

## Spatial Integration of Fruit and Vegetables Markets in Bangladesh

Abdul Latif SARKER\* and Takashi SASAKI\*\*

\*Science of Biological Production, The United Graduate School of Agricultural Science, Gifu University (Shinshu University)

\*\*Department of Food Production Science, Faculty of Agriculture, Shinshu University

**Summary.** The study was undertaken to discern the nature and extent of spatial integration of fruit and vegetables markets in Bangladesh, precise evaluation of which remains pending till to date. Ravallion model, well-suited for radial market structure in Bangladesh (regional markets surrounding central market, Dhaka), was applied to the monthly wholesale price data of potato and banana. The model provided insights into the dynamics of market integration, which a simple correlation model failed to do. Except one regional market for potato, all the remaining markets for both potato and banana were found not to be integrated with central market within the domain of monthly wholesale prices, though none of the selected markets was segmented from the central market. Seasonality of production was found to be an important source of weaker market integration. The hypothesis of no seasonality was rejected for 7 out of 8 regional potato markets and 4 out of 8 regional banana markets. Overall, integration of banana markets was found to be poorer than that of potato markets.

**Keywords :** spatial market integration ; market segmentation ; short-run integration ; radial market structure ; Ravallion model ; Timmer index

### Introduction

Spatial market integration, which means inter-relationship of price movements among spatially separated markets, is one of the most important criteria of market performance. In the case of Bangladesh, where periodic localized supply shortage in spatially separated markets is quite common, it is very important to understand the nature and extent of market integration. In a market economy, where required infrastructure and information are in place, localized scarcity is supposed to be eliminated through competitive commodity arbitrage by the traders, who will be induced by the price differential between scarce and surplus regional markets. The arbitrage will continue to exist until markets reach to an equilibrium, where price differential between markets will be just equal to interregional transport costs<sup>1)</sup>. The speed at which this equilibrium

occurs, i.e., markets adjust to spatial price differentials depends on market integration.

The knowledge of market integration in an underdeveloped market economy like Bangladesh is important in another context. Various imperfections, such as entrenched monopoly/monopsony and inadequate and costly information transmission may hinder the markets to perform efficiently. The needed policy intervention to improve the situation under such imperfection is essentially guided by the dynamics of market integration. The cost for incorrect policies based on discretionary assumption about the nature of market integration can be simply devastating<sup>2)</sup>.

No major attempt was made so far to investigate spatial market integration of Bangladeshi fruit and vegetables marketing system. There is only one study in Bangladesh, which has measured spatial market integration using simple correlation coefficients method<sup>3)</sup>. Correlation coefficients of prices among markets, although generally implies the likelihood of relations of prices among markets, they fail to infer the

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nature and extent of this relation. While it is true that prices in an efficient market system tend to move together, they may do so for other reasons (e.g., common price trends, common seasonality and other common factors affecting prices of markets under investigation)<sup>4)</sup>. It is quite likely that common temporal forces like general inflation and common seasonality would affect prices in various regional markets in the same way. But the problem arises as these common temporal factors tend to overwhelm the more subtle spatial price relations in the simple correlation model. What is important condition for market integration is that price differentials among markets in excess of transfer cost would be eliminated in time. The results produced by correlation model are influenced mainly by the common temporal forces, not by the fact of arbitrage and elimination of price differentials among markets<sup>5)</sup>. Therefore, correlation model has very limited inferential value to comment on market integration.

It is under this backdrop, the present study has attempted to analyze the extent and nature of spatial market integration of Bangladeshi fruit and vegetables markets, following a dynamic econometric model, which is able to pick up the more subtle spatial price differentials and not be overwhelmed by common economic trends.

## Methodology

### *The Model*

Different dynamic models have been employed by the researchers to study spatial market integration, based on the spatial market structure of the country under investigation<sup>6)</sup>. In Bangladesh, the spatial market configuration is essentially radial, i.e., a group of regional markets is encircling the main central market (Dhaka). Given that Dhaka is the largest consumption center (roughly 8% of total 120 million population lives in Dhaka) and the transport system heavily Dhaka-centric, it is quite plausible to assume that prices in Dhaka market influence the prices of other regional markets, or in other words, demand in Dhaka

largely affects interregional trades in Bangladesh. Therefore, the dynamic model, considering a radial structure of spatial markets, that can estimate the extent to which regional market prices are influenced by prices in central markets as postulated by Ravallion<sup>7)</sup> and subsequently modified by Timmer<sup>8)</sup> was used in this study. This study has followed a simplified version of the econometric technique proposed by Ravallion and index constructed by Timmer. These are discussed in brief as follows.

How regional market's price is influenced by central market price has been postulated by the following equation :

$$(P_{it} - P_{t-1}) = \alpha_i(P_{it-1} - P_{t-1}) + \beta_{i0}(P_t - P_{t-1}) + \beta_{i1}(P_{t-1}) + \gamma_i X + \mu_{it} \dots \dots \dots (1)$$

Where,

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

$P_t$  = price in central market ;

X = other factors (seasonality for example) influencing price ;

$\alpha$ ,  $\beta$  and  $\gamma$  = parameters of the model to be estimated ; and

$\mu_{it}$  = the error term

The above model postulates the change in regional price ( $P_{it} - P_{t-1}$ ) as a function of last period's spatial price margin between regional and central market ( $P_{it-1} - P_{t-1}$ ), the change in the central market price for the same period ( $P_t - P_{t-1}$ ), last period's central market price ( $P_{t-1}$ ) and other factors like seasonality and local market characteristics (X).

The parameter  $\alpha_i$  in equation (1) measures the extent to which last period's spatial price differential is reflected in this period's regional market price change. If the margin widened in the last time period (because of a price rise in central market) and transaction costs remained the same, traders would have an incentive to move produce away from regional to central market, thus pushing up price of regional market in the current time period. Parameter  $\beta_{i0}$  measures the extent to which regional price at a given time is determined by the change in the central market price during

the same time period. It therefore reflects the extent and speed of movement of information from central to regional markets so that price makers can act to adjust prices. General level of price in the central level in the past time may provoke changes of regional market price, which is reflected by parameter  $\beta_{i1}$ . Finally, other factors that can influence regional market price are seasonality of production, natural disasters crippling easy transport among market and so on, has been reflected by the parameter  $\gamma$ .

From equation (1) the following hypotheses can be tested :

(1) **Market Segmentation :** The hypothesis that the regional market is segmented from the central market means that changes in the central market price will have no effect, immediate or lagged, on prices of regional markets. In equation (1) market  $i$  is segmented if

$$\beta_{i0} = \beta_{i1} = 0 \dots\dots\dots(2)$$

This can be determined by testing equation (1) against the following restricted model with an F-test<sup>9)</sup> :

$$(P_{it} - P_{t-1}) = \alpha_i(P_{it-1} - P_{t-1}) + \gamma_i X + \mu_{it} \dots\dots\dots(3)$$

If equations (1) and (3) are equal according to the F-test, then  $\beta_{i0} = \beta_{i1} = 0$  and markets are segmented.

(2) **Short - Run Integration :** The 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 regional price. In terms of equation (1) it means that

$$\beta_{i0} = 1, \beta_{i1} = 0 \dots\dots\dots(4)$$

The hypothesis, also requires that there will no lagged effects of prices in the future :

$$\alpha_i = 0 \dots\dots\dots(5)$$

If both (4) and (5) are accepted, regional market  $i$  is integrated with central market in one time period.

Timmer has used the parameters of equation (1) and constructed an indirect but more subtle and general indicator of short-run market integration.

Assuming that the central market is equilibrium in long-run (i.e.,  $P_t - P_{t-1} = 0$ ) and there is no effect of seasonality or local market characteristics (i.e.,  $\gamma_i = 0$ ), then  $\alpha_i$  and  $\beta_{i1}$  indicate the relative contributions of past regional and central market prices to the determination of current regional prices. If past central market prices have the primary influences on regional prices, regional markets are well connected with the central market in the sense that supply and demand conditions in the central market are communicated effectively to regional markets to influence price there regardless of previous regional conditions. To show the relative strength of past regional and past central prices in the formation of present regional prices, Timmer has termed the ratio as index of market connection (IMC) and measured as below :

$$IMC = \frac{1 + \alpha_i}{\beta_{i1} - \alpha_i} \dots\dots\dots(6)$$

Given the model's specification,  $\alpha_i$  would be between 0 and  $-1$  under normal conditions, and the index would be normally positive. The closer the index is to 0 the greater the degree of market integration. Timmer has considered a coefficient less than 1 to reflect high degree of short-run market integration. Essentially the Timmer index indicates the degree to which regional markets are connected to the central market in the short-run, i.e., in one time period (one month in case of monthly data).

Another indicator of market integration that can be drawn from equation (1) evolves from the plausible result that  $\beta_{i0}$  is close to 1 but equation (5) does not persist. In this case, short-run integration can not be accepted, yet economic forces causing central market price changes are generally being reflected in the regional price levels. In this sense,  $\beta_{i0}$  measures relationship among prices of regional and central markets, much similar that simple correlation coefficient does. That is, a form of integration takes place, though regional and central markets are not integrated in the short-run.

(3) **Absence of Regional Characteristics :** This hypothesis indicates that  $\gamma_i = 0$  in equation (1). Whether local characteristics play any role in

the formation of local price can be determined by testing equation (1) against the following restricted model with an F-test :

$$(P_{it} - P_{t-1}) = \alpha_i(P_{it-1} - P_{t-1}) + \beta_{i0}(P_t - P_{t-1}) + \beta_{i1}(P_{t-1}) + \mu_{it} \dots\dots\dots(7)$$

If equation (1) and (7) are equal according to F-test, the hypothesis that regional market characteristics have no significant effect in the formation of regional prices will be accepted.

**Data**

Considering the importance and depending on the availability of data, market integration of this study was investigated for Bangladesh's most important vegetable, potato and fruit, banana. Monthly wholesale prices of these two items were collected from Agricultural Marketing Department of the Ministry of Agriculture. Data on wholesale price for potato was available for sixteen years (1982-97), i.e., 192 months, while the

same for banana for fifteen years (1983-97), 180 months.

Dhaka was considered to be the central market for both potato and banana. Location, availability of supply and availability of data were major considerations in selecting regional markets. Selected regional markets covered whole Bangladesh and represented a radial market structure encircling Dhaka (Fig 1). Potato price for eight markets, namely, Mymensingh, Sylhet, Barisal, Patuakhali, Rangpur, Dinajpur, Bogra and Rajshahi was examined. Among these markets, last 4 are located in northern Bangladesh (main producers of agricultural produce) and were also chosen for Banana. Price of banana was examined for a total 8 regional markets. The other four are Chittagong, Pirojpur, Jessore, and Khulna. All the selected regional markets for both potato and banana are main district level markets, having some kind of transport and communi-

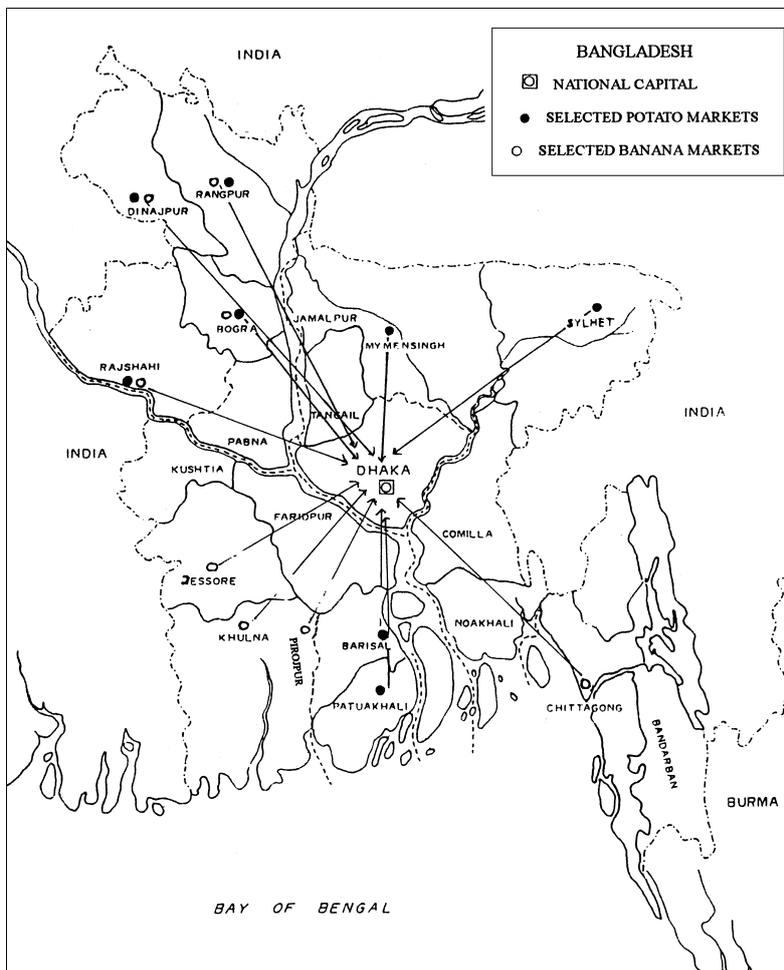


Fig. 1 : Simplified Bangladesh Map Showing Selected Potato and Banana Wholesale Markets

cation facilities with Dhaka. In Bangladesh, where transport and communication facilities still have much room to develop, investigating integration of major markets can be considered to be a first and logical step.

As to the regional market characteristics variable, only seasonality of production was considered. Dec-Feb is the main harvesting season for potato and although harvested year-round, Sep-Oct and Dec-Feb are two peak harvest seasons for banana in Bangladesh<sup>10</sup>. A single dummy variable for these months was used. Bangladesh experienced two severe floods (in 1987 and 1988) within the span of study period. A single dummy variable for flood months in these two years was used, but it had no significant impact in the formation of potato or banana prices of any regional markets and as such was excluded from the model.

## Results and Discussions

### *Integration of Potato markets*

Market integration results for potato are reported in Table 1. Calculated values of F-statistics for testing the hypothesis that regional markets for potato are segmented from Dhaka market were rejected at 1% level of significance for all regional markets. However, Timmer's IMC index

was less than 1 for only one market (Patuakhali).

Thus, *prima facie*, only 1 out of 8 regional markets was found to be integrated within the domain of monthly prices. The  $\beta_{10}$  coefficients were although significant at 1% level of significance for all markets, their values were not much closer to 1. The highest  $\beta_{10}$  coefficient was 0.75 for Barisal, which was followed by Patuakhali (0.72). Other coefficients were below 0.66 and the lowest one was found for Dinajpur (0.32). The implication of such  $\beta_{10}$  coefficient values not much close to 1 is that changes in the Dhaka price were not passed on fully in proportional terms to the regional markets.

The results are in sharp contrast to those shown by simple correlation coefficients. If correlation coefficients are to be taken as indicators of market integration, Mymensingh, Bogra and Rajshahi markets, having correlation coefficients 0.90 and more, also would have been integrated with Dhaka markets. But they were not in reality as identified by their lower  $\beta_{10}$  coefficients and higher IMC numbers. Higher  $\beta_{10}$  coefficients and lower IMC numbers for two markets, Barisal and Patuakhali, which are mainly connected with Dhaka through waterways, are not surprising. These two markets mainly compete with Dhaka for their potato supplies. They are located in areas not as surplus in potato as the other selected

Table 1 Market Integration for Potato in Bangladesh, 1982-97

Markets	r <sup>a</sup>	F-values for Hypotheses of		$\beta_{10}$	IMC
		Segmented Markets	No seasonality		
Mymensingh	0.92	106**	25**	0.65 <sup>b</sup>	1.64
Sylhet	0.88	52**	14**	0.55 <sup>b</sup>	1.58
Barisal	0.91	112**	1ns	0.75 <sup>b</sup>	1.21
Patuakhali	0.92	85**	4*	0.72 <sup>b</sup>	0.55
Rangpur	0.85	62**	25**	0.51 <sup>b</sup>	2.55
Dinajpur	0.87	31**	80**	0.32 <sup>b</sup>	2.67
Bogra	0.91	93**	34**	0.55 <sup>b</sup>	2.49
Rajshahi	0.90	89**	36**	0.56 <sup>b</sup>	2.60

\*\* and\* stand for hypotheses rejected at 1% and 5% levels, while ns implies that hypotheses are accepted.

<sup>a</sup> Simple correlation coefficient of monthly wholesale prices between each regional and central market.

<sup>b</sup> Significant at 1% level.

regional markets are, as indicated by acceptance of no seasonality for Barisal and poor rejection (5% level) of seasonality for Patuakhali (seasonality affects price seriously in production seasons in the surplus areas). Moreover, waterways in Bangladesh are cheapest among all modes of transportation and also less disrupted by political turbulence like transport strikes and road blockage.

#### **Market Integration for Banana**

Market integration results for banana have been reported in Table 2. Simple correlation coefficients are poorer than those of potato as discussed above. Chittagong, Khulna and Dinajpur had correlation coefficients below 0.50. Only Bogra had coefficient above 0.80. Like poorer correlation coefficients, IMC numbers were higher than those of potato. No regional markets were found to have been integrated with Dhaka in the short-run (including Bogra which had correlation coefficient as high as 0.80), although the hypothesis of segmented markets was rejected for all markets. The  $\beta_{10}$  coefficient was found significant at 1% level only for two markets (Khulna and Bogra). The same for Pirojpur was significant at 10% level and for Chittagong was non-significant. The coefficients for the remaining markets were significant at 5% level. Both magnitude and level of significance of the  $\beta_{10}$  coefficients of banana

markets were found poorer than those of potato markets.

Hypothesis for no seasonality was accepted for 4 out of 8 regional markets. Banana is a year-round crop in Bangladesh having two peak harvest time. Still seasonality of production was found to have influenced price changes for 4 regional markets.

#### **Concluding Remarks**

Following a dynamic model of measuring market integration, this study found that the major Bangladeshi potato and banana wholesale markets, though not segmented, are very poorly integrated with central wholesale market, Dhaka. Except one market for potato, all markets for potato and banana were found to have no integration within the domain of monthly wholesale prices. The overall integration result for banana was found to be poorer than those for potato markets, although seasonality of production influenced regional price changes more in potato than banana. Perishable nature of banana and lack of requisite infrastructure to reduce wastage during transportation might be the underlying reasons for such poorer market integration for banana markets. Seasonality in both the crops were found to be one of the major sources of lack

Table 2 Market Integration for Banana in Bangladesh, 1983-97

Markets	r <sup>a</sup>	F-values for Hypotheses of		$\beta_{10}$	IMC
		Segmented Markets	No seasonality		
Chittagong	0.39	8**	1ns	0.04 <sup>e</sup>	3.33
Pirojpur	0.52	12**	7**	0.11 <sup>d</sup>	4.69
Jessore	0.50	6**	1ns	0.14 <sup>c</sup>	6.13
Khulna	0.39	11**	5**	0.23 <sup>b</sup>	5.55
Rangpur	0.68	7**	6**	0.10 <sup>c</sup>	6.20
Dinajpur	0.44	20**	11**	0.11 <sup>c</sup>	6.52
Bogra	0.82	78**	1ns	0.38 <sup>b</sup>	4.10
Rajshahi	0.57	11**	1ns	0.11 <sup>c</sup>	6.14

\*\* stands for hypotheses rejected at 1% and 5% levels, while ns implies that hypotheses are accepted.

<sup>a</sup> Simple correlation coefficient of monthly wholesale prices between each regional and central market.

<sup>b</sup> Significant at 1% level.

<sup>c</sup> Significant at 5% level.

<sup>d</sup> Significant at 10% level.

<sup>e</sup> Statistically non-significant.

of market integration. Theoretically, regional oversupply gives traders an incentive to move supplies to deficit markets and ensures an integrated system. Apparently, this did not take place in potato and banana marketing in Bangladesh.

#### Notes

- 1) For details see Takayama and Judge (1971)
- 2) The matter has been discussed with examples in Ravallion (1986).
- 3) See Sabur (1990)
- 4) The best known review of Harriss (1979) pinpointed the problems of simple correlation coefficients in measuring market efficiency.
- 5) The point has been eloquently discussed by Heytens (1986).
- 6) So far, three major dynamic models: (i) Ravallion Model (see Ravallion 1986) (ii) Co-integration Model (see Johansen 1988) and (iii) Parity Bound Model (see Baluch 1997) have been applied for investigating market integration. The use of model depended mainly on the spatial market configuration and availability of data. First two models have extensively been used and extended by many researchers (important ones are, for example, Heytens 1986; Timmer 1987; Faminow and Benson 1990; Alexander and Wyeth 1992; Silvapulle and Jayasuria 1994 and Dercon 1995). Parity Bound Model requiring transport cost data besides market price data is yet to be applied by the researchers other than Baluch, who discovered the model and applied in the Philippines rice market.
- 7) Ravallion (1986) first developed the model and applied it to investigate the integration of Bangladeshi rice markets during 1972-75.
- 8) Coefficients of the model introduced by Ravallion (1986) were used by Timmer (1987) to construct an index, known as Index of Market Connection (IMC), which provides an easily understood measure of short-run market integration. Timmer applied it to the corn market of Indonesia. Also Heytens (1986) applied the index quite lucidly to data on gari and yam prices in Nigeria.

- 9) For details of F-test as has been used in this study, see Pindyck and Rubinfeld (1991).
- 10) For harvest seasons of potato and banana, see Bangladesh Bureau of Statistics (1995).

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## バングラデシュにおける青果物市場の統合性

Abdul Latif SARKER, 佐々木 隆

### 要 約

本論文では、今まで詳細な検討がなされてこなかったバングラデシュ青果物市場の統合性と統合の程度を検討した。検討に際しては、放射状の市場構造（中心であるダッカ市場を地方市場が取り巻く形）をもつバングラデシュに良く適合し、市場統合性に関し動態分析が可能な Ravallion モデルを用いた。また、データとしてはポテトとバナナの月別卸売市場価格を用いた。検討の結果、対象とした市場はいずれも中央市場から隔離された状態ではなかったが、ポテトに関する1地方市場を除き、他はすべて中央市場と強い統合性を有してはいなかった。季節性が無いという仮説が、ポテトについては8つの地方市場の内7つで、バナナについては8つの地方市場の内4つで棄却されたことから、生産の季節性が統合性の弱さをもたらす主な原因とみられた。なお総体として、バナナ市場の統合性はポテト市場に比べ弱いものとなっていた。

キーワード：市場の統合性，市場分割，短期的統合性，放射状市場構造，Ravallion モデル，Timmer 指標