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MARKET INTEGRATION AND SEASONAL PRICE VARIATION OF HIGH-VALUE VEGETABLE CROPS IN CHITTAGONG HILL DISTRICTS OF BANGLADESH

Shah Johir Rayhan[1]
Md Jahurul Islam[2+]
Mohammad Mizanul Haque Kazal[3]
M. Kamruzzaman[4]

[1]*Sher-e-Bangla Agricultural University, Associate Professor, Dept. of Management and Finance, Dhaka-1207, Bangladesh.*
Email: sohagag@gmail.com Tel: +88-02-914043
[2]*Master of Science in Agricultural Economics, Bangabandhu Sheikh Mujibur Rahman Agricultural University, Salna, Gazipur-1706, Bangladesh.*
Email: jahurul.bsmrau@gmail.com Tel: +8801715299022
[3]*Professor, Dept. of Development and Poverty Studies, Sher-e-Bangla Agricultural University, Dhaka-1207, Bangladesh.*
Email: mhkazal@gmail.com Tel: +88-02- 44814053
[4]*Professor, Department of Agricultural Economics, Bangabandhu Sheikh Mujibur Rahman Agricultural University, Salna, Gazipur-1706, Bangladesh.*
Email: kzamanau@yahoo.com Tel: +88-02-9205339

(+ Corresponding author)

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ABSTRACT

The present study analyzed the spatial price integration and seasonal price variations of brinjal and yard-long bean in the Chittagong hill districts of Bangladesh. Secondary data were amassed from the Department of Agricultural Marketing (DAM) for the time period of 2006-2015. Correlation coefficient and Engle-Granger (EG) co-integration tests were used as a tool for analyzing price integration among selected district markets. For the estimation of seasonal price variation, ratio to moving average method was adopted for the study. The findings of the study from this observed evaluation of spatial price linkage through correlation coefficients and co-integration among the selected markets of Bangladesh considering the wholesale price of selected vegetables indicated that these markets were well integrated but not strongly integrated. That means the Chittagong market for each commodity was significantly integrated but not significantly highly integrated because of not as much developed transportation system in the hilly areas. The average seasonal variation of price of brinjal was found to be the maximum in the month of October and the minimum in the month of March. The average seasonal price variation of yard long bean was utmost in February and lowest in the month of June. The outcome of the present study could benefit the farmers and market actors monetarily if the production and marketing system of vegetables are well developed.

Contribution/Originality: Since vegetables are inexpensively and socially important, the spatial price integration among the different vegetable market has not been discussed so far and analyzed for the intended study area where enormous prospects of vegetable production are present. This research is one of the very few researches which attempt to explore the potentiality of value addition practices, market integration and price variation of vegetables in CHT's Bangladesh.

1. INTRODUCTION

Vegetables are crucial not only for meeting the human diet but the high value of vegetables also includes the social, cultural, pecuniary and environmental values. However, the current per capita intake of vegetables is only 167 gram per day against a least requisite of 400 gram per day (HIES, 2017) which reflects an impoverished dietary

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status of the people in the country. Currently, our country generates around 4048000 metric tons of vegetables (HIES, 2017). Conversely, due to overabundant supply and nonexistence of suitable marketing and promotional facilities, a huge amount of harvested produce gets dissipated every year.

In terms of both monetary and economic returns, vegetables emerge to be highly competitive compared to rice. Vegetables normally are more expensive to produce per hectare than conventional crops. While staple crops are generally produced using a level of input intensity apposite to the monetary resources available within a household, high-value crops such as vegetables habitually require an intensive input regime, requiring large labor inputs in planting and harvesting that cannot be served with family labor alone. Due to the inconsistency in yields and prices, these high-value crops tend to have higher unpredictability in the case of earning revenue in developing countries.

The vegetable growers in the Chittagong Hill Tracts (CHT's) region will get fair prices of their produces if the agro-processing industry and proper marketing channel can be developed. The agricultural stakeholder and government authority should help to develop a proper marketing channel and value addition activities so that the farmers can sell their produces at fair prices. Vegetable growers count losses every year in CHT's as they often are compelled to sell their crops at lower prices compared with production costs due to lack of poor infrastructure, lack of traders and middleman, lack of variation in consumption patterns. The farmers are losing their interest to cultivate vegetables as they are denied fair prices and turned into tobacco cultivation. If this tradition is going on, it will be very alarming for the environment, soil fertility and human health in the hilly area. Evidently, there is a good scope to increase the income of the poor farmers by value chain and entrepreneurship development through the appropriate use of product diversification and set of a proper marketing channel for vegetables. Promotion of appropriate marketing knowledge, availability of processing materials and set up of small processing plant may increase farmers and entrepreneur's income in the long run.

In Bangladesh, the consumption of vegetables has been increasing swiftly in the current years, as the economy expands and the tendency to diversify the diet increases among the consumers. At the beginning of the 1990s, the idea of crop diversification started to draw an immense interest from economists and policymakers in Bangladesh. There are a number of reasons can be mentioned. First, with the support of inspiring growth and food safety (Islam, 2019) concentration unsurprisingly started to deviate from a constricted focus on wheat and rice production. Second, encountered with a gradual turn down in actual prices of food grains (Dorosh, 2001) concerns as regards continuous revenue generation in Bangladesh's agriculture sector started to surface, which also led to an interest in non-grain crops as the latter tend to offer better chances for revenue generation than grains. For instance, based on the study by Mahmud *et al.* (1994) vegetables leveled among the top high valued crops in Bangladesh. Third, vegetables are essential from the viewpoint of the quality of eating habits. Many nutritionists have emphasized the significance of micro-nutrients in human diets and vegetables are deemed as a fine source of necessary micronutrients. All of these factors have scintillated concentration in the production and marketing of vegetables in Bangladesh and have led to a considerable rise in applied research intended for vegetable crops. These understandings are in turn obligatory for developing and targeting priority research areas. Even though vegetables are economically and socially important, the value chain and market integration for the vegetables have not yet been studied and analyzed for the target study area (Bandarban, Rangamati and Khagrachari district) where the great potential of vegetable production exists. With the above considerations in mind, the present study has been articulated in light of the following objectives as follows:

1. To scrutinize the spatial price integration of selected vegetable in different markets;
2. To unearth the seasonal price disparity of selected vegetables in the different markets of Chittagong.

To corroborate the study, the remaining part of the paper is structured as follows. Section 2 gives an assessment of the interrelated works. This is followed by the materials and methods adopted in the study (Section 3). Then, the estimated outcome and discussion on the finding of the paper has been represented by section 4. Finally, the conclusion and possible policy recommendations are highlighted in section 5 and 6.

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2. REVIEW OF LITERATURE

Several studies had been done relating to value chain analysis, spatial price integration, and seasonal price variation of vegetables.

By using weekly wholesale and retail price data for three years, Mishra and Kumar (2014) examined the spatial integration of the vegetable market in Nepal. The results pointed out that the larger the perishability, the smaller the integration was among wholesale and retail markets of different vegetables. By investigating the short-run price adjustment, it was found that almost all vegetable markets responded on the long-run co-integrating equations while the momentum of price adjustment in the short-run was almost missing. Moreover, it was revealed that the longer the distance between markets, the weaker the integration was.

Akpan *et al.* (2014) examined the dynamics of price transmission and market integration of fresh tomato and pineapple in the rural and urban markets of Akwa Ibom State, Nigeria. The co-integration test uncovered the existence of co-integration between the rural and urban price of fresh tomato and pineapple. The coefficients of market integration in the rural and urban price equation exhibit assorted degrees of long-run market integration. The outcome of the error correction model (ECM) established the presence of the short run market integration between the rural and urban prices of fresh tomato and pineapple in the study area.

Piadozo (2013) examines the competency of vegetable price relations across the markets. Two models were utilized to check for market integration: (1) the Ravallion model, and (2) the co-integration analysis. The result demonstrated that there is market integration between Benguet vegetable trading centers and their end market. The market information system and communication amenities had contributed to vegetable market integration in vegetable trading in Benguet and its market destinations.

Chowdhury (2012) conducted a research to examine the seasonal price disparity and marketing system of brinjal in the chosen area of Bogra district. Marketing cost of brinjal cultivators was Tk.79 per quintal. BCR of brinjal cultivation was estimated at 1.79. Marketing cost was the lowest for *Faria* and net marketing margin was lowest for wholesalers compared to other market actors. The seasonal price variation of brinjal in Bogra market was found to be the highest for both wholesale and retail level in the month of October.

Ghosh (2012) observed that out of the five commodities that we have undertaken for their study, only one, that is, soybean shows the integration between domestic and international prices.

Firdaus and Gunawan (2012) assessed the integration level of local vegetable markets in Indonesia. Engle-Granger test explained that all prices of vegetable at PIKJ integrated with producer's prices, apart from red chili price. Ravallion model demonstrated that integration did not present for all commodities. However, there was no meaningful variation of the market integration performance between the highest and the lowest production area.

Nasrin (2012) in her study found that the outcome of empirical assessment of spatial price linkage through correlation coefficient and co-integration among six local markets specifically Dhaka, Rajshahi, Natore, Pabna and Rangpur of Bangladesh using monthly/annually wholesale prices of potato, cabbage, cauliflower, and brinjal specified these market were well integrated.

Shrestha *et al.* (2010) examined the market price co-integration of tomato and its consequence on Nepalese farmers, using secondary monthly time series of wholesale price data (since 2000 to 2010) of the Government of Nepal. The outcome of the error correction model (ECM) demonstrated that Kathmandu market was well co-integrated with source markets (Chitwan and Morang). Meanwhile, the vector error correction model (VECM) exposed that price regulation process was much quicker in source markets especially in negative price shocks in reaction to Kathmandu market, which influenced the farmers for rapid price adjustment that leads to being impaired and disheartened.

Mukhtar and Javed (2008) use the co-integration and Error-Correction Model (ECM) approach where they experienced long-run spatial market integration between price pairs of maize in four local markets of Pakistan.

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They found that the local markets of maize have well-built price linkages and thus are spatially integrated. Lahore market dictates with price structure in the other three local markets.

Alam and Begum (2007) assessed spatial price integration for crops viz. Aman (HYV), Boro (HYV), wheat, mustard and lentil in selected districts. Results demonstrated that Aman HYV markets were well integrated but the Boro HYV markets were not well integrated. Out of 21 paired markets, only 7 paired markets were integrated for unrefined lentil and 10 paired markets were integrated after processing. Seventeen market pairs are notably correlated during the harvest period of mustard (whole). All the correlation coefficients emerged as significant for mustard oil.

It was exposed from the study of Awal *et al.* (2007) that the variables were co-integrated and there was a stable symmetric relationship between the variables, i.e., the market was spatially integrated.

Ravallion (1986) set up a market integration model which can calculate approximately the degree to which local prices are manipulated by price in the reference market (e.g. Dhaka market for Bangladesh). He utilized his model for rice prices in Bangladesh before and during the 1974 food crisis. His analysis rejected the hypothesis that rice markets are segmented i.e. totally lacking integration but the test on short-run integration of markets was uncertain.

No specific studies were found to have addressed the value chain and market integration issues in the Chittagong Hill Tracts area. So, the present study is an endeavor to explore the integration in the market and seasonal price variation of vegetables in CHT's Bangladesh.

3. MATERIALS AND METHODS

3.1. Data Definition

To fulfill the stated objectives of the present study, secondary data were gathered from the different sources of published materials. For calculating spatial price integration, seven markets namely Chittagong, Bandarban, Khagrachari, Ragamati, Dhaka, Comilla and Feni were taken for this study. Monthly wholesale price comprising time period from 2006 to 2015 were taken into account from DAM report.

3.2. Spatial Price Integration

The fundamental idea behind the extent of market integration is to recognize the interaction among prices in spatially separated markets (Goletti and Babu, 1994). Thus integrated markets are defined as markets in which prices of diverse products do not act autonomously (Monke and Petzal, 1988). More specifically two markets were said spatially integrated, whenever trade takes place between them and if the price differentials for a particular commodity equal the transfer costs involved in moving that commodity between them.

3.3. Seasonal Price Fluctuation

The seasonal pattern was evaluated by the formation of seasonal index numbers. Different methods can be applied for determining the seasonal variation of the prices (Acharya and Agarwal, 1994).

These are -

i. Simple average method
ii. Ratio to trend method
iii. Ratio to moving average method and
iv. Link relative method

Among these four methods, ratio to moving average method was applied in this study. Ratio to moving average method is better to others because this method presents a true seasonal variation.

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3.4. Measurement of the Spatial Integration of the Market by the Correlation Coefficient

In this study 't' test of correlation coefficient was applied to assess the market integration finally. The approach presumes that with random price behavior expected of a non-integrated market, the bi-variate correlation coefficient of price movements will tend to be zero. Conversely, in a perfect integrated market, the correlation coefficient of price movement is expected to be unity.

The simple correlation coefficient for the prices in each pair of designated markets can be estimated by the following formula (Acharya and Agarwal, 1994).

$$r = \frac{n\Sigma xy - (\Sigma x)(\Sigma y)}{\sqrt{n(\Sigma x^2) - (\Sigma x)^2}\sqrt{n(\Sigma y^2) - (\Sigma y)^2}}$$

Where,

r = Simple correlation coefficient.

X= Price of the commodity in the first market at i-the point of time.

Y= Price of the commodity in the second market at i-the point of time.

There is often an issue of spurious correlation between time series variables- where there is an effect of inflationary growth (if it is price variable) or variable showing the same growth for some reason. So other sophisticated methods of evaluating market integration were also built up and used in this study.

3.5. Market Integration by the Co-Integration Method

In the present study, the concept of Co-integration developed by Engle and Granger (1987) has been adopted in testing market integration. Most market prices, whether international or domestic are basically non-stationary. Market integration was calculated by the co-integration method. The majority of econometric theories were based on the premise that the underlying data process is stationary. A stochastic process is considered to be stationary if its mean and variance are constant over time and the covariance value between two phases depends solely on the distance or gap or lag between the two-time phases and not on the real time at which the covariance is calculated (Gujarati, 2003). In actual fact, most economic time series are non-stationary. The application of regression models to non-stationary data may pose the problem of "spurious or nonsense" correlation (Gujarati, 2003). The concept of co-integration was adopted to conquer such problems because it offers a means of identifying and hence avoiding the spurious. The inherent principle of co-integration analysis is that, while the trend of many economic series demonstrates an upward or downward trend over time in a non-stationary manner, a group of variables may drift together. Co-integration test begins with the assumption that it is essential to have the same intertemporal features for a long-run equilibrium relationship to be present between two variables. In this case, a causal relationship can be measured between prices in various spatial markets (Monke and Petzel, 1984; Moodley *et al.*, 2000). Market integration also implies that there is a measurable long-run relationship between spatially separated prices for the same product. Thus, even if prices in the short run temporarily deviate from each other, the differentials, in the long run, should eventually converge. The degree of market integration is indicated by the speed of price convergence.

3.6. Empirical Model

3.6.1. Unit Root and Co-Integration Test

The unit root test is known as the test of stationary (or non-stationary) that has become extensively accepted (Gujarati, 2003). To introduce this test, the easiest way is to consider the following model:

$$Y_t = Y_{t-1} + u_t \qquad (1)$$

Where u_t is the stochastic error term that follows the classical assumption, namely it has zero mean, constant variance σ^2, and is not auto correlated. Such an error term is also recognized as a white noise error term. Equation 1 is a first-order or AR (1) regression in that regress the value of Y at a time (t-1). If the coefficient of Y_{t-1} is, in fact,

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equal to 1, what is identified as the unit root problem i.e., a non-stationary situation. Therefore, if runs the regression,

$$Y = \rho\, Y_{t-1} + u_t; \qquad -1 \leq \rho \leq 1 \qquad (2)$$

And in reality find that $\rho = 1$, then the stochastic variable Y_t has a unit root. In time series econometrics, a time series that has a unit root is known as a random walk (time series) and a random walk is an example of a non-stationary time series (Gujarati, 2003).

For theoretical reasons, the Equation 2 manipulate as follows: Subtract Y_{t-1} from both sides of (2) to obtain

$$Y_t - Y_{t-1} = \rho\, Y_{t-1} - Y_{t-1} + u_t$$

$$\Delta Y_t = (\rho - 1)\, Y_{t-1} + u_t \qquad (3)$$

This is alternatively written as,

$$\Delta Y_t = \delta\, Y_{t-1} + u_t \qquad (4)$$

Where $\delta = (\rho - 1)$ and Δ is the first difference operator. Note that $\Delta Y_t = (Y_t - Y_{t-1})$ therefore, instead of estimating (2) and Equation 3, we test the null hypothesis that $\delta = 0$. If $\delta = 0$, then $\rho = 1$ we have a unit root, meaning the time series under consideration is non-stationary Equation 4.

The individual price series was examined for the order of integration to decide whether or not they are stationary which is known as the unit root test (Gujarati, 2003). In the literature, a number of tests are available for stationary; this includes the Dickey-Fuller (DF) test, the Augmented Dickey-Fuller (ADF) test (Dickey and Fuller, 1979) and the Philips-Perron (PP) test (Phillips, 1986). The Dickey-Fuller test is applied to regressions in the following forms for theoretical and practical purposes:

Y_t is a random walk or without trend:

$$\Delta Y_t = \beta_t + \delta Y_{t-1} + U_t \qquad (5)$$

Y_t is a random walk with trend:

$$\Delta Y_t = \beta_t + \delta\, Y_{t-1} + t + U_t \qquad (6)$$

Y_t is a random walk with drift around a stochastic trend (constant plus trend):

$$\Delta Y_t = \beta_1 + \beta_2 t + \delta\, Y_{t-1} + U_t. \qquad (7)$$

Where t is the time or trend variable.

In each situation the null hypothesis is $\delta = 0 (\rho = 1)$; specifically, there is a unit root in the time series i.e. the series is non-stationary. The alternative hypothesis is that δ is less than zero; that is, the time series is stationary. Under the null hypothesis, the conventionally computed t statistics is known as the τ (tau) statistic, whose critical values have been tabulated by Dickey and Fuller. If the null hypothesis is rejected, it means that Y_t is a stationary time series with zero mean in the case of (1), that Y_t is stationary with a non-zero mean $[= \beta 1/(1 - \rho)]$ in the case of (2), and that Y_t is a stationary around a deterministic trend in Equation 7.

It is tremendously significant to note that for each of the preceding three specifications of the DF test, the critical values of the tau test to test the hypothesis that $\delta = 0$ is different. If the calculated absolute value of the tau statistics (τ) surpasses the DF or MacKinnon critical tau values, we reject the hypothesis that $\delta = 0$, in which situation the time series is stationary. Conversely, if the calculated (τ) does not surpass the critical tau value, we do not reject the null hypothesis, where the time series is non-stationary.

In carrying out the DF test as in Equation 4, 5, or 6, it was presumed that the error term was uncorrelated. But in case they are correlated, Dickey and Fuller have developed a test known as the augmented Dickey-Fuller (ADF) test. This test is conducted by "augmenting" the preceding equation by adding the lagged values of the dependent variable ΔY_t. The ADF test here consists of estimating if the error term is auto correlated, one modifies Equation 8 as follows:

$$\Delta Y_t = \beta_1 + \beta_2 t + \delta\, Y_{t-1} + \alpha_i \sum_{i=1}^{m} \Delta Y_{t-i} + \varepsilon_t \qquad (8)$$

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Where e_t is a pure white noise error term and where, $\Delta Y_{t-1} = (Y_{t-1} - Y_{t-2})$, $\Delta Y_{t-2} = (Y_{t-2} - Y_{t-3})$, etc., that is, one uses lagged difference terms. The number of lagged difference terms to include is often determined empirically, the idea is to include enough terms so that the error term in Equation 8 is serially uncorrelated. The null hypothesis is still that $\delta = 0$ or $\rho = 1$, that is, a unit root exists in Y (i.e., Y is non-stationary).

3.6.2. Spatial Price Relationship

The following co-integration regression was run to check the market integration for each pair of price series:

$$Y_{it} = \alpha_0 + \alpha_1 Y_{jt} + \varepsilon_t \qquad (9)$$

Where, Y_i and Y_j are price series of a particular commodity in two markets i and j, and ε_t is the residual term presumed to be distributed identically and independently. The market integration test is straight forward if Yi and Yj are stationary variables but if the price series proved to be non-stationary then we must carry out another test (Engle-Granger test) to check whether the variables are co-integrated is just another unit root test on the residual in Equation 9. Since the Y_i and Y_j are individually non-stationary, however, the regression may be spurious. In this context, the DF and ADF tests are known as the Engle-Granger (EG) test, the critical values of which was provided by Engle and Granger (1987). The test engaged regression of the first-difference of the residual lagged level and lagged dependent variables (Engle-Granger test) is as follows in the Equation 10:

$$\text{For Engle-Granger (EG) test, } \Delta \varepsilon_t = \beta\, \varepsilon_{t-1} \qquad (10)$$

If the calculated value of 't' of regression coefficient β is greater (in absolute term) than the tabulated value, our result is that the residuals from the regression are I (0), that is they are stationary and the regression is not spurious even though individually two variables are non-stationary.

4. RESULTS AND DISCUSSION

4.1. Spatial Price Integration of Selected Vegetable in Different Markets

4.1.1. Inter-Market Relationship of Selected Vegetables

The degree of interdependence of prices between various districts over the year is estimated by correlation coefficient for monthly prices of selected vegetables from the year 2006 to 2015 and the results of which are presented in the following tables.

4.1.2. Brinjal market

Table 1 presents the paired correlation coefficients for brinjal during the year of 2006-2015. The observation from the correlation coefficients is that brinjal markets are integrated. Most of the paired co-efficient is significant at the 0.01 level, meaning that all the vegetable markets have been well integrated in terms of price movement.

Table-1. Correlation coefficient of nominal monthly wholesale prices of brinjal in selected markets (2006-2015).

Location	Chittagong	Bandarban	Rangamati	Khagrachari	Dhaka	Comilla	Feni
Chittagong	1						
Bandarban	0.722**	1					
Rangamati	0.784**	0.780**	1				
Khagrachari	0.595**	0.677**	0.667**	1			
Dhaka	0.807**	0.658**	0.831**	0.597**	1		
Comilla	0.752**	0.634**	0.806**	0.544**	0.879**	1	
Feni	0.804**	0.726**	0.807**	0.657**	0.841**	0.852**	1

** Correlation is significant at the 0.01 level (2 tailed).
* Correlation is significant at the 0.05 level (2 tailed).

4.1.3. Yard-Long Bean Market

As can be seen from Table 2 that for all pairs of the market, the paired correlation coefficient of prices of yard long bean is high. That is markets are significantly integrated.

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Table-2. The correlation coefficient of nominal monthly wholesale prices of Yard-long Bean in selected markets (2006-2015).

Location	Chittagong	Bandarban	Rangamati	Khagrachari	Dhaka	Comilla	Feni
Chittagong	1						
Bandarban	0.793**	1					
Rangamati	0.694**	0.672**	1				
Khagrachari	0.766**	0.763**	0.828**	1			
Dhaka	0.850**	0.785**	0.695**	0.719**	1		
Comilla	0.810**	0.812**	0.752**	0.802**	0.830**	1	
Feni	0.798**	0.786**	0.763**	0.786**	0.836**	0.878**	1

** Correlation is significant at the 0.01 level (2 tailed).
* Correlation is significant at the 0.05 level (2 tailed).

4.2. Integration by the Co-Integration Method

An intuitive explanation of the main concept of co-integration analysis is that prices move from time to time and their margins are subject to different shocks that derived them apart or not. If in the long run, they demonstrate a linear constant relation, it can be said that they are co-integrated.

4.2.1. Unit Root and Co-Integration Test of Different Vegetables at Wholesale Markets

4.2.1.1. Brinjal Market

In order to test the stationary of the data, the DF and ADF tests for the annual brinjal wholesale price series data for the districts of Chittagong, Bandarban, Rangamati, Khagrachari, Dhaka, Comilla, and Feni were conducted during the 2006-2015 period and the estimated tau (τ) statistics and first differences are presented in Table 3. The tau (τ) statistics compared with absolute values signify that all the brinjal price series data were non-stationary, i.e., contains unit roots.

The set of regression was run once more after differencing all terms. The tau (τ) statistics on the lagged first-difference terms are showing that series are stationary after first differencing. These findings lead to the conclusion that the brinjal prices are stationary after differencing once.

The next step is to observe whether bi-variate co-integration exist among different price series. For this Chittagong brinjal Wholesale market was taken as reference market. As there will be a different combination of the given six wholesale brinjal markets, all combinations in a system of the bi-variate relationship were tried. Thus, a total of six combinations of co-integration regression estimated and the result has been presented in Table 4. The EG test of residual equation corroborated the stationary of the residual series. Thus DF and ADF result of unit root equation indicates that the potato price series are I (1).

EG results of residual equation indicate that residuals series (which are a linear combination of above brinjal price series) are I (0). Thus the findings indicate that the price series being I (1) and their linear combination being I (0) that the series co-integrated without any exception. Since the absolute values of the estimated τ values exceed any of these critical values, the conclusion would be that the estimated u_t is stationary (i.e., it does not have a unit root) and prices are individually non-stationary, are co-integrated.

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Table-3. Unit Root Test (Test of Stationary/Non-stationary) for the prices brinjal.

Market	Method Used	Condition used	Intercept	Coefficient of P_{t-1}	Coefficient of ΔP_{t-1}	Coefficient of (t)	DW Value	Decision
			β_1	δ	α_1	β_2		
Chittagong	DF	Without Constant		-0.069 (-2.034)			2.546	**Non-stationary**
		With Constant	8.403 (5.143)	(-0.419) (-5.610)			2.185	
		With Constant & Trend	6.964 (4.051)	-0.498 (-6.162)		0.050 (2.325)	2.104	
	ADF	1 Lagged Difference with trend	6.363 (3.452)	-0.562 (-5.993)	0.121 (1.296)	0.041 (1.867)	1.921	
Bandarban	DF	Without Constant		(-0.036) (-1.260)			2.630	**Non-stationary**
		With Constant	6.647 (4.493)	(-0.339) (-4.678)			2.261	
		With Constant & Trend	5.699 (3.961)	-0.490 (-6.005)		0.062 (3.496)	2.133	
	ADF	1 Lagged Difference with trend	4.621 (2.855)	-0.560 (-6.045)	0.162 (1.595)	0.053 (2.807)	1.996	
Rangamati	DF	Without Constant		-0.044 (-1.488)			2.455	**Non-stationary**
		With Constant	6.682 (4.461)	-0.322 (-4.729)			2.164	
		With Constant & Trend	5.532 (3.758)	-0.477 (-6.020)		0.070 (3.436)	2.037	
	ADF	1 Lagged Difference with trend	5.335 (3.346)	-0.498 (-5.310)	0.042 (0.434)	0.067 (3.106)	1.986	
Khagrachari	DF	Without Constant		-0.041 (-1.262)			2.245	**Non-stationary**
		With Constant	9.156 (4.333)	-0.381 (-4.541)			1.942	
		With Constant & Trend	7.986 (3.742)	-0.469 (-5.140)		0.071 (2.209)	1.885	
	ADF	1 Lagged Difference with trend	8.810 (3.774)	-0.412 (-3.794)	-0.108 (-0.993)	0.078 (2.340)	2.010	
Dhaka	DF	Without Constant		-0.044 (-1.581)			2.410	**Non-stationary**
		With Constant	8.026 (4.784)	-0.352 (-5.082)			2.106	
		With Constant & Trend	7.276 (4.462)	-0.503 (-6.181)		0.068 (3.233)	1.972	
	ADF	1 Lagged Difference with trend	7.557 (4.252)	-0.500 (-5.297)	-0.013 (-0.134)	0.068 (3.009)	1.984	
Comilla	DF	Without Constant		-0.024 (-1.128)			2.027	**Non-stationary**
		With Constant	5.605 (3.186)	-0.230 (-3.992)			1.859	
		With Constant & Trend	5.119 (3.454)	-0.285 (-4.378)		0.029 (1.759)	1.180	
	ADF	1 Lagged Difference with trend	5.799 (3.722)	-0.196 (-2.097)	-0.128 (-1.374)	0.033 (1.942)	2.006	

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Feni	DF	Without Constant		-0.044 (-1.528)			2.207	**Non-stationary**
		With Constant	4.819 (3.971)	-0.268 (-4.281)			1.999	
		With Constant & Trend	3.747 (3.032)	-0.386 (-5.262)		0.051 (2.870)	1.907	
	ADF	1 Lagged Difference with trend	4.027 (3.099)	-0.340 (-3.638)	-0.074 (-0.792)	0.055 (2.924)	2.021	

Figure in the parentheses show the coefficient of (t).
Dickey-Fuller critical values (τ values).
Source: Authors' Calculation.
- 3.75 and -3.00 at 1% and 5% level of significance respectively without considering the trend.
4.38 and -3.60 at 1% and 5% level of significance respectively considering trend.

Table-4. Co-integration results between Chittagong and other markets for brinjal.

Markets	Co-integration Regression	Co-integration Engle-Granger	Decision
Chittagong-Bandarban	$P_C = 3.688 + 0.847P_B$ $R^2 = 0.521$ (11.332)	$\Delta U_t = -0.702\ U_{t-1}$*** (-7.630)	Co-integrated
Chittagong-Rangamati	$P_C = 3.713 + 0.800P_R$ $R^2 = 0.614$ (13.698)	$\Delta U_t = -0.578\ U_{t-1}$*** (-6.738)	Co-integrated
Chittagong-Khagrachari	$P_C = 5.229 + 0.686P_K$ $R^2 = 0.354$ (8.747)	$\Delta U_t = -0.706\ U_{t-1}$*** (-6.846)	Co-integrated
Chittagong-Dhaka	$P_C = 1.397 + 0.821P_D$ $R^2 = 0.651$ (14.864)	$\Delta U_t = -0.537\ U_{t-1}$*** (-6.579)	Co-integrated
Chittagong-Comilla	$P_C = 1.464 + 0.772P_{Co}$ $R^2 = 0.565$ (12.394)	$\Delta U_t = -0.595\ U_{t-1}$*** (-7.061)	Co-integrated
Chittagong-Feni	$P_C = 4.659 + 0.869P_F$ $R^2 = 0.646$ (14.698)	$\Delta U_t = -0.683\ U_{t-1}$*** (-7.723)	Co-integrated

Figure in the parentheses show t-value of regression coefficient.
Source: Authors' Calculation.
-2.66 and -1.95 at 1% and 5% level of significance respectively without constant in the equation.
*** Significant at 1% level.

4.2.1.2. Yard-Long Bean Market

The finding reveals that all prices are non-stationary at level Table 5. In Table 6, the EG statistics show that all the markets for yard long bean are co-integrated at 1% level of significance. Co-integration tests are conducted on all pairwise possible combinations with the reference market. The co-integration results reject the null hypothesis of no co-integration among reference markets and selected other markets. Hence, the markets are integrated; implying the prediction that one market price with the help of other possible markets. For instance, all the selected markets could be predicted with the help of Chittagong market.

Table-5. Unit Root Test (Test of Stationary/Non-stationary) for the prices yard long bean.

Market	Method Used	Condition used	Intercept	Coefficient of P_{t-1}	Coefficient of ΔP_{t-1}	Coefficient of (t)	DW Value	Decision
			β_1	δ	α_1	β_2		
Chittagong	DF	Without Constant		-0.043 (-1.576)			2.104	**Non-stationary**
		With Constant	8.492 (4.517)	-0.329 (- 4.826)			1.861	
		With Constant & Trend	7.991 (4.490)	-0.538 (-6.424)		0.096 (3902)	1.740	
	ADF	1 Lagged Difference with trend	10.058 (5.363)	-0.418 (-4.594)	-0.271 (-2.960)	0.126 (4.793)	2.007	
Bandar ban	DF	Without Constant		-0.033 (-13.50)			2.272	**Non-station ary**
		With Constant	6.265 (4.112)	-0.268 (-4.352)			2.051	

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		With Constant & Trend	6.508 (4.627)	-0.561 (-6.600)		0.106 (4.634)	1.832	
	ADF	1 Lagged Difference with trend	7.673 (5.052)	-0.485 (-5.240)	-0.190 (-2.011)	0.129 (5.049)	2.066	
Rangamati	DF	Without Constant		-0.021 (-0.960)			2.204	**Non-stationary**
		With Constant	5.868 (3.794)	-0.236 (-3.911)			1.996	
		With Constant & Trend	5.683 (3.790)	-0.382 (-5.223)		0.061 (3.275_	1.889	
	ADF	1 Lagged Difference with trend	6.299 (3.942)	-0.332 (-3.564)	-0.081 (-0.860)	0.064 (3.235)	2.032	
Khagrachari	DF	Without Constant		-0.013 (-0.710)			2.331	**Non-stationary**
		With Constant	5.407 (3.844)	-0.217 (-3.884)			2.138	
		With Constant & Trend	6.868 (5.128)	-0.492 (-6.202)		0.084 (4.568)	1.917	
	ADF	1 Lagged Difference with trend	7.582 (5.111)	-0.453 (-4.859)	-0.088 (-0.948)	0.092 (4.542)	2.009	
Dhaka	DF	Without Constant		-0.031 (-1.313)			1.973	**Non-stationary**
		With Constant	7.309 (4.167)	-0.279 (-4.394)			1.776	
		With Constant & Trend	7.360 (4.444)	-0.490 (-6.073)		0.089 (3.908)	1.666	
	ADF	1 Lagged Difference with trend	9.639 (5.641)	-0.328 (-3.687)	-0.324 (-3.628)	0.120 (5.087)	2.039	
Comilla	DF	Without Constant		-0.025 (-1.109)			1.995	**Non-stationary**
		With Constant	5.971 (3.664)	-0.224 (-3.837)			1.824	
		With Constant & Trend	6.638 (4.437)	-0.528 (-6.454)		0.119 (4.903)	1.672	
	ADF	1 Lagged Difference with trend	8.842 (5.874)	-0.367 (-4.171)	-0.335 (-3.806)	0.157 (6.130)	2.080	
Feni	DF	Without Constant		-0.032 (-1.233)			2.410	**Non-stationary**
		With Constant	7.079 (4.022)	-0.272 (-4.218)			2.147	
		With Constant & Trend	6.892 (4.289)	-0.566 (-6.767)		0.125 (4.946)	1.933	
	ADF	1 Lagged Difference with trend	7.464 (4.270)	-0.533 (-5.716)	-0.068 (-0.730)	0.131 (4.677)	2.024	

Figure in the parentheses show the coefficient of (t).
Dickey-Fuller critical values (τ values).
Source: Authors' Calculation.
-3.75 and -3.00 at 1% and 5% level of significance respectively without considering the trend.
-4.38 and -3.60 at 1% and 5% level of significance respectively considering trend.

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Table-6. Co-integration results between Chittagong and other markets for yard long bean.

Markets	Co-integration Regression	Co-integration Engle-Granger	Decision
Chittagong-Bandarban	$P_C = 5.723 + 0.869P_B$ $R^2 = 0.628$ (14.135)	$\Delta U_t = -0.697\ U_{t-1}^{***}$ (-7.943)	Co-integrated
Chittagong-Rangamati	$P_C = 6.529 + 0.790P_R$ $R^2 = 0.481$ (10.465)	$\Delta U_t = -0.491\ U_{t-1}^{***}$ (-6.079)	Co-integrated
Chittagong-Khagrachari	$P_C = 2.437 + 0.966P_K$ $R^2 = 0.586$ (12.942)	$\Delta U_t = -0.579\ U_{t-1}^{***}$ (-6.825)	Co-integrated
Chittagong-Dhaka	$P_C = 2.544 + 0.893P_D$ $R^2 = 0.722$ (17.546)	$\Delta U_t = -0.476\ U_{t-1}^{***}$ (-6.048)	Co-integrated
Chittagong-Comilla	$P_C = 4.714 + 0.801P_{Co}$ $R^2 = 0.656$ (14.982)	$\Delta U_t = -0.547\ U_{t-1}^{***}$ (-6.565)	Co-integrated
Chittagong-Feni	$P_C = 6.038 + 0.773P_F$ $R^2 = 0.636$ (14.364)	$\Delta U_t = -0.540\ U_{t-1}^{***}$ (-6.373)	Co-integrated

Figure in the parentheses show t-value of the regression coefficient.
Source: Authors' Calculation.
-2.66 and -1.95 at 1% and 5% level of significance respectively without constant in the equation.
*** Significant at 1% level

4.3. Seasonal Price Variation of Selected Vegetables

4.3.1. Seasonal Price Variation of Brinjal during the Year 2006-2015

The monthly wholesale price of brinjal in Bandarban, Rangamati, Khagrachari and Chittagong market during the period from 2006 to 2015 was used for examining seasonal price variation. It is evident from Table 7 and Figure 1 that the seasonal price index of brinjal was the highest (131.21) in Bandarban district in the month of July, 134.88 in Rangamati district in the month of October, 127.54 in Khagrachari district in the month of October, 141.72 in Chittagong district in the month of July and average highest price index 131.51 was found in the month of October i.e. price becomes about 32 percent higher than the average price in this month and the lowest 51.81 in Bandarban, 78.28 Rangamati, 34.92 in Khagrachari, 54.15 in Chittagong district and 53.04 in average in the month of March in all districts i.e. price becomes 47 percent lower than the average price in this month. The important feature of brinjal price was that its prices were more or less the same from February to June. This implies that during this period the supply matched the demand for brinjal. The coefficient of variations (23.52, 22.50, 28.85, 30.33) among the markets are about same that means in that period, price of brinjal in Bandarban, Rangamati, Khagrachari and Chittagong district market were relatively correlated. The seasonal variation in price arises from the poor storage facilities and lack of retention power of the producers in the study areas. Brinjal is one of the most perishable products and it cannot be stored for a long time in open condition without proper storage facilities. So, the brinjal producers and traders want to sell their products as early as possible. When the production of brinjal increased, then the price of brinjal declined.

Table-7. Seasonal price variation of brinjal at the wholesale level for the period of 2006-2015 (Seasonal Indices).

Months	Bandarban	Rangamati	Khagrachari	Chittagong	Average
January	80.75	85.96	77.33	76.22	80.06
February	72.24	78.18	65.16	66.10	70.42
March	51.81	71.28	34.92	54.15	53.04
April	89.16	73.43	96.20	72.46	82.81
May	97.83	83.55	126.28	86.40	98.51
June	102.65	94.45	111.07	103.19	102.84
July	131.21	129.34	119.67	141.72	130.48
August	113.75	108.53	108.79	126.84	114.48
September	114.93	118.64	119.73	136.03	122.33
October	125.70	134.88	127.54	137.93	131.51
November	121.15	123.71	124.82	108.11	119.44
December	98.83	98.07	88.50	90.85	94.06
Highest	131.21	134.88	127.54	141.72	131.51
Lowest	51.81	71.28	34.92	54.15	53.04
Range	79.40	63.60	92.62	87.57	78.47
CV (%)	23.52	22.50	28.85	30.33	24.92
IPR	153.25	89.23	265.23	161.72	147.94

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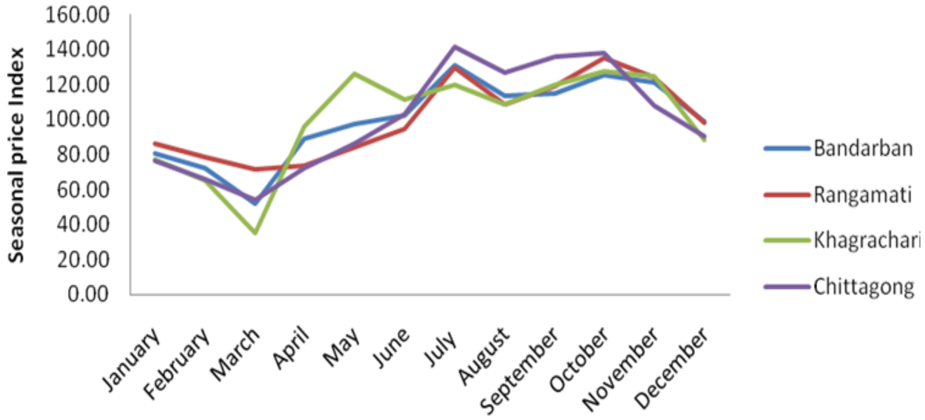

Figure-1. Seasonal price variation of brinjal.

Source: Authors' Calculation (Combining from DAM Website).

4.3.2. Seasonal Price Variation of Yard Long Bean during 2006-2015

The seasonal price index of yard long bean in Bandarban, Rangamati and Khagrachari district has been presented in Table 8 and in Figure 3. It is evident from Table 8 and in Figure 2 that during the period of 2006-2015, the highest price index was 131.65 at Chittagong district in the month of February that means the price of long yard bean in the month of February was 31.65 percent higher than the average price and the lowest was 71.91 in the month of May i.e., price becomes 28.09 percent lower than the average price in this month. The important feature is that from February the price of all markets was declining up to the months of May and thereafter the price of all markets were increasing. The coefficient of variations (11.31, 11.97, 6.86, 18.03) among the markets are about same that means in that period, price of yard long bean in Bandarban, Rangamati, Khagrachari, and Chittagong market district was relatively correlated. Supply of yard long bean comes to an end in January-February especially in February but the demand remains unchanged and also rises. The cause of falling prices of potato in May and June is that the supply of yard long bean was higher (because of harvesting season) than its demand. In this time other summer vegetables become easily available and the price of the potato begins to fall gradually.

Table-8. Seasonal price variation of yard long bean at the wholesale level for the Period of 2006-2015 (Seasonal Indices).

Months	Bandarban	Rangamati	Khagrachari	Chittagong	Average
January	105.82	100.37	99.02	97.13	100.58
February	110.80	111.39	110.03	131.65	115.97
March	106.34	106.51	106.56	117.30	109.18
April	97.46	107.45	97.84	91.76	98.63
May	75.38	86.89	91.54	71.94	81.44
June	78.81	75.35	89.65	73.28	79.27
July	103.04	86.36	95.52	89.15	93.52
August	102.29	100.14	94.28	90.86	96.89
September	104.74	96.02	101.95	100.24	100.74
October	107.06	110.06	110.63	114.27	110.51
November	100.03	115.96	104.27	115.93	109.05
December	108.22	103.50	98.71	106.49	104.23
Highest	110.80	111.39	110.03	131.65	115.97
Lowest	75.38	75.35	89.65	71.94	79.27
Range	35.42	36.04	20.38	59.71	36.70
CV (%)	11.31	11.97	6.86	18.03	11.19
IPR	46.99	47.83	22.73	83.00	68.43

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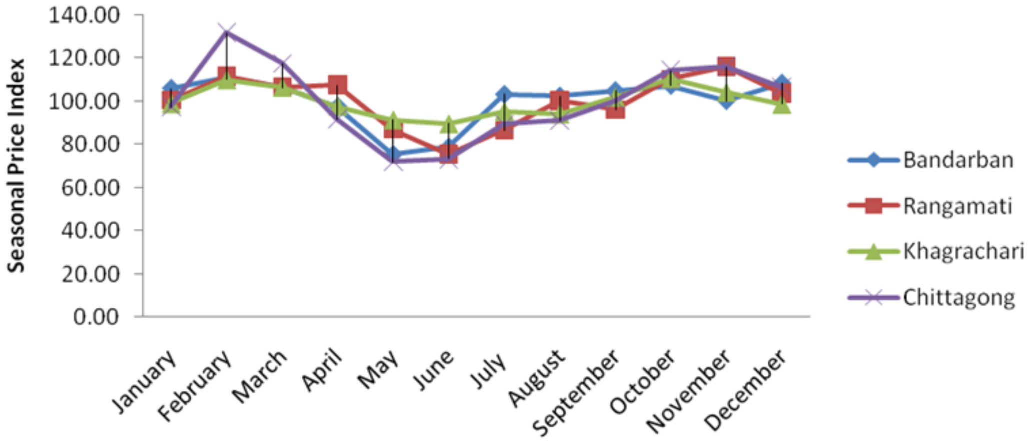

Figure-2. Seasonal price variation of yard long bean.
Source: Authors' Calculation (Combining from DAM Website).

5. CONCLUSION

The outcomes of the empirical assessment of spatial price linkage through correlation coefficients and co-integration among selected markets of Bangladesh using the wholesale price of selected vegetables mentioned that these markets were well integrated but not strongly integrated. That means the Chittagong market for each commodity was significantly integrated but not significantly highly integrated because of less developed carrying system in the hilly areas. The average seasonal price variation of brinjal was the highest in the month of October and the lowest in the month of March. The average seasonal price variation of yard long bean was the highest in the month of February and lowest in the month of June. Based on the overall outcomes of the study, it can be accomplished apparently that substantial scope exists to augment the output of high-value vegetables and to enlarge the value chain. Therefore, the producers and market actors could surely be assisted monetarily if the production and marketing system of vegetables are well managed.

6. RECOMMENDATION

Since the production of this vegetable cultivation is profitable; Government may take the necessary action for expansion of the high-value vegetables in the Chittagong hill districts through awareness programs and training by the Department of Agricultural Extension (DAE). The findings of the study suggested that vegetable wholesale market will be highly integrated with the development of transport and telecommunication facilities, price information in one market to another market to another distance market within a short time. The market infrastructure and transportation facilities are also needed to improve the CHTs for addressing vegetable entrepreneurship development.

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