price of Tk 318 per maund, the relevant ceiling or peak season price for this year would be Tk 343 and the support or harvest season price would be Tk 293 per maund.

Simulation of the Stabilization Model

The simulation exercise reflects the price stability and application of policy instruments that would have prevailed during 1976-84 had the stabilization model formulated here been in operation then. This exercise is based on the assumption that a 4 percent price band in annual prices and an 8 percent price band in seasonal prices are the ranges within which the government allows prices to vary with changes in domestic production. In light of the earlier discussion, these price ranges are consistent with private trade making a normal profit.

The simulated and actual price regimes for rice shown in Table 18 are developed according to the following procedures.

1. The predicted prices (column 1, Table 18) are derived from the solution of the alternate model described earlier. The real prices are converted into nominal terms using the price deflator.

2. Then the normal prices—the trend prices for each year—are estimated from the trend equation based on 1968-84 time series (excluding 1973/74 and 1974/75). If for any year the predicted price is higher or lower than the normal price, then the upper- or lower-bound price is selected as the target annual price (column 2). For example, in 1976/77 the normal price, Tk 112.3, is lower than the predicted price, Tk 124.3. Therefore, the target price is derived by multiplying the normal price by the factor 1.04. The year 1978/79 demonstrates the case when the lower-bound price becomes effective. In this year, the trend or normal price was Tk 154.3, which was higher than the predicted price of Tk 142.6. Therefore, the target annual price for 1978/79 is Tk 148.1 ($154.3 \times 0.96 = 148.1$). See Appendix 3 for notes on modifying the procedure in future years and for adjusting the long-run price alignment.

3. The target floor price is obtained by multiplying the target annual price by the seasonal factor of 0.92 (1.00-0.08). Similarly, the target ceiling price is derived by multiplying the target annual price by the seasonal factor of 1.08.

Table 18—Actual prices of rice, 1976/77-1984/85, compared with prices simulated by the model

Year	Predicted Annual Price	Target Annual Price[a]	Target Ceiling Price	Target Floor Price	Actual Annual Price	Actual Ceiling Price	Actual Floor Price	Difference Between Actual and Target Prices: Ceiling[b]	Floor[c]	Annual[d]
	(taka/maund)							(percent)		
1976/77	124.3	116.8	126.1	107.5	110.0	129.9	98.1	3.0	8.7	6.2
1977/78	142.2	138.6	149.7	127.5	139.0	150.0	125.0	0.2	1.9	−0.3
1978/79	142.6	148.1	159.9	136.3	144.9	183.0	129.0	14.4	5.3	2.2
1979/80	191.5	182.3	196.9	167.7	204.7	233.0	182.0	18.3	−8.5	−10.9
1980/81	178.1	188.5	203.6	173.4	168.9	180.8	155.9	−11.2	10.1	11.6
1981/82	211.6	208.6	225.3	191.9	216.3	291.0	181.0	29.1	5.6	−3.7
1982/83	237.2	228.8	247.1	210.5	239.6	265.0	218.0	7.2	−3.6	−4.5
1983/84	247.7	248.9	268.8	229.0	257.2	282.0	233.0	4.9	−1.7	−3.2
1984/85	292.9	291.5	314.8	268.2	286.0	316.5	246.9	0.5	7.9	1.9

Source: Computed from actual price data provided by Bangladesh, Ministry of Agriculture, Department of Agricultural Marketing, Dhaka.

[a] The text explains how this target is arrived at.

[b] The difference between target and actual ceiling prices is expressed as a percentage of the target ceiling price.

[c] The difference between the target and actual floor prices is expressed as a percentage of the target floor price.

[d] The difference between the actual and target annual prices is expressed as a percentage of the actual price.

The nature of the price fluctuation between the proposed and the existing modes of stabilization is examined in Table 19. If the proposed mode of stabilization had been operative during 1976-84, the fluctuation in annual prices would have varied from 3.4 to 23.1 percent, as compared with variations of −17.3 to 41.3 percent under the existing system. The proposed stabilization model allows some variation in annual prices but it contains severe fluctuations. Seasonal (or intrayear) fluctuations are also reduced under the proposed mode of stabilization. Seasonal prices vary by a stable 15 percent every year in the proposed model compared with variations from a low of 13.8 percent in 1980/81 to a high of 37.8 percent in the following year under the existing system.

What are the implications for policy instruments associated with the two modes of stabilization? The comparison of actual public procurement and distribution figures and those that would have been required under the proposed procedure are shown in Table 20. The simulated procurement and distribution figures in the table were derived by examining monthly prices. If the actual ceiling price in a particular month is above the ceiling price, then the quantity required to bring down the actual to the target ceiling price is estimated using equation (30). All monthly requirements are added to arrive at the incremental quantity of open market sales that the government should have undertaken. These quantities are shown in column 3 of Table 20.

The incremental quantity that the government would have to procure over the amount acquired with the existing procedure to support the floor price is estimated following a similar month-by-month evaluation of prices. If the actual floor price is lower than the target floor price, then the additional quantity to be procured to bring up the actual to the target floor price is estimated using equation (30). All such monthly estimates are added to arrive at the total additional quantity of procurement. It must be noted that distribution and procurement are seasonal operations, but their estimates are based on equation (30), which is based on annual data. A complete model based on seasonal prices is not possible due to the data problems described in Chapter 5. It

Table 19—Actual variability in rice prices compared with variability under the proposed model, 1976/77-1984/85

Year	Proposed Model: Fluctuation in Annual Price[a]	Proposed Model: Fluctuation in Seasonal Price[b]	Actual Figures: Fluctuation in Annual Price	Actual Figures: Fluctuation in Seasonal Price
		(percent)		
1976/77	...	14.8	...	24.5
1977/78	18.7	14.8	26.4	16.7
1978/79	6.9	14.8	4.2	29.5
1979/80	23.1	14.8	41.3	21.9
1980/81	3.4	14.8	−17.5	13.8
1981/82	10.7	14.8	28.1	37.8
1982/83	9.7	14.8	10.8	17.7
1983/84	8.8	14.8	7.3	17.3
1984/85	17.1	14.8	11.2	22.0

Source: Actual fluctuation figures are computed from data provided by Bangladesh, Ministry of Agriculture, Department of Agricultural Marketing, Dhaka.
[a] The fluctuation in annual prices is the difference in prices between years t_n and t_{n+1} measured as a percentage of the price in t_n.
[b] The fluctuation in seasonal prices is the difference in the ceiling (Cn) and the floor (fn) prices measured as a percentage of Cn.

is hoped that this difference in method does not make a substantial difference in outcome. What it implies, however, is that actual operation of procurement and distribution activities has to be closely monitored, and these activities should be changed according to the actual response in ceiling and floor prices.

The tasks of procurement and distribution under the proposed procedure vis-à-vis the actual procedure can be examined, keeping the background explanation in mind. For both public open market sales and procurement, 1977/78 appears to be a year when the current procedure and the proposed model are almost the same. In 1976/77, as well as 1978/79 and 1980/81, procurement should have been larger than it was. There should have been no procurement in 1979/80 and procurement quantities

Table 20—Actual public distribution and procurement of foodgrains, 1976/77-1984/85, compared with quantities simulated by the model

Year	Public Distribution: Actual	Public Distribution: Simulated	Public Distribution: Difference	Procurement from Domestic Production: Actual	Procurement from Domestic Production: Simulated	Procurement from Domestic Production: Difference
			(1,000 metric tons)			
1976/77	1,216	1,266	50	313	680	367
1977/78	1,557	1,569	12	541	557	16
1978/79	1,483	1,570	87	317	580	263
1979/80	1,784	2,479	695	226	0	−226
1980/81	1,123	808	−315	841	1,390	549
1981/82	1,344	1,662	318	287	241	−46
1982/83	1,190	1,440	250	168	141	−27
1983/84	1,205	1,475	270	145	128	−17
1984/85	1,327	1,340	13	133	286	153

Source: Actual figures are from Bangladesh, Bureau of Statistics, *Statistical Yearbook, 1985* (Dhaka: BBS, 1986).

should have been smaller than they actually were in 1981/82 through 1984/85. This could have been accomplished by adjusting the procurement price as reflected in equation (24).

For public distribution, the sharpest departure of simulated from actual occurs in 1979/80. This was a semifamine year in Bangladesh when actual open market sales of an additional 695,000 tons could have prevented the price from going above the ceiling. On the other hand, public distribution of foodgrains in the following year, 1980/81, when crops were good, should have been about 800,000 tons instead of the actual distribution of 1.12 million tons. This could have been accomplished by adjusting the administered price downward in 1979/80 and upward in 1980/81 (equation 25).

Cost Implications

The higher the degree of price stabilization, the higher should be the cost to the public exchequer. It is this budgetary cost that is estimated here.

As discussed in Chapter 3, budgetary costs include the administrative costs, costs of the discretionary food subsidy meant for welfare of the poor, and the costs involved in maintaining foodgrain stocks. The cost estimates below relate to the cost of stock only for a number of reasons. First, stocking cost is by far the largest of the three components. Second, the administrative and discretionary subsidy costs can be treated as fixed costs. Only the stocking cost is implicated by the adoption of the new procedure for price stabilization; it does not impinge on the other two aspects of costs that are related to the existing program. Moreover, it is not feasible to disentangle the various elements of costs under the present program from those related to price stabilization and those directed to food subsidy objectives. Therefore, comparison of the costs involved in the proposed model with those of the existing model is made on the basis of current stocking costs vis-à-vis the stocking costs under the proposed system.

Thus the question becomes one of determining how much stock is maintained for the current system and how much will be required for the proposed system. It does not consider complications surrounding the issue of an "optimal stock," which is itself an important but controversial issue in Bangladesh. The stock maintained for running the current system is available year by year. The mean stock level of 1976/77-1984/85 is taken as the stock for the current system. Additional stock required for the proposed system is determined on the basis of how much is needed for the additional public sales and purchases necessary for implementing the proposed system. This estimate is roughly equivalent to the mean incremental public distribution (based on column 3 in Table 20) plus two standard deviations of the distribution. No additional stock is necessary for procurement operation. The estimated stock for public distribution will meet the needs for the first four to six months of a year and thereafter will be replenished from domestic procurement or imports or a combination of both. Thus, the estimate of incremental stock for the proposed model takes into account the opportunity for trade.

The estimated stocks and their costs shown in Table 21 indicate that public stock of foodgrains would have to increase by about 700,000 tons if the proposed system of price stabilization were adopted without reducing the current magnitude of the rationing program. In reality, the environment of stable market prices that the proposed system would bring about might reduce the pressure on ration distribution. In that event, the actual incremental cost for the proposed program would be smaller than the estimate shown in the table. Introduction of the proposed system implies a gradual transition from a system geared more to ration distribution to one oriented more to open market sales by government.

Table 21—Comparison of costs related to the current (1986/87) and the proposed systems of price stabilization

Price Bands[a]	Stock Required for the Current System	Incremental Stock Required for the Proposed System	Cost of Current System[b]	Incremental Cost for the Proposed System
	(1,000 metric tons)		(Tk million)	
4 percent band in annual prices and 8 percent band in seasonal prices[c]	668	700	541.1 ($16.4)	567.0 ($17.2)
4 percent band in annual prices and 10 percent band in seasonal prices	668	470	. . .	380.7 ($11.5)

[a] The price band system is not applicable to the current system.
[b] Cost estimates are based on Tk 5,400 per ton of rice and an interest rate of 15 percent per year. The figures in parentheses are U.S. dollar equivalents at the official exchange rate in 1986/87.
[c] This price band and its related procurement and distribution figures are shown in Table 20.

The cost of the proposed system could be reduced further if the political tolerance to price instability could accept a wider price variation.

Operating Rules and Use of Policy Instruments

Price Targets and Stock

Planning for the next year's stabilization program should begin with the determination of a price target within the price band at the end of the current year. Although price-based planning of the food system would be a shift from the current practice of quantity planning, it would not mean that quantity targets would be abandoned, considering that budgetary planning cannot proceed without quantitative physical targets. Quantity targets are derived with some degree of consistency from the price targets.

Before deriving price targets, one should be sure that the price band is set correctly. In the initial phase of the shift from the existing to the proposed system, it is advisable to be cautious and to permit a price band to evolve over time that is optimal in the sense that it leaves no scope for sub- or supernormal profits in trading. A 4 percent band in annual prices and an 8 percent band in seasonal prices is appropriate to begin with because it is consistent with current frequencies of heightened interventions through open market sales and fluctuations in real prices. Such a price band is normal for traders in interyear stocking of foodgrains.[11]

The selection of a target price and estimation of the predicted prices are clearly dependent on production and income estimates. As indicated earlier, estimates of effective production for aus and boro for the next year (say 1985/86) are available with certainty at the time of the annual planning exercise in 1984/85. Only forecasts of aman rice and wheat are available then. Even though some adjustment in target and predicted prices is possible as later forecasts come in, public stock plays a more crucial

[11] No recent empirical study is available to support this point, but a past study by Farouk (1970) and discussions with current traders lend credence to it.

role in adjustment than target or predicted prices because, even if better estimates are available in the later part of the year, it is too late for imports to be shipped and received in the same year. Thus, correctly estimating the variability of aman and wheat production is critical for determining the size of stock required for price stabilization.

Analysis of data for 1975-85 indicates that the maximum fall in production of aman and boro in any year was about 865,000 tons. A shortfall of 500,000-600,000 tons in aman production can be expected in 2 out of every 10 years. A 600,000-ton shortfall in rice is equivalent to a shortfall of 960,000 tons of foodgrains with 60 percent wheat and 40 percent rice for the purpose of stabilizing rice prices in Bangladesh.[12] Therefore, an opening stock of about 1 million tons of foodgrains appears to be a critical requirement for stabilization of prices.

Historically, the opening stock in public godowns averaged about 650,000 tons, but in certain years the opening stock was as low as 200,000 tons, which is considered to be of no effect when operational problems are taken into consideration. The physical capacity of public godowns to hold stock runs as high as 2 million tons. A stock of up to about 1 million tons is not likely to be constrained by administrative ability to manage it.

For price stabilization, it is better to err on the side of maintaining a too-large stock than to hold too small a stock, because the price forecast is difficult to make, and private stockholding may be greatly influenced by the level and stability of public stock. Although no treatment of private stock is included in this analysis, it nevertheless influences market price, mainly because information on private stock is seldom available. Empirical evidence on the relation between private and public stock is rare. A study in Indonesia has shown that private traders' speculative behavior is extensively molded by the ability of government to act in markets (Siamwalla 1987). This ability is generally reflected in the level of public stocks. A recent survey indicates a similar behavioral response among rice traders in Bangladesh. This survey, which attempts to make a qualitative assessment of factors relating to stocking decisions of traders, shows that none of the ration variables such as ration price, quota, or offtake enter into stocking decisions of rice traders. On the other hand, more than 90 percent of traders in both wholesale and retail groups consider open-market sales of foodgrains by the government an important factor in their stocking decisions (BECON 1986, Shahabuddin 1987). Of course, the ability of the government to conduct effective open market sales, particularly during the October-November peak price season, depends greatly on opening stock.

Imports and Public Distribution

Imports and public distribution are intimately connected in the food policies of Bangladesh. The determinants of imports have been examined previously (see Appendix 2, Table 25 for results of regressions with import data). This analysis shows that shortfalls in domestic production and availability of food aid are the principal determinants of imports. There are various other political and vested interests often considered as factors of inducements to import, but no basis exists to describe, much less to quantify, these speculative efforts.

Shortfalls in domestic production are central to determining the required volume of imports. As shown in Chapter 5, assessments of production loss due to natural

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[12] It has been found, on the basis of price relations between rice and wheat, that the influence on market price of rice from the increase of market supply of one unit of rice, all else being equal, is equivalent to the same influence from the increase in wheat supply by 1.6 units (Ahmed 1979). This factor is used to convert rice into wheat equivalents.

calamities tend to be overstated during floods and understated during drought. Also, private stock, an unknown quantity, may have a tendency to decline sharply following sequential repetitions of natural calamities. Therefore, natural calamity, if it occurs repeatedly, may affect supply and prices more seriously than would be indicated by the sum of crop damages from sequential natural calamities. These considerations warrant a careful monitoring of crop production and forecasts.

Income has a more important effect on demand for foodgrains and hence on their prices in Bangladesh than in developed or many other developing countries. Estimates of income should be based on the gross national product (GNP) rather than on the gross domestic product (GDP). In this analysis the relationship with GDP as the measure of income was inconsistent. GNP per capita has increased faster than GDP per capita since 1977/78, implying an increase in the contribution of the external accounts to the economy of Bangladesh. The effects of income as well as price levels, given the target price for stabilization, should be taken into consideration in estimating the import target. The current practice of estimating the consumption requirement at the rate of 16 ounces of rice per capita per day should be revised to include income and price effects.

Internal Procurement

The first estimate of the target of procurement is derived from the difference in the price target and the predicted prices elaborated in Tables 18 and 20. This estimate, based on the annual aggregate, is only a rough approximation, however, because procurement is largely a seasonal activity influenced by various seasonal and regional diversities. It will require fine-tuning based on up-to-date knowledge of regional diversities, if possible.

The need for flexibility in the procurement program arises from another reason alluded to earlier. Seasonal prices are often influenced by erratic behavior of factors that are hard to identify. The stock decisions of private traders, including large farmers, are dominant among them. Generally, when a good crop follows a bad crop, the harvest season fall in price is not as sharp as when a good crop follows two successive bad crop seasons. Similarly, election year expenditures or other sudden spurts in public expenditures may induce unpredictable pressure on the demand side, which may cause harvest and peak season prices to deviate from normal patterns. Some degree of flexibility in both procurement and open market sales programs is necessary to counter these erratic influences.

8

CONCLUSIONS

More than 100 million people live in Bangladesh, and the country is known worldwide for its extreme poverty. With no room for extension of cultivated land, the increasing pressure of population has resulted in fragmentation of farms into smaller and smaller units and created a tremendous need for expansion of nonagricultural employment. The number of households depending on markets for supply of foodgrains has been increasing rapidly. Rice is the dominant foodgrain in the diet of the population; thus stability of rice prices is critical to social stability in Bangladesh. Because of the influence of rice prices on prices of jute and other cash crops, stability in the rice market implies a stable environment that is necessary not only for growth of agriculture but growth of the entire economy. A modest success in adoption of modern technology in agriculture has been found to coincide with a greater degree of variability in rice prices in recent years.

No government in Bangladesh can afford to keep aloof from the happenings in the foodgrain sector. But intervention in foodgrain markets involves costs in resources that are required for long-term programs to eradicate poverty. Therefore, government intervention is required for efficiency, and it is limited to the containment of extreme fluctuation of prices and supply. In the past, the government primarily depended on the rationing system to keep prices from rising abnormally. In recent years, the government has used ration distribution, open market sales, and postharvest procurement for stabilizing prices. Application of these policy instruments is based on targets of quantities to be distributed, imported, and procured from domestic production. In the absence of a consistent approach based on price instead of quantity targets, the government's efforts have been relatively ineffective and wasteful.

The framework for stabilization of rice prices in Bangladesh accommodates operations of private traders as principal actors in consonance with a complementary public intervention in foodgrain markets. The framework and operational principles stipulated here may seem cumbersome to those who are generally reluctant to make a change in the management of Bangladesh's food sector. But the procedure is in fact relatively simple. As mentioned earlier, the current system is relatively ineffective in maintaining stability in market prices, and the urgency of continuing the rationing system is also likely to diminish once a stable price environment is established. The existing Food Monitoring Unit (FMU) under the Ministry of Food can provide the institutional basis for application of the framework. A small amount of investment to upgrade the skill and professional strength of FMU will enable it not only to adopt the framework as developed here but also to improve upon it as new experience is gained through its application.

APPENDIX 1: THE CENSUS X-11 PROCEDURE

The Census X-11 procedure is a Fortran-based program for decomposition of time-series data into component parts. The basic steps for computing each iteration of estimates of the seasonal (S), irregular (I), and trend (T) factors are listed below. The procedure executes three iterations to stabilize the irregular and seasonal components.

1. NP = nominal price series,
2. T1 = 2 × 12-term moving average of NP (first trend estimate),
3. SI1 = NP/T1 (first seasonal, irregular estimate),
4. S1 = 3 × 5-term moving average of SI1 (first seasonal estimate),
5. End points are filled in,
6. I1 = SI1/S1 (first irregular estimate),
7. SI1a = weighted SI1 (observations more than two standard deviations from the mean are given 0 weights),
8. S2 = five-term moving average of SI1a for each month (second seasonal estimate),
9. SA1 = NP/S2 (first estimate of seasonally adjusted series), and
10. T2 = 13-term moving average of SA1 (second trend estimate).

For two more iterations, use NP and T2 to redo steps 3 to 10.

APPENDIX 2: SUPPLEMENTARY TABLES

Table 22—Integration of nominal prices into trend, seasonal, and irregular factors, 1960 and 1984

Year	Month	NP	=	T	×	S	×	I
1960	1	21.69		24.21		0.9068		0.9879
1960	2	23.79		25.03		0.9391		1.0121
1960	3	24.42		25.90		0.9505		0.9920
1960	4	26.47		26.80		0.9874		1.0005
1960	5	27.83		27.65		1.0147		0.9918
1960	6	29.97		28.08		1.0466		1.0196
1960	7	30.33		27.87		1.0782		1.0095
1960	8	28.41		26.99		1.0447		1.0076
1960	9	25.59		25.81		1.0064		0.9850
1960	10	24.65		24.72		1.0042		0.9929
1960	11	21.98		24.02		1.0289		0.8893
1960	12	23.56		23.78		0.9916		0.9990
1984	1	246.90		258.72		0.9329		1.0230
1984	2	264.80		260.48		0.9915		1.0253
1984	3	264.25		260.85		1.0319		0.9817
1984	4	280.20		261.86		1.0741		0.9962
1984	5	286.60		268.08		1.0723		0.9970
1984	6	282.80		281.69		1.0231		0.9812
1984	7	286.00		297.69		0.9563		1.0046
1984	8	302.00		308.49		0.9580		1.0218
1984	9	296.00		311.49		0.9364		1.0148
1984	10	313.00		309.74		1.0171		0.9935
1984	11	305.00		307.98		1.0247		0.9664
1984	12	310.00		306.73		0.9814		1.0298

Notes: NP is nominal price, T is the trend factor, S is the seasonal factor, and I is the irregular factor.

Table 23—Correlation coefficients of interdistrict aus rice prices, 1976-82

District	2	3	4	5	6	7	8	9	10
Barisal (2)	1.000	0.925	0.849	0.918	0.987*	0.996*	0.994*	0.976*	
Bogra (3)		1.000	0.884	0.955*	0.901	0.915	0.906	0.875	
Chittagong (4)			1.000	0.979	0.835*	0.884	0.874	0.906	
Chittagong Hill Tract (5)				1.000	0.909	0.935*	0.929	0.934*	
Comilla (6)					1.000	0.984*	0.992*	0.971*	
Dhaka (7)						1.000	0.998*	0.992*	
Dinajpur (8)							1.000	0.991*	
Faridpur (9)								1.000	
Jessore (10)	0.987*	0.947*	0.992	0.967*	0.969*	0.993*	0.988*	0.983	1.000
Khulna (11)	0.996*	0.922	0.869	0.932	0.995*	0.996*	0.998*	0.983*	
Kishoregarij (12)	0.972*	0.920*	0.821	0.905*	0.997	0.982*	0.988*	0.955*	
Kushtia (13)	0.972*	0.920	0.820	0.905	0.997*	0.981*	0.987*	0.959*	
Mymensingh (14)	0.979*	0.947*	0.784	0.882	0.953*	0.958*	0.953*	0.912	
Noakhali (15)	0.996*	0.924	0.873	0.932	0.988*	0.988*	0.988*	0.985	
Pabna (16)	0.980*	0.922	0.927	0.958*	0.957*	0.992*	0.985*	0.989*	
Patuakhali (17)	0.989*	0.958*	0.914	0.965*	0.972*	0.992*	0.987*	0.977*	
Rajshahi (18)	0.925	0.999*	0.871	0.950	0.907	0.912	0.907	0.871	
Rangpur (19)	0.967*	0.970*	0.820*	0.918	0.964*	0.949*	0.951*	0.908	
Sylhet (20)	0.972*	0.986*	0.889	0.957*	0.944*	0.965*	0.957*	0.933	0.982*
Tangail (21)	0.986*	0.975*	0.868	0.944*	0.967*	0.976*	0.972*	0.944	0.984*

Table 24—Correlation coefficients of interdistrict aman rice prices, 1976-82

District	2	3	4	5	6	7	8	9	10
Barisal (2)	1.000	0.965*	0.653	0.734	0.608	0.578	0.975*	0.546	0.813
Bogra (3)		1.000	0.812	0.869	0.780	0.758	0.909*	0.724	0.933*
Chittagong (4)			1.000	0.993*	0.995*	0.991*	0.496*	0.930*	0.960*
Chittagong Hill Tract (5)				1.000	0.983*	0.975*	0.587	0.922*	0.981*
Comilla (6)					1.000	0.999*	0.451*	0.937*	0.941*
Dhaka (7)						1.000	0.420	0.934*	0.941*
Dinajpur (8)							1.000	0.400	0.701
Faridpur (9)								1.000	0.400
Jessore (10)									1.000
Khulna (11)	0.857	0.958*	0.935*	0.964*	0.922*	0.909*	0.758	0.845	0.996
Kishoregarij (12)	0.779	0.907*	0.978*	0.993*	0.971*	0.961*	0.652	0.898*	0.996*
Kushtia (13)	0.781	0.910*	0.976*	0.990*	0.968*	0.960*	0.657*	0.891*	0.997*
Mymensingh (14)	0.832	0.939*	0.962*	0.985*	0.946*	0.934*	0.713	0.870	0.997
Noakhali (15)	0.649	0.811	0.999*	0.992*	0.997*	0.994*	0.494*	0.943*	0.963*
Pabna (16)	0.672	0.832	0.991*	0.986*	0.991*	0.994*	0.494	0.943*	0.963*
Patuakhali (17)	0.999*	0.969*	0.656	0.735	0.611	0.582	0.977*	0.562	0.818
Rajshahi (18)	0.908*	0.983*	0.880*	0.926*	0.864	0.845	0.833	0.814	0.974
Rangpur (19)	0.877	0.969*	0.892*	0.932*	0.884*	0.869	0.801	0.818	0.982*
Sylhet (20)	0.684	0.841	0.989*	0.990*	0.993*	0.987	0.545	0.932*	0.978
Tangail (21)	0.586	0.760	0.994*	0.976*	0.996*	0.997*	0.422	0.917*	0.939

11	12	13	14	15	16	17	18	19	20	21
0.998	0.991	0.970	0.955	0.992	0.996	0.999	0.943	0.995		
1.000	0.984*	0.994*	0.963*	0.998*	0.979*	0.989*	0.924*	0.966*		
	1.000	0.979*	0.984*	0.988*	0.978*	0.995*	0.969*	0.982*		
		1.000	0.974*	0.989*	0.954*	0.975*	0.927*	0.980*		
			1.000	0.969*	0.937*	0.965*	0.949*	0.982*		
				1.000	0.987*	0.993*	0.923*	0.961*		
					1.000	0.993*	0.914	0.927		
						1.000	0.952*	0.965*		
							1.000	0.977*		
								1.000		
0.965*	0.996*	0.959*	0.978*	0.971*	0.967*	0.988*	0.983*	0.979*	1.000	0.996*
0.980*	0.999*	0.980*	0.988*	0.983*	0.968*	0.990*	0.975*	0.989		1.000

* This number is significant at the 0.01 level.

11	12	13	14	15	16	17	18	19	20
1.000	0.987*	0.989*	0.995*	0.937	0.954*	0.861	0.987*	0.992*	0.957*
	1.000	0.999*	0.995*	0.978*	0.985*	0.782	0.957*	0.966*	0.990*
		1.000	0.996*	0.977*	0.987*	0.784	0.956*	0.967*	0.971*
			1.000	0.960*	0.969*	0.833	0.972*	0.976*	0.971
				1.000	0.993*	0.652	0.897*	0.919*	0.992*
					1.000	0.674	0.899*	0.919*	0.992*
						1.000	0.916*	0.886*	0.690
							1.000	0.996*	0.915*
								1.000	0.930*
									1.000
0.908*	0.960*	0.960*	0.936	0.993*	0.991*	0.585	0.839	0.861	0.981*

*This number is significant at the 0.01 level.

Table 25—Estimates for rice markets using the simultaneous system of equations, 1960-84

Equations and Variables	Coefficients	t-Ratio
Demand equation (22)		
Constant	185.99	11.11
Y_{t-1}	18.07	0.79
PR_t	−1.61	−3.25
SW_t	−4.21	−5.13
Procurement equation (24)		
Constant	−1.11	−0.16
QR_t	−0.02	−0.92
ADP_t	0.38	1.33
OS_t	0.38	0.75
PR_t	−0.16	−0.79
Public distribution equation (25)		
Constant	−3.63	−0.48
PR_t	0.09	0.52
$ADPR_t$	0.06	0.36
Z_t	0.66	3.80
Import equation (28)		
Constant	10.34	5.65
GAP	0.00	2.36
FA	0.01	4.57
WP	−0.03	−0.28

Table 26—Selected data for 1976-84 used in the analysis of rice price stabilization

Year	Nominal Price of Rice	Deflated Price of Rice	Weighted Ration Price	Deflated Ration Price	Procurement Price	Deflated Procurement Price
			(Tk/maund)			
1976	110.02	28.07	80.60	20.56	120.0	30.61
1977	139.00	32.18	77.20	17.87	134.0	31.02
1978	144.92	32.28	87.30	19.44	136.0	30.29
1979	204.71	37.63	98.70	18.14	165.0	30.33
1980	168.86	27.91	115.50	19.09	170.0	28.10
1981	216.31	32.38	137.70	20.61	191.0	28.59
1982	239.61	32.34	154.30	20.82	210.0	28.34
1983	257.23	32.64	168.70	21.41	225.0	28.55
1984	286.00	33.49	170.50	19.96	248.0	29.04

Year	Rice Production	Wheat Production	Opening Stock of Rice	Rice Imports	Public Distribution	Procurement of Rice	Previous Year's GNP	F.O.B. Price	GNP in Real Terms
			(1,000 metric tons)				(Tk million)	(US$/ton)	(Tk million)
1976	13,003	203	800	819	1,216	313	107,602	220.40	29,724.3
1977	12,549	308	373	1,634	1,557	541	105,816	247.85	25,935.3
1978	13,553	438	597	1,134	1,483	317	131,516	311.80	29,487.9
1979	12,250	728	209	2,979	1,784	226	146,610	339.95	28,917.2
1980	14,292	968	791	1,059	1,123	841	178,337	278.09	33,025.3
1981	14,140	857	1,239	1,229	1,344	287	201,849	301.14	33,144.3
1982	14,181	970	578	1,844	1,190	168	225,886	242.25	35,130.1
1983	15,265	1,073	793	2,135	1,205	145	263,721	175.00	35,304.0
1984	14,473	1,296	631	2,575	1,327	133	304,250	171.00	34,771.4

Source: Bangladesh, Bureau of Statistics, *Yearbook of Statistics*, various issues.
Note: Prices are for the coarse variety of rice.

APPENDIX 3: MODIFICATIONS NECESSARY FOR APPLICATION OF THE PROCEDURE FOR SELECTION OF TARGET PRICES IN FUTURE YEARS AND FOR ADJUSTMENT TO LONG-RUN PRICE MANAGEMENT

This supplement aims to clarify two points: (1) What changes in estimation of normal or trend prices are necessary for the selection of target prices after 1984/85? (2) What procedure is appropriate to make the short-run stabilization procedure described in this paper consistent with any future need to realign rice prices in a desirable long-run direction?

Although the hypothetical case described below is not applicable to Bangladesh, where domestic prices are slightly higher than the world price even assuming a 25 percent overvaluation of Bangladesh's exchange rate, the procedure is described here for those who wish to adapt the methodology to other country situations.

Modification for Future Target Prices

In the simulation for 1976/77-1984/85 a trend line estimate of prices is used based on 1968/69-1984/85 price series (excluding crisis years of 1973/74 and 1974/75). For future years, say for 1985/86, the extrapolation of the trend would provide the normal price for that year. But for 1986/87, the trend should be reestimated by dropping 1968/69 and including 1985/86—the latest year of available data. This trend then would be extrapolated for 1986/87. For each coming year thereafter, the trend line should be reestimated, dropping one year at the beginning and including the latest year at the end of the price series.

Modification for Adjusting Prices for the Long Run

It is clear from the discussion that the concept of "normal price" has been adopted here as a reference for selection of the target annual price by comparing it with the predicted price. If this normal price is judged to be very low in comparison with, say, world price, due to accumulated past distortions, what changes in the procedure are necessary to allow the correction of this past distortion through the selection of annual target prices? Suppose that in year 1984/85 the normal price is lower than the world price (or the long-run desirable level of rice price) by 15 percent, and it is decided that this distortion should be corrected in three consecutive years, for example in 1985/86, 1986/87, and 1987/88. Assuming that this distribution of accumulated distortions implies an increase of Tk 15 per maund each year over the initial target annual prices based on trend and predicted prices, the final target annual price would then be equal to each initial estimate of target annual price plus Tk 15. This upward adjustment in target prices would of course imply a larger volume of procurement and a smaller volume of public distribution and imports than would be the case without the adjustment to world prices, unless import and administered prices are also adjusted in a consistent manner. Adjustment in import and administered prices also implies a change in predicted price.

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