PN-ABS-187
BN 99628

STRUCTURAL DETERMINANTS OF MARKET INTEGRATION. THE CASE OF RICE MARKETS IN BANGLADESH.

by

Francesco Goletti

and

Naser Farid

International Food Policy Research Institute (IFPRI)
Bangladesh Food Policy Project

Funded by USAID under Contract No. 388-0027-C-00-9026-00

June 1993

The authors accept full responsibility for the views expressed in this report as well as for any errors or omissions. The contents do not necessarily reflect the position of USAID or the Ministry of Food, Government of Bangladesh.

PN-ABS-187

STRUCTURAL DETERMINANTS OF MARKET INTEGRATION. THE CASE OF RICE MARKETS IN BANGLADESH.

by

Francesco Goletti[1]

and

Naser Farid[2]

June 1993

International Food Policy Research Institute
1200 17th Street, N.W.,
Washington, D.C., 20036, U.S.A.

---

[1] Postdoctoral Fellow, Markets and Structural Studies Division, IFPRI.

[2]Assistant Chief, Food Planning and Monitoring Unit, Ministry of Food, Bangladesh.

A

STRUCTURAL DETERMINANTS OF MARKET INTEGRATION.

THE CASE OF RICE MARKETS IN BANGLADESH.

1. Introduction

The study of market integration has usually tried to characterize the degree of comovement of prices across spatially separated markets. Since prices are the most readily available and often the most reliable information on developing country marketing systems, market integration studies has almost exclusively referred to events resulting in price changes. Most specifically, market integration is restricted to the interdependence of price changes across spatially separated locations in a market (Wyeth 1992).

Past research has identified various measures of market integration including correlation coefficients (see Farruk 1970, Lele 1972, Jones 1972, Blyn 1973), short and long term tests of integration (see Ravallion 1986), long term multipliers and times to adjust (see Boyd and Borsen 1986, Mendoza and Rosegrant 1991, and Goletti 1993a), cointegration coefficients (see Ardeni 1989, Goodwin and Schroeder 1991, Wyeth 1992, Palaskas and Harris 1991, Goletti 1993b), symmetry tests (Goletti 1993a), causality and centrality tests (see Mendoza and Farris 1992, Goletti 1993a, Alderman 1993).

Most of these studies have identified market integration with one specific measure, be it correlation coefficients, cointegration coefficients, or any other of the measures mentioned above. However, a comparison of various measures as well as an analysis of the structural factors affecting these measures of market integration has been largely neglected, with the exception of the Goodwin and Schroeder 1991, and Faminow and Benson 1990.

The concept itself of market integration is not well defined. It refers to comovements of prices, and, more generally, to the smooth transmission of price signals and information across spatially separated markets. In many instances, prices are not well defined, because quality varies widely. Markets are complex institutions, encompassing hierarchies and interlinked transactions that may involve the simultaneous consideration of various commodities (see Palaskas and Harris 1991).

To expect that a simple measure based on often unreliable price sources can describe the process of transmission of information conveyed by price signals is quite heroic or pretentious. A more systematic effort to relate the available measures of market integration to structural factors should be undertaken.

The objective of this paper is to understand how different measures of market integration may be used to derive conclusions about the structural determinants of market integration. The underlying hypotheses are that marketing infrastructure, price stabilization policy, and the degree of self-sufficiency in production are the major determinants of market integration.

There are several reasons to study market integration. First, by offering a taxonomy of markets it opens the possibility of clustering groups of integrated markets, so that it allows to avoid duplication of interventions. If locations A, B, and C, are well integrated, then the government may well think of withdrawing from, or at least reduce its effort to influence the process of price transmission in those locations. A scarcity in A will be quickly transmitted to B, and C, making it redundant to duplicate the same program (for example an open market sale operation, or a procurement activity). Second, to know the extent of price transmission across different locations within a country may be quite useful to improve the design of liberalization programs. It is customary to design a liberalization program, as if the various regions of a country were all equally developed, and equally responsive to incentives transmitted from the capital city. However, because of the existence of transaction and adjustment costs, the response may vary and takes time. By giving a more detailed picture of the process of transmission of incentives across the marketing chain, knowledge of market integration is relevant to the success of market liberalization. Moreover, it ensures that a regional balance occurs among food deficit, food surplus regions, and regions producing non-food cash crops (see Delgado 1986). If price transmission does not occur, the localized scarcities and abundances may result in excessive strain for the population (see Ravallion 1986). The study of market integration allows to monitor price movements, and in particular the speed of adjustment to shocks arising in different localities of the country. The knowledge of the time needed for a local shock in the rice sector to be transmitted to all the other spatially separated

markets is paramount to a more effective management of price stabilization policy. Third, models of integration can be used to predict prices all over the territory. By knowing the relation of prices in neighboring markets, it facilitates price monitoring and forecasting analysis, in order to give prompt answers to questions concerning the price situation of the country. Fourth, by identifying the structural factors responsible for the integration of markets, investment policy that is directed to the development of markets could be improved. This information is relevant to understand which types of marketing infrastructure is more likely to benefit market integration.

The organization of the paper is as follows. Section 2 gives the main issues and methodology used in the remaining sections. Section 3 describes the data used in the paper. Section 4 reports different approaches to measure market integration, highlighting some of their uses. Section 5 links the previous measures of market integration to structural factors. Section 6 gives the conclusions.

2. The main issues and methodology

This paper addresses two main sets of issues.

The first set of issues is about the *concept and measurement of market integration*. What is it meant exactly by saying that markets are integrated? How is market integration measured, and therefore translated into an operational concept? How do different measures of market integration relate to each other, and what different insights do they give?

The second set of issues is about the *relation between market integration and structural factors*. Assuming that we know how to measure market integration, what are the main factors responsible for it? To what an extent marketing infrastructure, policy, and production characteristics are the main determinants of market integration?

We address these issues with a *two-stage approach*.

In the first stage, time series analysis of price data is conducted in order to arrive at a reasonable set of measures of market integration. Four measures are considered. The first is given by the old correlation coefficient of prices. In order to detrend prices, first differences instead of levels are used. The second measure consists in cointegration coefficients that capture the existence

of stable long term relation between price series. The third measure is given by long term multipliers that express the cumulative response of one market to price shocks originating in another market, incorporating the dynamics of price transmission. The last measure is an elaboration of the third one, where not only the magnitude of price adjustment, but also the time needed to adjust is taken into account.

In the second stage, the measures of integration computed in the first stage are linked to structural factors. The structural factors considered in this paper are those related to marketing infrastructure, policy, and production.

Marketing infrastructure is the set of transportation, communication, credit, and storage facilities that allow a smooth functioning of markets.

Policy affects market integration in a variety of ways. Price stabilization policy, trade restrictions, credit and transport regulations are just a small sample of the numerous public interventions affecting the marketing system.

Finally, the production feature of the area surrounding each market will determine its self-sufficiency status relative to the rest of the country. Markets divide into those that have generally a surplus in the commodity under consideration, those that have generally a deficit, and those that are generally marginally self-sufficient. The more diverse is their respective self-sufficient position, the more likely will be that two markets are integrated.

3. Data

Marketing infrastructure

Data on population, areas, production, communications and transportation infrastructure was assembled on a district basis for 1990/91. Table 1 shows some of the structural characteristics of Bangladesh, particularly the high density of population, the marginal self-sufficiency in terms of grain production, and the extremely low indicators for transportation and communication infrastructure.

In terms of geographic distribution. tructural variables exhibit quite a variety of behavior. Whereas road, bank branches, and a post offices have relatively little variation over regions, railways

density, density of electric connections, and telephone per capita have quite a large variation as measured by a coefficient of variation of over 100 percent.

Roads and railways are badly developed in the South and South West, mainly because this is a deltaic area, where roads are continuously interrupted by rivers. In the Chittagong Hill tract the hilly nature also makes difficult the road and railways construction. The only badly connected part in the North West is Pabna region. The NW-SE axis is relatively well developed in terms of road and railway infrastructure.

With respect to telephone connection, the only relatively well developed areas are the regions where the main three cities of the country are located, namely Dhaka, Chittagong, and Khulna. Outside of the largest urban areas, telephone connections are very thinly spread.

In district such as Khulna, Sylhet, Noakhali, and Chittagong Hill Tract, post offices appear to have the highest density. One possible explanation is the high number of many emigrants from these areas of the country. It does not seem related to the rice business. Moreover, this statistics is not informative of the amount of correspondence. One would expect that the number of letters per capita in Dhaka is higher.

The highest density of bank branches is in Dhaka and Chittagong, as expected. The high number in Sylhet is explained with an argument similar to the high density of post offices, namely the relations with Sylhet-born people who have emigrated abroad and who send money back home. The number of branches is not necessarily related with the amount of loanable funds and credit available in a certain area. It is only indicative of the convenience represented by a high number of offices available to conduct bank operations.

For electric connection only Dhaka and Chittagong are relatively well developed. Most of the country is badly developed, as also pointed out by the high coefficient of variation of this index.

Disturbances. Disturbances are categorized into 14 groups (see table 2). They include disturbances such as strikes, flood, drought, pest attacks, cyclones, salted water, government godown closed, etc. They are obtained by screening of newspapers for news relative to all districts. The total number of

disturbances was higher in 1991/92 than in previous years, as the result of more strikes, particularly transportation strikes. All disturbances were further classified into two categories (see table 3). The first category has been denominated strike disturbances, and include full day strikes, half day strikes, transportation strikes, and curfews. This category is directly affecting the movement of goods, in so far as they make either impossible or extremely difficult interdistrict transportation of commodities such as rice. At best, they delay deliveries; at worst, they cause damage and serious disruptions in the flow of trade. The second category has been denominated supply disturbances, and they include floods, Indian water, dam flooding, drought, salted water, pest attacks. They affect production of rice directly, and create localized scarcities. The disturbances originating from supply shocks have been relatively stable, even though they have declined in the last year of the sample.

Prices. Data on prices have been collected from the Department of Agricultural Marketing. These are weekly wholesale rice prices between 1989/90 and 1991/92, for the 64 district headquarters (Zila). Many missing data were encountered in the data set. A fitting procedure consisting of three steps was used to arrive at a data set of wholesale coarse rice price. This is the first time that such data were computerized and used in an analysis of rice markets of Bangladesh. The fitting procedure outlined below is therefore an initial attempt to produce a unified weekly price time series at district level for Bangladesh. As such, it needs further exploratory work. In the first step, four rice prices series compiled by the Department of Agricultural Marketing were considered: Aman HYV, Aman local coarse, Aus HYV, and Boro HYV. For each series a linear interpolation of missing data was used whenever no more than 4 consecutive weeks were missing. In the second step, the four weekly series were put together to create a series of weekly coarse prices. For each week of the year, the minimum price available among the four series was chosen. In the third step, a new interpolation of missing data, as in the first step, was undertaken on the series constructed in the second step.

Looking at mean and coefficients of variation of prices (see table 4), a few observations can be made. First, the volatility of prices seems to decline between 1989/90 and 1990/91. Second, the level of variability of weekly prices is higher than the variability of nationwide monthly prices of

wholesale coarse price, as reported for example in Goletti 1993a. The percentage difference is about 2-3 points. Third, contrary to prior expectations, the price variability is quite limited, being less than 10 percent in all years, for most of the markets considered. Finally, the price variability among districts is between 4 and 9 percent with an increasing movement during the 1990/91 (see figure 1).

Policy

Numerous policy interventions may be identified that have a bearing on market integration. However, the only set of policies that is considered in this paper is that related to foodgrain price stabilization. In its attempt to stabilize seasonal and inter-year fluctuations, the government affects the behavior of markets. The main instrument used in the context of Bangladesh is stock policy, involving operations with foodgrain stocks, consisting of rice and wheat. The main operations are those related to public distribution, procurement, and open market operations. Public distribution involves either subsidization of consumption of foodgrains to target groups, or in kind transfers according to specific programs, such as food for work programs. Procurement involves the purchase of domestically produced rice at pre-specified prices with the purpose of supporting prices. Open market sales involve the sales of rice and wheat at pre-specified prices, with the purpose to avoid price hikes.

The government maintains public stocks of foodgrains and releases those stocks or increases them in order to stabilize prices. This general behavior suggests a simple, crude measure of the degree of policy intervention. Since the correlation between public stocks and prices is expected to be negative, the higher the absolute value of such a correlation, the higher is the degree of policy intervention. Since we were not able to obtain weekly public stocks for all districts, we have used end of the month stocks instead, and computed the correlation between the average monthly prices at each district and the end of month stocks. The results are reported in table 5, where also the correlations of first differences of prices and public stocks are shown.

4. Measures of Integration

The intuitive idea behind the measurement of market integration is to understand the interaction among prices in spatially separated markets. In the extreme case of two markets A and B completely separated from each other, the prices of the same commodity should not be related. If the areas where market A is located experiences a bad harvest, prices will suddenly increase. In market B, there is no reason to assume that a bad harvest has also occurred. In the absence of communication flows between the two markets, prices in B would not show any movement. On the other hand, if A and B were integrated, the price in B would also increase. This is because some food would flow from B to A decreasing the available supply in B. At the same time the price in A would be lower than in the absence of market integration.

Therefore, the comovement of prices gives an indication of the degree of market integration. However, it is conceivable that two pairs of markets (A,B) and (A',B') exhibit the same price comovement and yet show a different process of price adjustment. That suggests that the dynamics of price adjustment may also give important information about the integration of the two markets. If, for example, price shocks from A to B take longer to be transmitted than from A' to B', even though the index of price comovement between A and B is the same as between A' and B', then we may think of the second pair more integrated than the first one.

This section considers various measures of integration. All these measures are derived from transformation of time series of prices, and involve various degrees of complexity, where complexity is measured by the computational difficulty involved. The less complex measures will be considered first. The first two measures, correlation coefficients and cointegration coefficients are explicitly trying to capture the comovement aspect of price integration. The last two measures, long term multipliers and composite measures, try to capture the dynamic aspect of price integration.

Correlation Coefficients

One simple way to study market integration is to consider correlation of price series at different markets. This is intuitively related to the idea that integrated markets exhibit prices that

move together. Price correlations are the easiest way to measure these comovements. However, the traditional tests of market integration focused on correlation coefficients of spatial prices (see Lele 1972 for India, Farruk 1970 for Bangladesh, Jones 1972 for Nigeria) mask the presence of other synchronous factors, such as general price inflation, seasonality, population growth, procurement policy, etc. Early criticism of this approach has been advanced by Blyn 1973, Harriss 1979, and Timmer 1974.

One way to take care of some of this criticism is to consider correlation of price differences, which has the attractive property of interpreting market integration as interdependence of price changes in different markets. Moreover, price change would largely eliminate common trends that introduce spurious correlation. This is the measure used in this paper and it will be denoted by ρ_{ij} = Correlation of price changes between market i and market j, where i is different from j. For 64 markets, there are 64*63/2=2016 such correlation coefficients.

A statistics to test if the coefficients are significantly different from zero is given by

$$T = \sqrt{(n-1)}\ \frac{\rho_{ij}}{\sqrt{(1-\rho_{ij}^2)}} \qquad [1]$$

which has a t distribution with n-2 degrees of freedom, under the hypothesis that $\rho_{ij} = 0$ (see Lindgren 1976).

Besides the problem of spurious correlation, there are other serious problems related to the often non stationary nature of the price series involved. These problems are taken up by the cointegration analysis undertaken in the following paragraphs.

Cointegration coefficients and market segmentation

Within the analysis of one commodity that is undertaken in this paper, a relevant issue is to understand if there is a stable relation among prices in different localities. Prices move from time to time, and their margins are subject to various shocks, that may drive them apart or not. If in the long run they exhibit a linear constant relation then we say that they are *cointegrated.* Let p_{it}

denote the rice price at time t and at location i of a certain given quality and a certain given marketing stage.

In order to study the interdependence of prices between any pair of markets i and j, it has been recently (see Palaskas and Harriss 1991, Goodwin and Schroeder 1991, Ardeni 1989) suggested to study if there is any relation among the price series in the two markets, such as the one expressed by a linear relation of the type

$$p_{i,t} = \alpha + \beta \cdot p_{j,t} + u_t \qquad [2]$$

Since the price series are generally nonstationary, this relation has interest only if the error term u_t is stationary, implying that price changes in market i do not drift far apart in the long run from market j. When u_t is stationary the two series are said to be cointegrated. However, standard statistical techniques do not allow to conduct explicit significant tests of the parameters α and β. Engle and Granger (1987) proposed a two-step procedure for evaluating the properties of a pair of nonstationary economic time series.

In the first step, each series is taken separately and tested for the order of econometric integration, that is for the number of times the series needs to be differenced before transforming it into a stationary series. The test for integration is the Augmented Dickey Fuller test (Dickey and Fuller, 1979).

$$\Delta p_{i,t} = \alpha_0 + \alpha_1 p_{i,t-1} + \sum_{k=1}^{k=K} \alpha_{k+1} \Delta p_{i,t-k} + \epsilon_t \qquad [3]$$

where Δ refers to the difference operator, that is $\Delta x_t = x_t - x_{t-1}$, for each variable x. The null hypothesis is that the series $p_{i,t}$ is integrated of order 1, and the alternative hypothesis is that the series is of order 0. If the t statistics for the coefficient α_1 is greater in absolute value than a critical value given by the Augmented-Dickey Fuller critical value, then the null hypothesis is rejected. The

alternative hypothesis of stationarity is accepted. If the null hypothesis is not rejected, then one must go on to test whether the series is of order of integration higher than just 1, possibly of order 2. In this case the same regression equation [2] is applied to the second differences $\Delta^2 p_{i,t} = \Delta (\Delta p_{i,t})$.

In the second step, the residual u_t of the OLS regression [1] between the two series is again tested for stationarity, with the Augmented Dickey Fuller test.

If the first stage results in two nonstationary series, both integrated of order 1, and the second stage results in a stationary error term, then the two series are said to be cointegrated of order 1,1.

The presence of cointegration between two series is indicative of interdependence between the two series. In other words, cointegration is indicative of non segmentation between the two series. Cointegration analysis is a powerful tool to give a clear answer about the existence or not of a relation between two economic time series. Unfortunately the cointegration coefficient β cannot be tested to see how strong this interdependence is (see Palaskas and Harris 1991).

In the previous section it was seen that two markets A and B are cointegrated when prices exhibit a stable long term linear relation. Market segmentation refers to the case when the two markets do not exhibit cointegration neither in the direction from A to B nor from B to A. This could be easily checked in the data set to hold for 216 links out of 2016 links. However, in order to have practical relevance, the definition of market segmentation should be restricted even further.

It makes sense to consider only those pairs of markets that are not close. If market A and B are very far away from each other, the lack of cointegration may be due to transportation costs. It is more interesting to focus on those markets that, in spite of being "close enough", do not exhibit cointegration.

The problem is to define what constitutes a "close enough" distance. One reasonable way to solve this problem in the case of rice markets in Bangladesh, is to considered only those markets such that a truck could do a delivery within one day. A crude approximation is to consider markets separated by a distance of less than 250 km, assuming that this is the maximum distance that could be covered by one day trip of a truck loaded with rice bags.

Under these assumptions, segmented markets are those markets that are not cointegrated with each other and that are separated by a distance of less than 250 km.

The result is interesting, because out of 2016 links, only about 44 are segmented in the sense specified above (see table 6). This would confirm the intuition gathered during rapid appraisal surveys of rice markets in Bangladesh (see Goletti 1993c).

Finally, it is useful to point out that the segmented links could be easily tracked down and policy intervention focused on them, in order to arrive at an effective solution, without setting up complex panterritorial policies.

Dynamic Adjustments

Often, it is not enough to say that markets are integrated. One would like to know the extent of integration. Segmentation occurs when there is no cointegration. *Perfect integration* would occur if the price in one market is just a translation of the price in the other market, implying that price changes are the same. The translation factor can be interpreted as a transfer cost between the two markets. However, it is only in extreme cases that perfect integration or segmentation occurs. Most of the time, intermediate degrees of integration occur. The effort of the analyst is then to make precise how to measure these different degrees. The main issue becomes that to measure the *magnitude* of price transmission. The immediate impact of price shocks should be distinguished from the impact that is building over time. The process of price transmission usually takes time, as the result of complex dynamic adjustments. A short run and a long run can then be distinguished, and dynamic multipliers computed.

The reduced form of a structural model of spatial equilibrium (see Takayama and Judge 1971) allows to compute magnitude and speed of the dynamic adjustment process. The price p_{it} is expressed as dependent on a set θ_t of variables affecting both supply and demand. Under the conditions of perfect competition, and risk neutrality, the market equilibrium is efficient (see Newbery and Stiglitz 1981). However, these conditions are never satisfied. Imperfect competition, imperfect information, the absence of markets to deal with risk, and many institutional constraints (such as anti-

hoarding laws, limitations to credit for trading) introduce structural rigidities and affect the dynamics of the price transmission process. Moreover, the presence of expectations and storage implies that prices are better described by a dynamic process whereby the current and past value exogenous variables are taken into account, as in the following expression:

$$p_{i,t} = f(\theta_t, \theta_{t-1}, \ldots, \theta_0) \qquad [4]$$

Information about the structural variables θ_{t-i} is difficult to obtain. Boyd and Brorsen 1986, and Ravallion 1986 proposed to decompose this dynamic process into a deterministic part D_t and a stochastic part S_t as follows:

$$p_{i,t} = D_t + S_t + \epsilon_t \qquad [5]$$

The deterministic part includes trend and seasonal dummies. The stochastic part is modelled as an autoregressive process, whereby the values of prices are regressed upon their past. Whereas cointegration analysis offers a method to understand if there is any long run relation, the autoregressive process of price changes allows to study the dynamics of price transmission. Price changes, instead of price level are the preferred unit of analysis. First differences of logarithm are taken because they offer an immediate interpretation in terms of percentage change. For every pair of market locations i and j, the following bivariate autoregressive process is estimated:

$$p_{i,t} = \sum_{k=1}^{k=m_i} \alpha_{i,k}\, p_{i,t-k} + \sum_{h=0}^{h=n_j} \beta_{i,h}\, p_{j,t-h} + X_{i,t}\, \gamma_i + \epsilon_{i,t} \qquad [6]$$

where $p_{i,t}$ is the price of rice in market i at time t, $p_{j,t}$ is the price of rice in market j at time t; X_{it} are exogenous variables such as seasonal dummies and time trend, and $\epsilon_{i,t}$ is an error term. $\alpha_{i,k}$, $\beta_{i,h}$, and γ_i are coefficients to be estimated, and m_i, and n_j are the number of lags of prices in market i and j, respectively.

In the estimation, problems of simultaneity may be encountered, related to the contemporaneous use of price in market i and in market j. Since both prices may respond to the same type of shocks, it is expected the error term $\epsilon_{i,t}$ to be correlated with the price $p_{j,t}$. To overcome this problem, an instrumental variables estimation of $p_{j,t}$ has been used, taking lagged values of the prices of all markets included in the study. The three lags, one for prices in market i, one for prices in market j, and one for the instrumental variables, are determined simultaneously by application of the Akaike information criterion (see Akaike 1969).

The *magnitude of price adjustment* is estimated with dynamic multipliers. Dynamic multipliers are interpreted as the effect of a price change due to a random shock or a shift in an exogenous variable. In the context of the model introduced above, the cumulative effect of a shock to price in market j on the price in market i, after k periods is

$$\lambda_k^{ij} = \sum_{h=0}^{k} \frac{\partial E[p_i(t+h)]}{\partial p_j(t)} \qquad [7]$$

The full adjustment of the dynamic process described by the model is given by the long run dynamic multiplier, which corresponds to

$$\lambda^{ij}_{\infty} = \lim_{k\to\infty} \mu^{ij}_k \qquad [8]$$

These expressions can be computed recursively as follows.

The immediate impact of price $p_{i,t}$ and $p_{j,t}$ on the expected value of $p_{i,t}$ is given by $\partial Ep_{i,t}/\partial p_{i,t} = 1$, and $\partial Ep_{i,t}/\partial p_{j,t} = \beta_{i0}$. For subsequent periods the following recursive formulas are used:

$$\frac{\partial Ep_{i,t+h}}{\partial p_{i,t}} = \sum_{r=1}^{\min(m,h)} \alpha_{i,r} \frac{\partial Ep_{i,t+h-r}}{\partial p_{i,t}}, \quad h=1,2,\ldots \qquad [9]$$

and

$$\frac{\partial Ep_{i,t+k}}{\partial p_{j,t}} = \sum_{s=0}^{\min(t,k)} \beta_{i,s} \frac{\partial Ep_{i,t+k-s}}{\partial p_{i,t}}, \quad k=1,2,... \qquad [10]$$

Composite measures involving both magnitude and speed of adjustment

The analysis of dynamic adjustments allows to study the *speed* of price transmission. That is, how many days, weeks, or months are needed for prices to be transmitted from one location to another? This is an issue of concern to policy makers for reasons related to planning of food distribution and price stabilization. Sometimes, the speed of the response of prices is related to the efficiency of the market system. However, this assumption is not validated. Rapid adjustments are just an indication of flexibility of the mechanism. They do not necessarily imply well functioning systems. Within the context of this discussion, it is important to consider the speed of adjustment as just another dimension of integration. Given two markets A and B with the same value of the magnitude of price adjustment with respect to a third market C, then the lower is the time to complete this adjustment, the better integrated the market. In other words, this suggests a new indicator of integration which is a combination of the magnitude and speed of adjustment. A ratio of the two would is an example of such and indicator, after normalization between 0 and 1. This ration is denoted by μ, with $\mu=\lambda/\tau$, where λ is the long term multiplier and τ is the time to adjust to the long run.

Comparison among main indicators of market integration

As shown in table 7, whereas over 50 percent of markets are integrated according to the correlation and cointegration measures, only 35 percent of the market links are integrated according to the dynamic adjustment measures (magnitude, speed, and composite measure). One possible

explanation for this lower percentage in the case of measures that explicitly involve dynamics of price transmission is that the requirements for the long term multipliers to be significantly different from zeros are more stringent than the requirement that prices simply move together. Unfortunately, it is not true that if markets are cointegrated, they also exhibit a long term multiplier different from zero. The link between cointegration coefficient and long term multipliers has still to be fully understood in the literature.

Table 7 also reports the descriptive statistics for these measures of integration, showing that the average correlation coefficient of price changes is 23 percent, the average cointegration coefficient is 0.68, that the long term adjustment is 61 percent and takes an average of 2.6 weeks.

5. Factors of integration

Market integration, however measured, is the result of the action of traders, as well as the operating environment determined by the infrastructure available for trading and policies affecting the price transmission. All the measures of integration considered so far, have in common the feature of being computed using only price information available in a specified period of time (156 weeks, covering three years). Each market link is summarized by just one number. This is quite an ambitious, and dangerous thing to do. Markets are complex institutions, and their performance as well as their integration is the result of numerous factors.

Among these factors marketing infrastructure related to transportation and communication is an obvious candidate as explanatory variable. The effect of foodgrain policy, with particular reference to price stabilization, need also to be taken into account. In the extreme case, perfect market integration occurs when prices are stabilized at the same level all over the country. This is rarely the case, but it is indicative of the fact that integration as measured by price comovements and price transmission is heavily affected by government intervention. A third structural factor is the degree of dissimilarity in rice production of various markets. The more dissimilar are the markets, the more incentive they have to trade with each other. A final factor that might explain integration is the presence of monopolistic practices, as suggested by Faminow and Benson 1990. Recent surveys

conducted in rice markets in Bangladesh seem to lend little reliability to collusive or basis point pricing as a good description of the market structure (see Chowdhury 1992).

The various groups of factors can be succinctly expressed as follows.

$$\text{Market integration} = f(\text{marketing infrastructure, price stabilization, production}) \qquad [11]$$

The hypotheses are that marketing infrastructure contributes to integration positively; the degree of dissimilarity of production per capita is also affecting positively market integration, since the more dissimilar the markets the more the incentive to trade with each other; and, finally, price stabilization affects positively the comovement of prices, even though makes more difficult the transmission of signals from one market to another.

In order to test these hypotheses, one needs to specify the variables mentioned in the formulation [11], and to estimate the related equations.

For each pair of markets i and j, let M_{ij} denote a measure of market integration. The four measures introduced in the previous section will be used, namely the correlation of price differences, ρ_{ij}, the cointegration coefficient, b_{ij}, the long term multiplier λ_{ij}, and the composite measure, μ_{ij}, incorporating both long term multiplier and time to adjust.

Marketing infrastructure includes transportation, communication, and credit.

Transportation infrastructure and costs are captured by the road distance between market i and j, d_{ij}, the road density, $road_{ij}$, measured by the density of paved roads per squared kilometer in the areas surrounding the two markets i and j, the railways density, $rail_{ij}$, measured by the density of railways per squared kilometers in the areas surrounding the two markets i and j, and the number of strikes, $strike_{ij}$, in the areas surrounding the two markets i and j.

Communication is measured by the density of telephones per capita, $tele_{ij}$, in the areas surrounding markets i and j; credit availability is measured by the density per squared kilometer, $bank_{ij}$, of bank branches in the areas surrounding markets i and j.

The choice of the variable used to measure marketing infrastructure is clearly limited by the availability of data at district level that we were able to obtain at this stage of the research. Since the results that we got so far are encouraging, it is probably worthwhile to pursue further data collection in order to measure these explanatory variables more accurately.

Price stabilization policy is supposed to influence market integration in a complex matter. On one hand, by smoothing seasonal and interyear fluctuations it enhances the comovement of prices across markets. On the other hand, this very stabilizing process may hinder the transmission of price signals across markets, in a way that long term multipliers should be able to capture. In order to test these hypotheses, it is necessary to get an index of the degree of price stabilization policy undertaken by the government in various districts. One simple way to do this is to consider the correlation between prices and end of period public foodgrain stocks, in each district, as explained in section 3. This variable is denoted by $policy_{ij}$. This correlation is expected to be negative; its absolute value is taken to be indicative of the degree of foodgrain price stabilization policy.

Production affects market integration through the degree of dissimilarity in rice self-sufficiency of various markets. If market i is a surplus market and market j is a deficit market, then the likelihood that i and j are linked by trade in rice is higher than if both markets were surplus or deficit, ceteris paribus. The degree of dissimilarity is measured by the absolute value of the percentage difference in production per capita, and is denoted by $prodct_{ij}$. Another variable related to production that we were able to get is the number of production shocks affecting various districts. These shocks include days of flooding, drought, cyclone, salted water, pest attack, as collected from newspapers. They are denoted by $shock_{ij}$. Their effect on market integration is not clear a priori. When the production shocks are of a tremendous magnitude, as for example during the flooding of 1987/88 and 1988/89, one would expect that market integration is disrupted. In the case of normal production shocks, they may even positively affect market integration, in so far as they add incentives to trade between affected areas and other areas.

The equations that are estimated are then of the following type:

$$M_{ij} = f(d_{ij}, road_{ij}, rail_{ij}, strike_{ij}, tele_{ij}, bank_{ij}, policy_{ij}, prodct_{ij}, shock_{ij}) \quad [12]$$

The results of the estimation are reported in detailed form in table 8. Table 9 summarizes the results. The positive feature of the model is that the effect of some structural factors appear to be robust across different specification of the measure of market integration. Distance is affecting market integration negatively, as expected; but this effect is significant only for correlation and cointegration coefficients. Road infrastructure has a positive effect on market integration, significantly so for correlation and composite measures of integration. The sign of telephone density is quite puzzling, and contrary to our hypothesis of a positive effect of communication on market integration. The puzzle may be partly explained by the type of data that we have on telephone. What is relevant to trade is not simply the availability of telephones in an area, but the availability of country-wide telephones, as opposed to local phones that work only through an exchange operator in the district headquarter. In a recent survey of rice markets in Bangladesh (Goletti 1993c) it was found that some areas that depend heavily on rice trade, such as Bogra district, have very few country-wide telephones available to traders.

Bank branches density does not allow to derive any conclusion. This is probably because this variable is a very bad proxy of credit available to traders. Possibly, the total amount of bank deposits or loans by district could be a better indicator.

Railways density has also a puzzling negative sign, especially for long term multiplier and composite measures of integration. One partial explanation is that, as the survey mentioned above suggested, rail transportation is undertaken over very long distances, when prompt delivery is not a major consideration, as in the case of deliveries to the government. Moreover, the density of railways is not necessarily related to the location of main trade links. The railway train network was built largely in colonial times for considerations independent of rice trade.

Strikes have a significant negative effect on market integration, since they disrupt normal trade. Dissimilarity in production affects market integration positively. Shocks to production also show a positive effect on market integration. This has probably to do with the period considered in the

estimation, namely the three years 1989/90 to 1991/92, characterized by only mild (relative to Bangladesh history) production shocks.

Finally, the degree of price stabilization policy seems to have an asymmetric effect on correlation and cointegration coefficients, on one hand, and on long term multiplier and composite measures, on the other hand. One possible explanation is that price stabilization is strengthening the degree of price comovements as measured by correlation coefficients and cointegration coefficients, but is hindering the process of price transmission as measured by long term multiplier and composite measures.

6. Conclusions

This paper has explored several issues related to market integration, according to a two stage approach. The first stage used time series methods to construct four measures of market integration; the second stage introduced structural variables to explain market integration. The analysis was applied to rice markets in Bangladesh, and it used a very comprehensive and new data set that included weekly prices of rice over a period of 3 years for 64 districts, and structural variables at district level.

The major conclusion of the first stage is that the degree of market integration in Bangladesh is quite high. The segmented markets are less than 10 percent of all conceivable links in the network of the 64 markets of the data set, a network of 2016 links. Moreover, if only those links among markets that are separated by a distance of less than 250 kms from each other are considered, the number of segmented market links is just 44.

The major conclusion of the second stage is that market integration is affected negatively by distance of markets and number of strikes, whereas it is positively affected by the density of paved road, the degree of dissimilarity in production, and the number of production shocks. Moreover, whereas price stabilization policy has a positive effect on price comovements among markets, it hinders the process of price transmission.

Several implications for policy emerge from the previous analysis. First, a withdrawal of the government from price stabilization policy will lower the comovement of prices, even though the transmission of price signals will flow more efficiently among markets. Second, an important role of the government in enhancing market integration is related to investment in road infrastructure. Finally, a negotiating role in solving labor relation conflicts will help in reducing the frequency and the incidence of strikes, enhancing thus the strength of market integration.

REFERENCES

Akaike, H., 1969 "Fitting autoregressive models for prediction", Annals of the Institute of Statistical Mathematics, 21(1969): 826-839.

Ardeni, P.G. 1989. "Does the law of one price really hold for commodity prices?", Amer. J. of Agric. Ec., 661-69.

Blyn, G. 1973, "Price series correlation as a measure of market integration", Indian Journal of Agricultural Econ., 28, no. 2.

Boyd, M., and B.W. Brorsen, 1986, "Dynamic Price Relationships for US and EC corn gluten feed and related markets", European Review of Agricultural Economics, 13(1986): 199-215.

Chowdhury, N. 1992. Rice markets in Bangladesh. A study in structure, conduct, and performance. International Food Policy Research Institute, Washington, D.C.

Delgado, Christopher L. 1986, "A variance components approach to food grain market integration in Northern Nigeria", Am. J. Agr. Ec., V. 68, pp. 970-79.

Farruk, Muhammad Osman. 1970. The structure and performance of the rice marketing system in East Pakistan. Occasional Paper no 31. Ithaka, N.Y., U.S.A.: Cornell University, Department of Agricultural Economics.

Goletti, F. 1993a, The role of markets and public foodgrain system in a growing rice economy. The case of Bangladesh, International Food Policy Research Institute, Washington, D.C., January 1993.

Goletti, F. 1993b, " The effects of supply shocks on market integration. An application to Bangladesh rice markets", International Food Policy Research Institute, Washington, D.C., May 1993.

Goletti, F. 1993c, "Rapid appraisal of the rice market network in Bangladesh", International Food Policy Research Institute, Washington, D.C., June 1993.

Goodwin, B.K., and T.C. Schroeder 1991. "Cointegration tests and spatial price linkages in regional cattle markets", Amer.J. of Agric. Econ., May 1991, 453-64.

Harriss, Barbara 1979, "There is a method in my madness: or is it vice versa? Measuring agricultural product performance", Food Research Institutes Studies, Vol. 17.

Dickey, D.A., and Fuller, W.A. 1979. "Distribution of the estimators for autoregressive time series with a unit root", Journal of the American Statistical Association, 74 (366): 427-31.

Jones, W.O. 1972, Marketing staple food crops in tropical Africa, Cornell University Press

Lele, Uma 1972. Food Marketing in India: private performance and public policy, Cornell University Press.

Mendoza, M., and P.L. Farris, 1992, "The impact of changes in government policies on economic performance (the ARCH model)", Journal of Policy Modelling, 14(2): 209-212.

Mendoza, M. and M. Rosegrant, 1991, "Marketing of Corn in the Philippines: market integration and the dynamics of price formation", in Rosegrant and Gonzalez, "The Philippines Corn Livestock Sector: policy and performance", (International Food Policy Research Institute, mimeo).

Newbery, David M.G., and Joseph Stiglitz. 1981. The theory of commodity price stabilization: A study in the economics of risk. Oxford: Oxford University Press.

Palaskas, T.B., and B. Harriss, 1991. "Testing market integration: new approaches with case material from the West Bengal food economy". Institute of Economic Analysis, Manor Road, Oxford.

Ravallion, M. 1986, "Testing Market Integration", Amer. J. Agr. Econ., Vol 68, No. 1

Takayama, T, and Judge G. 1971, Spatial and Temporal Price and Allocation Models, North Holland

Timmer, Peter C. 1974, "A model of rice marketing margins in Indonesia", Food Research Institute Studies, Vol. 13, no. 2.

Wyeth, John 1992. "The measurement of market integration and application to food security policies", Discussion paper 314, Institute of Development Studies, University of Sussex, U.K.

Table 1__ Marketing Infrastructure and Production

Variable	ALL SAMPLE Mean	ALL SAMPLE Standard Deviation	FIRST THIRTILE Mean	FIRST THIRTILE Standard Deviation	THIRD THIRTILE Mean	THIRD THIRTILE Standard Deviation
Road density (Km per squared Km)	0.07	0.03	0.03	0.01	0.11	0.02
Railways density (Km per squared Km)	0.02	0.02	0	0	0.04	0.01
Electricity Connections Density (Number per Squared Km)	11	26	3	1	24	44
Telephone density (number per million people)	1035	2485	281	56	2343	4092
Post office density (number per million people)	13	6	8	2	20	6
Bank branches density (number per million people)	52	16	39	5	69	17
Rice production per capita (Kg per capita per year)	174	63	111	29	242	47
Wheat production per capita (Kg per capita per year)	10	12	0	1	23	12
Population density (inhabitants per squared Km)	822	521	473	184	1232	712

Source: Data collected by Naser Farid.

Table 2__ Types of Disturbances.

TYPE	1989/90	1990/91	1991/92	1989/92
Full day strike	347	267	276	890
Half day strike	7	2	8	17
Curfew	0	2	0	2
Transportation strike	296	91	1055	1442
Demurrage	7	20	6	33
Government godown closed	1	0	0	1
Government godown pest attack	1	0	0	1
Tidal surge and cyclone	108	46	33	187
Flood damage	27	35	34	96
Indian water	52	64	48	164
River/dam broken	50	91	30	171
Salted water	0	18	0	18
Drought	38	29	64	131
Pest attack	69	90	90	249

Source: Data collected by Naser Farid.

Table 4__ Price Statistics by districts

	1989/90			1990/91			1991/92			1992/93		
	MEAN	CV	MISSING	MEAN	CV	MISSING	MEAN	CV	MISSING	MEAN	CV	MISSING
DINAJPU	911	4.4	0	944	6.9	0	1067	5.0	0	974	8.8	0
THAKURG	917	5.8	0	965	6.4	16	1067	4.9	0	985	8.7	16
PANCHAG	912	4.0	0	943	5.6	5	1071	6.6	0	976	9.1	5
RANGPUR	900	6.0	0	970	5.5	0	1067	6.8	0	979	9.3	0
LALMONI	882	6.2	0	992	7.2	17	1090	7.0	1	987	11.4	18
NILPHAM	882	5.8	0	997	7.6	17	1033	6.2	0	968	9.5	17
KURIGRA	927	5.8	0	1015	6.6	15	1045	4.9	15	988	7.8	30
GAIBAND	890	7.1	0	983	6.7	0	1051	7.6	0	975	9.8	0
BOGRA	892	5.3	0	985	8.3	12	1050	5.5	0	975	9.4	12
JOYPURH	900	5.9	0	966	6.2	9	1029	6.3	0	965	8.3	9
RAISHAH	911	5.5	0	944	5.3	0	1076	4.1	0	977	8.8	0
NOAGAON	923	5.3	0	1013	8.4	5	1081	5.0	0	1006	9.1	5
NATORE	913	4.3	0	1039	7.0	0	1064	6.0	0	1005	8.9	0
NAWABGO	921	8.0	0	1017	7.8	8	1086	5.4	0	1008	9.8	8
PABNA	938	6.2	0	1023	6.0	0	1084	5.6	0	1015	8.4	0
SIRAJGA	874	7.8	0	957	5.8	0	1039	6.1	0	957	9.6	0
KUSHTIA	885	5.9	0	1003	6.6	6	1015	5.3	0	967	8.5	6
CHUADAN	930	5.8	0	991	10.2	0	1042	4.9	0	987	8.7	0
MEHERPU	925	7.9	0	999	6.9	0	1059	6.8	0	994	9.0	0
JESSORE	934	6.0	0	994	6.1	19	1110	7.3	0	1015	10.1	19
JHENAID	893	6.8	0	1019	9.4	0	1031	6.8	0	981	10.1	0
MAGURA	916	7.7	0	1021	7.3	0	1048	6.0	0	995	9.0	0
NARAIL	944	8.8	0	1064	8.5	0	1032	5.9	0	1014	9.3	0
KHULNA	897	6.6	0	1053	8.2	0	1025	5.6	0	992	9.7	0
SATKHIR	887	7.1	0	1017	9.0	5	1031	4.0	5	975	9.7	10
BAGERHA	926	7.4	0	1033	11.0	0	1024	4.5	4	994	9.6	4
BARISAL	938	6.1	0	1000	6.9	5	1073	6.5	0	1004	8.6	5
JHALOKA	945	7.2	0	998	6.7	6	1105	6.0	0	1017	9.4	6
PIROJPU	915	8.1	0	1031	8.2	8	1075	5.7	0	1006	10.0	8
BHOLA	909	7.6	0	1001	5.7	14	1080	7.2	0	996	10.1	14
PATUAKH	954	10.6	0	1019	5.5	16	1133	7.0	0	1037	10.9	16
BARGUNA	899	7.8	0	1012	4.7	9	1083	4.6	0	997	9.7	9
MYMENSI	930	8.5	0	1021	5.9	0	1098	7.7	0	1017	10.0	0
NETROKO	947	7.9	0	1007	6.3	0	1096	7.9	0	1017	9.5	0
KISHORE	916	7.3	0	1028	5.4	0	1074	7.2	0	1006	9.4	0
JAMALPU	914	8.4	0	1045	5.2	0	1065	8.5	0	1008	9.9	0
SHERPUR	931	7.1	0	1081	7.9	6	1096	8.4	0	1034	10.7	6

	1989/90			1990/91			1991/92			1989/92		
	MEAN	CV	MISSING	MEAN	CV	MISSING	MEAN	CV	MISSING	MEAN	CV	MISSING
TANGAIL	924	6.4	0	1024	7.8	0	1087	6.9	0	1012	9.7	0
FARIDPU	924	5.2	0	995	5.5	0	1073	4.8	0	997	8.0	0
RAJBARI	966	8.1	0	1008	6.1	8	1068	6.4	0	1014	8.1	8
MADARIP	974	4.9	0	1007	6.7	0	1121	5.2	0	1034	8.3	0
GOPALGO	936	5.9	0	1012	7.0	12	1068	4.2	0	1005	7.9	12
SHARIAT	984	6.3	0	1034	8.5	0	1157	5.2	0	1058	9.6	0
DHAKA	923	8.1	0	1034	7.4	8	1115	5.3	0	1024	10.4	8
GAZIPUR	951	6.1	0	1039	6.1	0	1096	4.8	21	1018	8.1	21
NORSHIN	941	7.6	0	1058	7.8	0	1085	7.2	0	1029	9.7	0
NARAYAN	925	7.4	0	1023	7.1	4	1090	4.5	0	1012	9.2	4
MUNSHIG	899	7.6	0	1037	5.3	6	1034	6.3	0	995	9.5	6
MANIKGO	947	6.1	0	1116	9.6	7	1131	6.2	0	1070	10.2	7
SYLHET	904	10.6	0	1074	6.6	0	1037	5.8	0	1005	10.5	0
MOULVI	964	8.1	0	1075	4.3	8	1141	6.6	0	1059	9.6	8
HOBIGON	929	12.8	0	1088	5.2	16	1092	9.7	0	1031	12.3	16
SUNAMGO	965	8.8	0	1082	4.8	0	1107	8.2	5	1050	9.4	5
COMILLA	950	8.5	0	1071	4.0	26	1126	6.5	0	1045	10.2	26
B.BARIA	929	10.1	0	1088	8.6	10	1094	7.7	0	1034	11.5	10
CHANDPU	939	7.4	0	1042	6.2	18	1083	5.6	0	1019	8.9	18
NOAKHAL	967	8.8	0	1027	8.7	23	1134	6.1	0	1045	10.4	23
LAKSHMI	1008	10.8	27	986	5.3	0	1166	4.5	27	1035	9.9	54
FENI	972	7.7	0	1016	5.6	6	1143	4.9	0	1045	9.3	6
CHITTAG	1001	7.9	0	1037	7.3	9	1124	6.0	2	1054	8.6	11
COX'S_B	985	7.8	0	990	6.1	20	1125	6.4	0	1039	9.4	20
RANGAMA	992	7.7	8	1021	7.1	13	1174	7.1	0	1070	10.6	21
KHAGRAC	925	4.1	45	1027	12.2	4	1101	4.2	8	1053	10.0	57
BANDARB	993	5.8	13	1007	8.0	13	1075	3.4	18	1023	6.9	44
ALL	931	7.1	1	1019	6.9	6	1082	6.0	2	1010	9.4	10

Table 3__ Disturbances by districts

	1989/90			1990/91			1991/92			1989/92		
	STRIKE	SUPPLY	TOTAL	STRIKE	SUPPLY	TOTAL	STRIKE	SUPPLY	TOTAL	STRIKE	SUPPLY	TOTAL
DINAJPU	10	3.0	13	6	2.0	8	26	3.0	29	42	8.0	50
THAKURG	10	4.0	14	6	1.0	7	25	3.0	28	41	8.0	49
PANCHAG	10	4.0	14	6	4.0	10	25	1.0	26	41	9.0	50
RANGPUR	10	10.0	21	6	6.0	12	30	5.0	35	46	21.0	68
LALMONI	10	11.0	21	6	13.0	19	25	6.0	31	41	30.0	71
NILPHAM	10	2.0	12	6	3.0	9	25	3.0	28	41	8.0	49
KURIGRA	10	1.0	11	6	7.0	13	25	6.0	31	41	14.0	55
GAIBAND	10	5.0	15	6	3.0	9	25	5.0	30	41	13.0	54
BOGRA	13	7.0	20	7	4.0	12	25	9.0	34	45	20.0	66
JOYPURH	10	1.0	11	7	3.0	10	25	1.0	26	42	5.0	47
RAJSHAH	11	4.0	15	7	3.0	10	25	1.0	26	43	8.0	51
NOAGAON	11	0.0	11	6	2.0	8	26	2.0	28	43	4.0	47
NATORE	10	5.0	15	6	6.0	12	26	4.0	30	42	15.0	57
NAWABGO	10	1.0	11	6	6.0	12	25	3.0	28	41	10.0	51
PABNA	16	9.0	25	6	13.0	19	25	13.0	38	47	35.0	82
SERAJGA	11	10.0	21	6	6.0	12	27	10.0	38	44	25.0	71
KUSHTIA	10	3.0	13	5	2.0	7	21	1.0	22	36	6.0	42
CHUADAN	9	5.0	14	6	2.0	8	19	0.0	19	34	7.0	41
MEHERPU	9	7.0	16	5	4.0	9	19	0.0	19	33	11.0	44
JESSORE	12	1.0	13	5	1.0	6	21	2.0	23	38	4.0	42
JHENAID	9	5.0	14	5	1.0	6	20	2.0	22	34	8.0	42
MAGURA	9	10.0	19	5	4.0	9	19	3.0	22	33	17.0	50
NARAIL	9	15.0	24	5	22.0	27	19	15.0	34	33	52.0	85
KHULNA	15	5.0	20	7	6.0	14	23	2.0	25	45	13.0	59
SATKHIR	9	10.0	19	5	15.0	21	19	11.0	30	33	36.0	70
BAGERHA	9	8.0	17	5	11.0	17	20	6.0	26	34	25.0	60
BARISAL	16	0.0	16	7	3.0	11	20	6.0	26	43	9.0	53
JHALOKA	9	0.0	9	5	2.0	7	19	2.0	21	33	4.0	37
PIROJPU	9	3.0	12	5	3.0	8	19	3.0	22	33	9.0	42
BHOLA	9	2.0	11	6	12.0	19	19	3.0	22	34	17.0	52
PATUAKH	9	3.0	12	5	12.0	18	19	6.0	25	33	21.0	55
BARGUNA	9	2.0	11	5	10.0	16	19	8.0	27	33	20.0	54
MYMENSI	10	6.0	16	5	5.0	10	19	8.0	27	34	19.0	53
NETROKO	9	10.0	20	5	8.0	13	19	5.0	24	33	23.0	57
KISHORE	9	5.0	14	5	7.0	12	19	11.0	30	33	23.0	56
JAMALPU	9	5.0	14	5	3.0	8	19	0.0	19	33	8.0	41
SHERPUR	10	2.0	12	5	6.0	12	19	0.0	19	34	8.0	43
TANGAIL	14	6.0	20	5	2.0	7	21	3.0	24	40	11.0	51
FARIDPU	9	3.0	12	5	2.0	7	19	4.0	23	33	9.0	42
RAJBARI	9	5.0	14	5	3.0	8	19	5.0	24	33	13.0	46
MADARIP	9	2.0	11	6	7.0	13	19	2.0	21	34	11.0	45
GOPALGO	11	1.0	12	5	1.0	6	19	1.0	21	35	3.0	39
SHARIAT	9	2.0	11	5	3.0	8	19	0.0	19	33	5.0	38
DHAKA	11	4.0	15	12	8.0	20	24	12.0	38	47	24.0	73
GAZIPUR	12	12.0	24	5	5.0	10	19	8.0	27	36	25.0	61

	1989/90			1990/91			1991/92			1989/92		
	STRIKE	SUPPLY	TOTAL	STRIKE	SUPPLY	TOTAL	STRIKE	SUPPLY	TOTAL	STRIKE	SUPPLY	TOTAL
NORSHIN	10	4.0	14	5	3.0	8	18	3.0	21	33	10.0	43
NARAYAN	10	13.0	23	5	10.0	15	21	19.0	40	36	42.0	78
MUNSHIG	10	1.0	11	5	3.0	8	20	4.0	24	35	8.0	43
MANIKGO	9	2.0	11	5	8.0	13	18	6.0	24	32	16.0	48
SYLHET	12	14.0	28	5	10.0	16	21	7.0	28	38	31.0	72
MOULVI_	9	1.0	10	5	5.0	10	18	5.0	23	32	11.0	43
HOBIGON	9	5.0	15	5	4.0	9	18	5.0	23	32	14.0	47
SUNAMGO	12	12.0	26	5	5.0	10	18	3.0	21	35	20.0	57
COMILLA	9	8.0	17	5	12.0	17	18	11.0	29	32	31.0	63
B.BARIA	9	10.0	19	5	10.0	15	24	10.0	34	38	30.0	68
CHANDPU	9	4.0	13	5	1.0	6	18	1.0	19	32	6.0	38
NOAKHAL	9	5.0	14	5	9.0	15	18	2.0	20	32	16.0	49
LAKSHMI	9	6.0	15	5	4.0	9	18	1.0	19	32	11.0	43
FENI	9	4.0	14	5	5.0	10	18	3.0	21	32	12.0	45
CHITTAG	15	14.0	29	11	19.0	34	21	5.0	27	47	38.0	90
COX'S_B	9	9.0	19	8	7.0	19	19	6.0	25	36	22.0	63
RANGAMA	9	3.0	12	5	1.0	6	18	0.0	19	32	4.0	37
KHAGRAC	9	3.0	12	5	5.0	10	18	1.0	19	32	9.0	41
BANDARB	9	7.0	16	5	1.0	6	18	3.0	21	32	11.0	43
ALL	10	5.4	16	6	5.8	12	21	4.7	26	37	15.9	53

Table 5__ Degree of Price Stabilization

DISTRICT	Corr(P,G)	Corr(DP,DG)
DINAJPUR	0.09	0.27
THAKURG	-0.09	-0.09
PANCHAGA	-0.09	-0.07
RANGPUR	-0.54	-0.23
LALMONIR	-0.34	-0.04
NILPHAMA	-0.47	-0.30
KURIGRAM	-0.36	-0.01
GAIBANDA	-0.49	-0.34
BOGRA	-0.40	-0.25
JOYPURHA	-0.40	-0.27
RAJSHAHI	-0.74	-0.34
NOAGAON	-0.46	-0.10
NATORE	-0.35	-0.21
NAWABGON	-0.40	-0.30
PABNA	-0.26	-0.13
SERAJGAN	-0.25	-0.43
KUSHTIA	-0.34	-0.29
CHUADANG	-0.32	-0.17
MEHERPUR	-0.12	0.03
JESSORE	-0.49	-0.22
JHENAIDA	-0.24	-0.19
MAGURA	-0.46	0.13
NARAIL	-0.17	-0.15
KHULNA	0.04	0.15
SATKHIRA	-0.39	-0.17
BAGERHAT	-0.58	-0.20
BARISAL	-0.32	0.05
JHALOKAT	-0.62	-0.25
PIROJPUR	-0.10	0.16
BHOLA	-0.49	0.44
PATUAKHA	-0.46	0.11
BARGUNA	-0.83	-0.20
MYMENSIN	-0.67	-0.21
NETROKON	-0.62	-0.42
KISHOREO	-0.73	-0.35
JAMALPUR	-0.69	-0.30
SHERPUR	-0.63	-0.34
TANGAIL	-0.63	-0.12
FARIDPUR	-0.63	-0.06
RAJBARI	-0.48	-0.07
MADARIPU	-0.47	-0.17

DISTRICT	Corr(P,G)	Corr(DP,DG)
GOPALGON	-0.41	-0.31
SHARIATP	-0.59	-0.30
DHAKA	-0.40	0.25
GAZIPUR	-0.38	-0.00
NORSHIND	-0.68	-0.14
NARAYANG	-0.32	0.25
MUNSHIGO	-0.10	0.06
MANIKGON	-0.21	-0.09
SYLHET	-0.62	-0.02
MOULVI_B	-0.85	-0.57
HOBIGONJ	-0.55	-0.02
SUNAMGON	-0.68	0.02
COMILLA	-0.81	-0.33
B.BARIA	-0.71	-0.22
CHANDPUR	-0.40	-0.28
NOAKHALI	-0.80	-0.28
LAKSHMIP	-0.81	-0.51
FENI	-0.75	-0.18
CHITTAGO	-0.56	-0.19
COX'S_BA	-0.30	-0.38
RANGAMAT	-0.55	-0.30
KHAGRACH	-0.16	-0.05
BANDARBA	-0.14	0.09

Table 6__ Segmented Links: markets not cointegrated and less than 250 km apart

Link #	District I	District J	Cointegration	Cointegration	Distance	Correlation
1	PANCHAGA	LALMONIR	-2.15	-0.70	176	0.27
2	RANGPUR	LALMONIR	-2.41	-1.13	39	0.37
3	LALMONIR	NOAGAON	-2.18	-1.36	194	0.11
4	NILPHAMA	NOAGAON	-2.40	-0.98	212	-0.02
5	KURIGRAM	NOAGAON	-2.80	-0.98	205	0.19
6	BOGRA	JOYPURHA	-2.00	-2.86	57	0.25
7	BOGRA	GOPALGON	-2.50	-2.78	228	0.23
8	BOGRA	. DHAKA	-2.34	-2.37	220	-0.04
9	RAJSHAHI	NOAGAON	-2.17	-1.82	88	0.16
10	RAJSHAHI	NAWABGON	-1.34	-2.39	48	0.09
11	RAJSHAHI	KUSHTIA	-1.71	-2.43	142	0.02
12	PABNA	MANIKGON	-2.81	-2.37	103	0.08
13	MAGURA	COMILLA	-2.28	-2.06	231	0.08
14	JHALOKAT	GOPALGON	-2.51	-2.18	121	0.22
15	JHALOKAT	DHAKA	-2.06	-2.80	153	0.03
16	JHALOKAT	MANIKGON	-1.52	-1.28	193	0.10
17	BHOLA	MUNSHIGO	-2.78	-2.59	202	0.42
18	NETROKON	MANIKGON	-2.88	-2.74	202	0.30
19	SHERPUR	MANIKGON	-2.47	-1.80	170	0.29
20	FARIDPUR	MANIKGON	-2.47	-2.85	56	0.06
21	RAJBARI	MANIKGON	-2.69	-0.95	44	0.41
22	MADARIPU	GOPALGON	-2.07	-2.85	69	0.35
23	MADARIPU	MANIKGON	-2.08	-1.75	123	0.14
24	GOPALGON	MUNSHIGO	-2.35	-2.22	154	-0.11
25	GOPALGON	MANIKGON	-2.54	-2.04	121	0.26
26	GOPALGON	COMILLA	-2.37	-1.59	211	-0.02
27	GOPALGON	B.BARIA	-2.15	-2.61	237	0.12
28	DHAKA	LAKSHMIP	-1.72	-1.70	194	0.10
29	GAZIPUR	LAKSHMIP	-2.82	-2.55	234	-0.03
30	MUNSHIGO	LAKSHMIP	-2.07	-1.59	206	0.01
31	MUNSHIGO	CHITTAGO	-2.89	-2.83	245	0.11
32	MOULVI_B	HOBIGONJ	-1.60	-2.77	46	0.16
33	MOULVI_B	SUNAMGON	-2.59	-2.38	128	0.23
34	COMILLA	LAKSHMIP	-2.19	-1.66	113	-0.08
35	B.BARIA	LAKSHMIP	-2.06	-1.78	204	-0.06
36	NOAKHALI	KHAGRACH	-2.21	-1.94	215	-0.10
37	NOAKHALI	BANDARBA	-1.70	-1.80	203	0.21
38	LAKSHMIP	FENI	-0.48	-2.89	48	0.24
39	LAKSHMIP	CHITTAGO	-1.66	-2.56	137	-0.02
40	LAKSHMIP	KHAGRACH	-0.24	-0.32	219	0.16
41	LAKSHMIP	BANDARBA	-1.92	-2.34	209	-0.20
42	FENI	KHAGRACH	-2.54	-1.63	171	-0.03
43	CHITTAGO	BANDARBA	-2.76	-1.90	72	0.09
44	COX'S_BA	KHAGRACH	-2.41	-1.80	230	-0.01

Table 7__ Comparison of various measures of integration

Measure of Integration	Percentage of significant market links	Average of the Measure of integration over the significant market links	Standard deviation of the measure of integration over the significant market links
Correlation coefficient ρ	53	0.23	0.08
Cointegraion coefficient b	56	0.68	0.14
Long term multiplier λ	35	0.61	0.25
Time to adjust τ	35	2.6	1.15
Composite measure μ	35	0.31	0.24

TABLE__ DETERMINANTS OF MARKET INTEGRATION

	Correlation of Price Differences			Cointegration Coefficient			Long Term Multiplier			Composite measure			Mean of Independent Variable
	ρ			b			λ			ρ			
Variable	Coefficient	T-statistics	Correlation with Dependent Variable	Coefficient	T-statistics	Correlation with Dependent Variable	Coefficient	T-statistics	Correlation with dependent Variable	Coefficient	T-statistics	Correlation with dependent variable	
Constant	0.0765	3.06		0.6337	12.50		0.4391	5.56		0.135	3.19		
Distance	-0.0001	-5.72	-0.27	-0.0002	-3.79	-0.30	-0.0001	-1.46	-0.10	0	0.26	-0.02	310.822
Paved Road Density	0.6721	4.78	0.32	-0.2372	-0.83	0.05	0.5447	1.23	0.00	0.6741	2.84	0.11	0.140
Telephone Density	5.0815	1.69	0.07	-15.561	-2.14	-0.07	-32.0849	-2.83	0.03	-12.1121	-1.99	0.00	0.003
Bank Branches Density	-0.0007	-2.15	0.15	0.0013	2.05	0.03	0.0015	1.52	0.07	0.0009	1.68	0.06	85.684
Railways Density	0.0002	0.80	0.07	0	0.02	0.00	-0.0019	-2.90	-0.02	-0.0013	-3.78	-0.09	43.167
Number of Strikes	-0.0002	-2.61	-0.02	-0.0001	-0.42	-0.10	-0.0005	-2.61	-0.03	-0.0003	-2.91	-0.15	237.368
Number of Shocks to Production	0.0003	2.99	0.12	0	-0.15	-0.10	0.0011	3.19	0.04	0.0002	1.04	-0.08	104.421
Degree of Diversificity in Production	0.0151	1.86	0.07	0.0131	0.79	-0.01	0.1024	3.98	0.19	0.0279	2.05	0.08	0.374
Degree of Price Stabilization	0.0605	4.59	0.33	0.0589	2.21	0.17	-0.1536	-3.69	-0.13	-0.0501	-2.24	0.02	0.938
Mean of Dependent Variable	0.1526			0.6582			0.3424			0.1364			
Valid Cases	361			361			361			361			
R^2	0.2845			0.1344			0.1167			0.1007			

Table 9__ Summary effects of structural factors on measures of integration.

	Correlation of Price Differences	Cointegration Coefficients	Long Term Multiplier	Composite Measure	Congruence among measures
Distance	-	-	0	0	-
Paved Road Density	+	0	0	+	+
Telephone Density	0	-	-	-	-
Bank Branches Density	-	+	0	+	?
Railway Density	0	0	-	-	-
Number of Strikes	-	0	-	-	-
Degree of Price Stabilization	+	+	-	-	+/-
Degree of Dissimilarity in Production	+	0	+	+	+
Production Shocks	+	0	+	0	+
R^2	28.4	13.4	11.7	10.0	

Notes

+ means significatively positive effect.
- means significatively negative effect.
0 means not signifatively different from zero.
Congruence refers to the overall conclusion from the different measures of integration.
+/- means that it has a positive effect on correlation and cointegration coefficients and a negative effect on long term multiplier and composite measures.