An Investigation into the Spatial Rice Market Integration in Bangladesh: Application of Vector Error Correction Approach

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Title

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Abstract

Market integration is a metric for market efficiency, notably pricing efficiency. This paper examined the type and degree of market integration in Bangladesh using latest available weekly rice market price data from the six district markets in Bangladesh from January 2014 to December 2018. The findings demonstrated that the wholesale price series of rice are stationary at first difference, but non-stationary at levels. The vector error correction model is then implemented after the Johansen-Juselius approach has been used to examine the co-integrating relationship between the various district markets. The negative and statistically significant coefficients of error correction term for the rice markets in Barishal, Chattogram, and Sylhet districts show that short-run dynamics are convergent with long-term equilibrium. According to the estimated results of the error correction model, there is an equilibrium relationship between the rice markets in Dhaka with rice markets in Barishal, Chattogram, Dinajpur, and Khulna over the long run. In the short run, the calculated co-efficient values, however, indicate that there is only a weak transmission of price changes from one district market to another within the same week.

Keywords

Market Integration

Spatial Price Transmission

Agricultural Trade

Error Correction Model

Bangladeshi Rice Market

Agricultural Market Integration

1. Introduction

Agricultural price policy is significantly influenced by the degree of market integration, which has long been a point of interest for the researchers around the globe. According to Pan and Li (2019), when the price difference of a homogenous commodity across two separated markets is at most equal to the transaction costs of items and information spreading freely between them, the market is perfectly integrated. Understanding market integration, or more precisely, market efficiency, may be significantly assessed by analyzing diverse price correlations (Deb et al., 2020). Spatial market integration is regarded as a key indicator of market efficiency as it can improve resource allocation efficiency, reduce social costs, and enhance social welfare, whereas spatial market fragmentation will have a negative impact on market development, increase society's deadweight loss, and diminish overall economic efficiency (Pan and Li, 2019). A cluster of integrated markets should always be the aim of a unified pricing model.

Governments and academics worldwide have long been interested by the study of market integration. Using an error correction model, Ozturk (2020) investigated whether Turkey's grain market is co-integrated with the global gran market and found that Turkish rice market is not co-integrated with the global rice market. Makbul (2020) et al. used the average monthly rice prices in 33 major cities from January 2014 to December 2017 to study the integration of rice market and supply chain management among Indonesia's main cities. Their study findings indicated that not all Indonesian rice markets are fully integrated. Baquedano & Liefert (2014) examined that if prices in urban consumer markets inside developing nations are co-integrated with respect to the prices in global markets for agricultural commodities by using a single error correction model. The consumer markets of the developing countries were observed to be co-integrated with global markets in their study after an analysis of over 60 country/commodity combinations. In order to identify and explain the characteristics that restrict geographic arbitrage and price equalization within a single nation, Moser et al (2009) investigated the degree of spatial integration of the markets in Madagascar. The findings of the study suggested that markets were reasonably well integrated at the sub-regional level and that constraints impeding integration included high crime rates, remoteness, and a lack of information. Onumah et al. (2022) researched rice price volatility and transmission in Ghana using monthly rice price data from 2013 to 2019 and by applying an error correction model, and thereby found the evidence of co-integration between world and Ghanaian rice market. Svanidze & Götz (2019) applied a threshold vector error correction model approach and discovered that the Russian wheat market was segmented and that high trade costs are impeding Russian market's ability to function as efficient spatial markets. Zhou et al. (2000) analyzed the integration of rice markets in Southern China using the co-integration technique and monthly pricing data. The findings of their study demonstrated a widespread lack of integration among China's rice markets and the main barriers to market integration were determined to be inadequate transportation infrastructure, government actions, and the small amount of grain available for arbitrage. Iregui and Otero (2017) used consumer price index data for 153 items in 13 Colombian cities to analyze the degree of geographical market integration in Colombia. According to their analysis, unprocessed food products tend to experience market integration more frequently than processed foods, other traded goods, and untraded goods.

The degree and type of market integration are especially significant when it comes to localized food markets that are broadly disseminated in location and are located in the developing countries like Bangladesh. There have been a few studies on the rice market integration in Bangladesh, but the findings have been inconsistent. Goletti et al. (1995) conducted a study on the structural determinants of rice market in Bangladesh and opined that the degree of rice market integration is rather moderate. Dawson and Dey (2002) tested the rice market integration in Bangladesh and found perfect integration of rice market in Bangladesh. Hossain and Verbeke (2010) analyzed whether the regional/ divisional rice markets in Bangladesh have become spatially integrated following liberalization of rice market by applying vector error correction approach and using rice price data from six divisional markets over the period of 2004 to 2006. They found that the rice market in Bangladesh during the study period was moderately linked together. Deb et al. (2020) investigated market integration and price transmission along the vertical supply chain of rice in Bangladesh using data from November 2016 to June 2017 and found that the wholesale and retail rice prices are co-integrated in the long run and price were found to be at wholesale levels for both upstream and downstream rice markets.

This article makes a major contribution. This study evaluated whether rice markets in Bangladesh are spatially integrated by using most recent accessible weekly data on wholesale rice prices (from 2014 – 2018) in Bangladesh and that is why latest and rigorous perspective on Bangladesh's rice market integration can be found in this study. According to Goletti et al. (1995), transportation, communication, credit and storage facilities, price stabilization policy, trade restrictions, credit and transportation rules and the level of production of an area may affect market integration. Because some of these factors affecting market integration change over time, so does the degree of market integration, therefore, it is crucial to assess integration using recent data. Due to its use of the most recent weekly data, this study can shed important light on Bangladesh's current spatial integration of its rice market and can provide valuable policy recommendations.

2. Rice Market in Bangladesh

The staple food in Bangladesh, rice, accounts for two-thirds of the country's caloric needs and half of its protein intake (Sayeed & Yunus, 2018). Thus, rice prices and rice consumption are contentious topics in Bangladesh. The climate and topography in Bangladesh are ideal for rice cultivation in Bangladesh. There are three growing seasons for rice such as Aus, Aman, and Boro and all of the Bangladesh's districts are engaged in rice cultivation. Regarding the production volume, Boro is Bangladesh's most significant and dominant crop. Rice is cultivated in small and family farms, and the May-June is the dominant rice-growing season in Bangladesh (Sayeed & Yunus, 2018).

One of the main objectives of the Government of Bangladesh's food strategic plan is to assure sustainable food security for all citizens. Bangladesh's rice market is extensively fragmented, with many rice varieties having their own separate regional and social markets and coming in at noticeably varying costs. In order to support lower income households, the public procurement system runs as a distinct value chain. It often pays premium for paddy rice, which is then given through government programs and approved retailers. Market forces dominate the rice industry in Bangladesh. The rice value chain is, nevertheless, managed at all levels by millers and private traders, where private traders, millers, and wholesalers procure and sell locally produced rice, which contributes to the significant price difference between farm and retail price (Rahman et al., 2020). Over the past 30 years, Bangladesh has made significant strides in the production of rice. Over 48 percent of the rural population in Bangladesh derives their primary income from the rice industry, which accounts for 70 percent of the country's agricultural GDP (Sayeed & Yunus, 2018). According to Yunus et al., (2019), the average annual per-capita consumption rate of rice in Bangladesh is 144.5 kg, making up 67.5 percent of daily calorie intake (FAO, 2021). In 2020–2021, Bangladesh produced and consumed 34.6 and 35.8 million metric tons (MMT) of rice, respectively, making it the third-largest market worldwide (United States Department of Agriculture, 2021).

3. Materials and Methods

3.1. Data and Data Sources

For the purpose of this study, data on weekly wholesale rice prices of six districts in Bangladesh such as Dhaka, Chattogram, Sylhet, Barishal, Khulna and Dinajpur were collected from the Department of Agricultural Marketing, Government of the People's Republic of Bangladesh, between the periods January 2014 to December 2018. Each district had a total of 260 observations. The wholesale rice prices were reported in Tk/kg. Statistical software package E-views was used to conduct all the analysis of this study.

3.2. Model Selection and Specification

For addressing the issues of similar trends and non-stationarity of food prices observed in bivariate price correlation models, time series approaches will be used in this research. The degree of market integration, seasonality, and short-run and long-run integration concerns were all properly studied by using time series approaches (Ravallion, 1986). In estimating market integration, it is required to check if each price series used in the study is stationary or non-stationary. This naturally reduces the likelihood of performing incorrect regression, which lead to result in the selection of optimal model. If the series are I(1), it will be possible to test the null hypothesis that there is no co-integration against the alternate hypothesis of one or r co-integrating vectors by using maximum likelihood procedure established by Johansen (1988). Next, a Vector Error Correction Model (VECM) will be used to detect the degree, speed, pattern of district wise rice price transmission in both the short-run and long-run based on the findings of Johansen's co-integration tests. The appropriate lag length of the variables for the tests will be selected through information criteria such as FPE, AIC, HQIC and SBIC (Brooks, 2008).

3.2.1. Stationarity Test

A time series must be stationary in order to be used in regression analysis, as non-stationary time series might result in illegitimate and spurious associations. A stationary series is one whose mean, variance, and autocorrelation are independent of time, or rather demonstrate stable mean and variance, and have an autocorrelation that is stable across time. Two tests such as Phillips-Perron (PP) test and the Augmented Dickey-Fuller (ADF) test will be used to examine the variables' stationarity. ADF analyzed the alternate hypothesis of stationarity condition against the null hypothesis of non-stationarity, where the stationarity condition in the pertinent series is established by the rejection of null hypothesis. The ADF entails estimating equation (1) as follows:

$$\Delta Y_t = \beta_1 + \beta_2 + \delta y_{t-1} + \sum_{i=1}^{m} \alpha_1 \Delta y_{t-1} + \varepsilon_t \qquad \ldots\ldots\ldots\ldots (1)$$

Here ε_t is a pure white nose term that is independently and identically distributed as a normal distribution with zero mean and constant variance and presumed to be homoscedastic, and Y_t is the relevant price series.

Another test, the PP Test is a non-parametric test to detect serial correlation in the series. According to Ng and Perron (1995), PP test statistic can be seen of as Dickey-Fuller statistics because they have been proven by applying Newey-West (1994) heteroscedasticity to serial correlation and also an estimate of the covariance matrix that is consistent with autocorrelation. The PP statistics have the similar asymptotic distribution as the ADF t-statistic and normalized bias statistics under the null hypothesis that $\delta = 0$. Another benefit of PP over ADF is that, in PP there is no need to define a lag length for the test regression (Ng and Perron, 1995). In order to determine the order of integration, which indicates whether or not price series are integrated of the same order, both ADF and PP test identify the order of difference at which the series becomes stationary. Prior to performing the stationarity test, it is crucial to perform graphical analysis that consists of visualizing data in query on a graph as Gujarati and Sangetha (2010) observed that it is usually good to plot the time series under analysis before continuing the formal unit root test since such plots provide a preliminary indication of the anticipated nature of the time series. It should be noted that before conducting the analysis, all the rice price series have been transformed into the natural logged form.

3.2.2. Co-integration and VECM Framework

The existence of a constant relationship across prices in several locations is the focus of co-integration analysis. Different series are considered to be co-integrated if there is a long run linear link between them (Engle & Granger, 1987). The credibility of the study findings is increased by co-integration, which enables a method of handling time series that prevent incorrect results. Johansen's (1988) method provides a reliable way to examine the long run relationship between stationary pricing variables and also allowed for the testing of various co-integrating vectors. In this approach, to ascertain the quantity of co-integrating vectors in a co-integration regression, it creates test statistic known as the likelihood ratio (LR) test, which is maximum eigenvalue test and trace test. Trace test tests the null hypothesis of r co-integrating vectors, where r = 0, 1, 2….n-1, it is computed as

$$LRtr\left(\frac{r}{n}\right) = -T\sum_{i=r+1}^{n}\log(1-\lambda) \quad \ldots\ldots\ldots (2)$$

The maximum eigen value test tests the Ho of co-integrating vectors against the H_1 of r+I co-integrating vectors for r= 0,1,2,….n-1. This test statistic is computed as:

$$LRmax\left(\frac{r}{n}+1\right) = -Tlog(1-\lambda) \quad \ldots\ldots\ldots (3)$$

Here, n denotes the variables in the system, T represents the sample size and λ shows maximum eigenvalue. Because it explicitly treats all the variables as endogenous and soles the endogenity problem by offering an estimation procedure that does not necessitate the random selection of a variable for normalization, Johansen's approach to co-integration is now widely used to assess the degree of market integration.

The short run characteristics of the co-integrated series have been assessed and price adjustment across rice market is quantified by using a vector error correction model (VECM). Hendy and

Juselius (2000) stated that when variables are stationary at first difference and co-integrated, the application of the VECM is facilitated. In order to quantity how price deviations return to equilibrium, VECM takes into account the possibility that shocks in one market may not immediately affect others or that they may take time to travel. According to Obayelu and Salau (2010), vector error correction model considers all variable to be endogenous, restricts long run behavior to converge to co-integrating relationships, and permits short-run adjustment dynamics.

When X and Y are I(1) and co-integrated in a two variable VAR,

$$\Delta X_t = C_1 + \gamma_1 Z_{t-1} + \beta_1 \Delta X_{t-1} + \cdots + a_1 Y_{t-1} + \cdots + \varepsilon_{xt} \quad \text{.......... (4)}$$

$$\Delta Y = C_2 + \gamma_2 Z_{t-1} + \gamma_1 \Delta X_{t-1} + \cdots + \delta_1 Y_{t-1} + \cdots + \varepsilon_{xt} \quad \text{........... (5)}$$

Here, where ε_{xt} denotes bivariate white noise.

4. Results and Discussion

4.1. Descriptive Statistics

Table 1 presents the descriptive statistics of the data used in the study, line graphs created from the original data for the six selected district markets are shown in Figure 1, while the logarithm of the six rice market price series and their first difference price series are presented in Figures 2 and 3, respectively. From table 1, it has been observed that the mean wholesale price of rice in all the selected districts vary between Tk. 44.38 to Tk. 49.90. Maximum price of rice was observed in Dhaka, while the minimum price was observed in Dinajpur. By analyzing figure 1,2 and 3, it is found that there were some spatial variations between the district markets as well as some seasonal fluctuations.

Table 1: Descriptive Statistics

Districts	Dhaka	Barishal	Chattogram	Dinajpur	Khulna	Sylhet
Mean	49.90	44.38	48.56	45.68	45.50	46.47
Maximum	56.70	51.30	55.40	51.00	52.00	54.20
Minimum	37.80	38.88	42.00	38.00	38.60	39.88
Std. Dev	4.71	2.36	3.52	2.58	2.96	3.33
Observations	260	260	260	260	260	260

Source: Authors' calculation

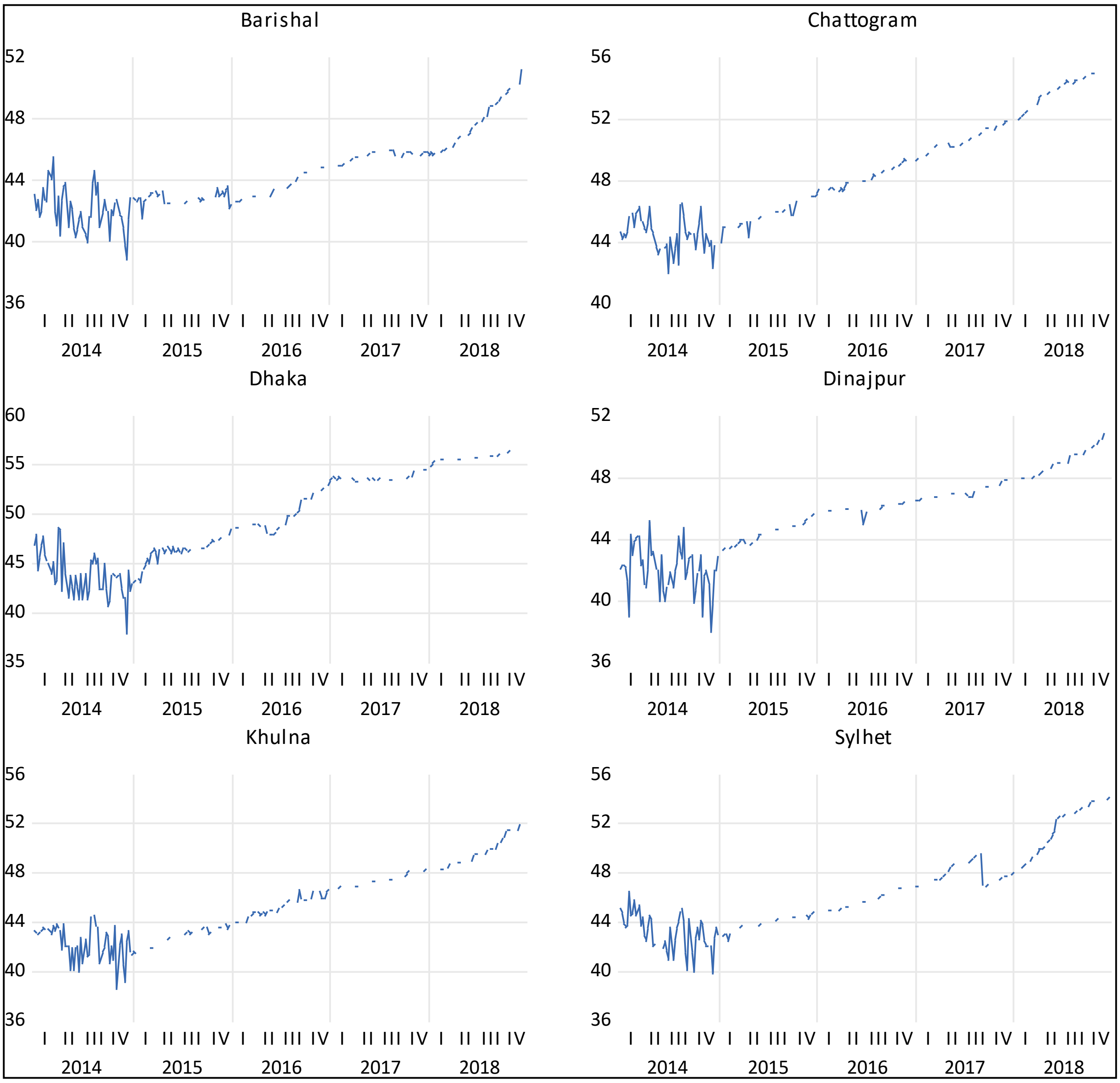

Figure 1: Weekly whole sale rice prices (six districts) in Bangladesh from January 2014 to December 2018, Source: Authors'calculation

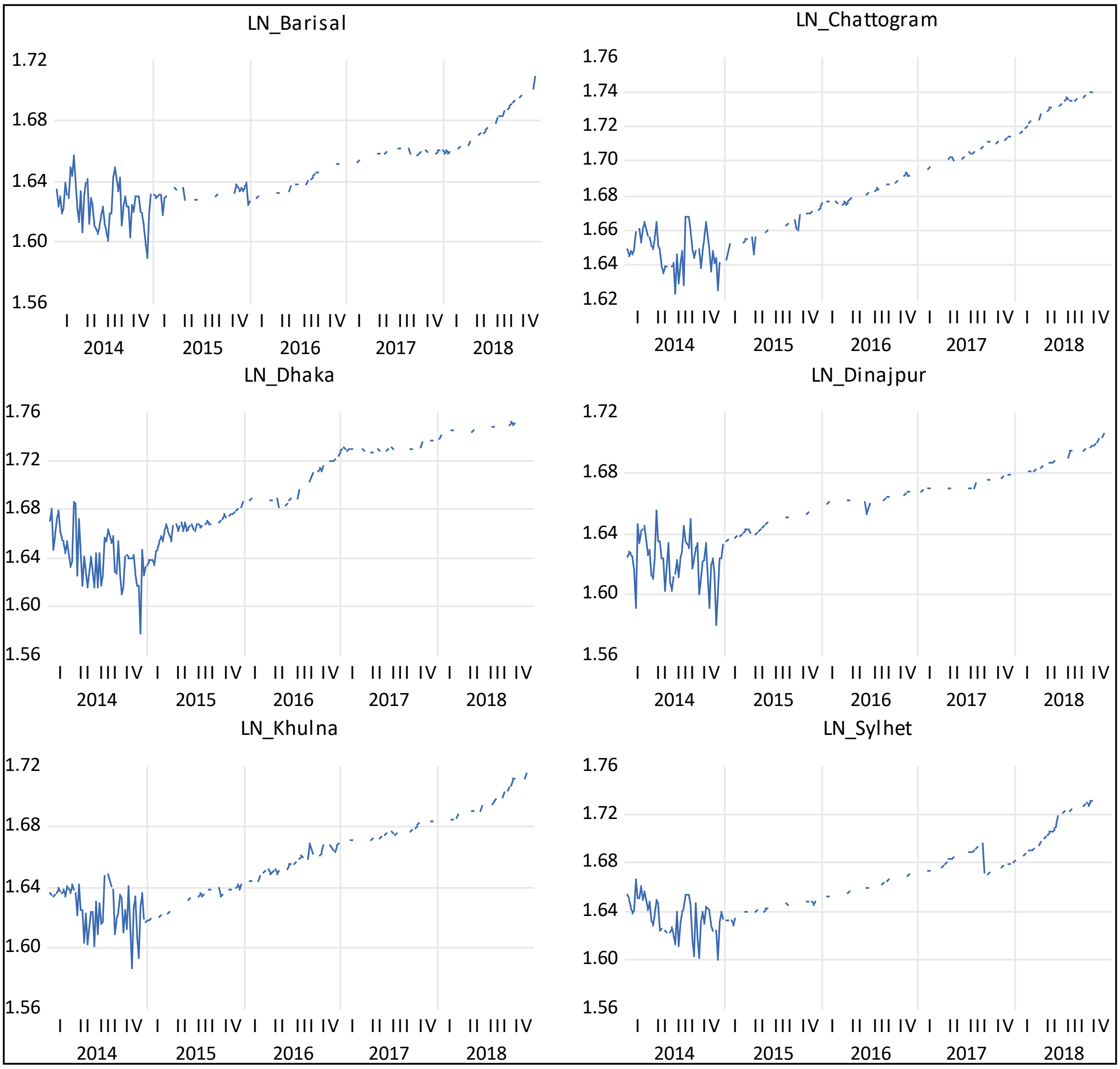

Figure 2: Weekly log wholesale rice prices (six districts) in Bangladesh from January 2014 to December 2018, Source: Authors'calculation

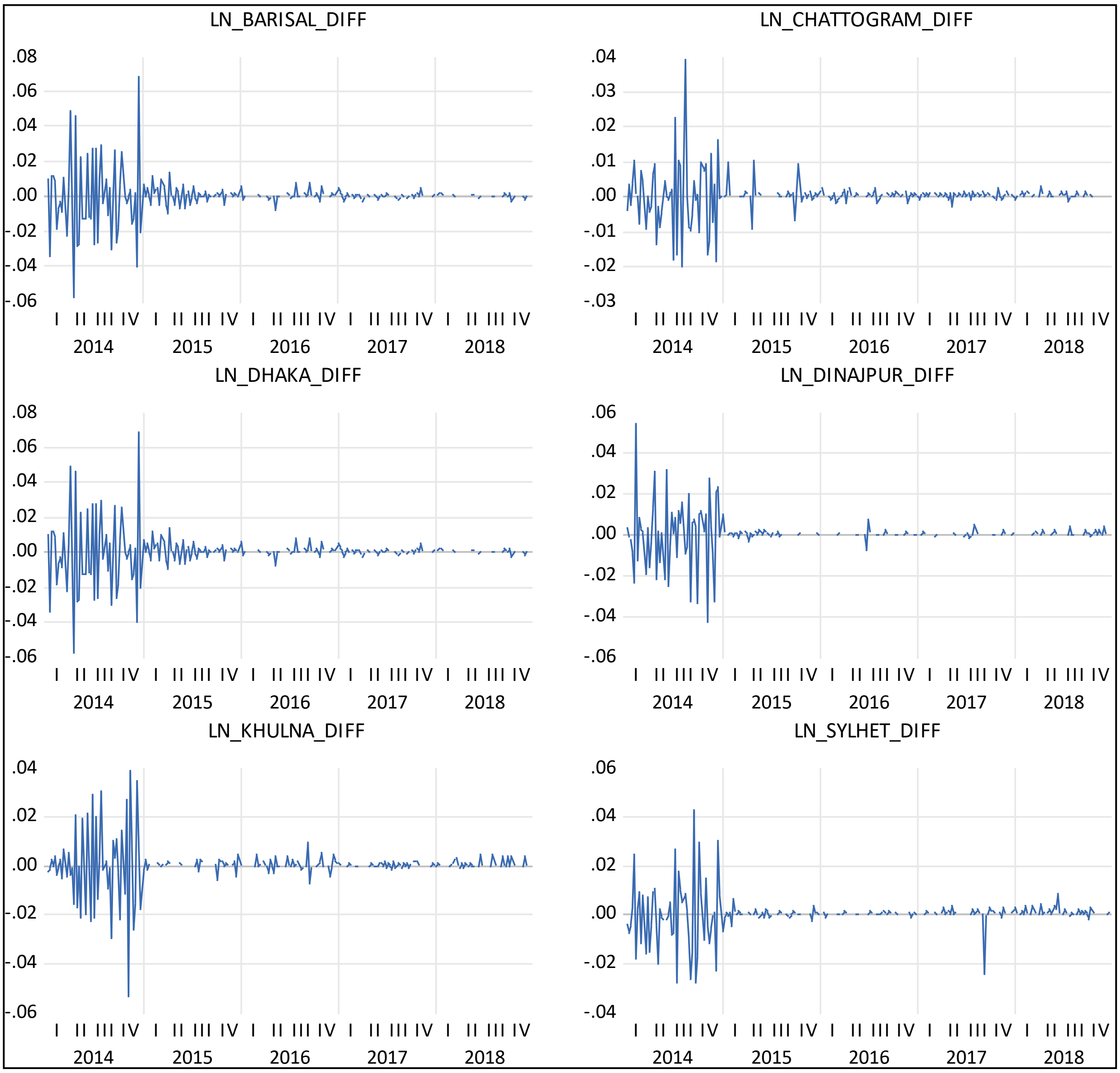

Figure 3: Weekly log wholesale rice prices (six districts) in Bangladesh in First Difference, Source: Authors' calculation

4.2 Unit Root Test Result

Table 2 displays the results of the unit root test using the Augmented Dickey Fuller (ADF) and Phillips-Perron (PP) methods. Each variable underwent these tests between January 2014 and December 2018. The variables are found as non-stationary at levels and, therefore, any attempt to use them will lead to spurious regression. The variables, however, were all stationary at their first difference and integrated at the same level, which is I(1).

Table 2: Result of Unit Root Tests

District	Levels		First Difference		Levels		First Difference	
	ADF	P-value	ADF	P-Value	PP	P-Value	PP	P-Value
Barishal	1.24	0.99	***-10.96	0.00	-1.26	0.64	***-32.97	0.00

Chattogram	0.89	0.99	***-6.42	0.00	-0.18	0.93	***-38.46	0.00
Dhaka	-0.55	0.87	***-19.93	0.00	-0.99	0.75	***-33.80	0.00
Dinajpur	-0.14	0.94	***-5.98	0.00	-1.56	0.50	***-33.29	0.00
Khulna	0.57	0.98	***-15.96	0.00	-0.50	0.88	***-29.55	0.00
Sylhet	0.19	0.97	***-18.20	0.00	-0.34	0.91	***-23.52	0.00

Source: Authors' calculation; Note: * denotes unit root in the first difference is rejected at 1% level of significance**

4.3. Test of Co-integration

Table 3 displays the findings of Johansen and Juselius multivariate co-integration approach. The eigen value test detects two co-integrating equations, while the trace test shows three co-integrating equations. According to Lütkepohl et al. (2001), the power of trace test in some situations superior to that of maximum eigen value test. Also, the higher the number of co-integrating vectors, the stronger the relationship between the variables in the system (Kargbo, 2005). All these indicate the presence of long-run relationship between the variables.

Table 3: Result of the multivariate co-integration rank test

Eigen Value	Trace Test				Maximum Eigen value test			
	Null	Trace Statistic	P-Value	Hypothesized number of cointegrating equations	Null	Max Eigen Statistic	P-value	Hypothesized number of cointegrating equations
0.21	r=0	166.58	0.00	None*	r=0	60.26	0.00	None*
0.15	r≤1	106.32	0.00	At most one*	r=1	41.71	0.01	At most one*
0.08	r≤2	64.61	0.04	At most two*	r=2	23.36	0.39	At most two
0.07	r≤3	41.24	0.07	At most three	r=3	20.37	0.22	At most three
0.04	r≤4	20.87	0.18	At most four	r=4	12.92	0.33	At most four
0.03	r≤5	7.94	0.25	At most five	r=5	7.94	0.25	At most five

Source: Authors' calculation; Note: * denotes rejection of null hypothesis at 1% level of significance

4.4. Vector Error Correction Model

Simply being aware of market integration is insufficient, it is also crucial to understand at what degree the markets are integrated. This necessitates separating the short and long term effects or price variations occurring in one region from those occurring in another. Dynamic adjustments allow researchers to examine the speed to adjustment and the time required for prices to propagate from one market to another. The estimated results of the VECM show that in the long run there exists an equilibrium relationship between Dhaka rice markets with Barishal, Chattogram, Dinajpur and Khulna rice markets (Equation 6 & Table 5).

$ECT_{t-1} =$
$1.00\, DHAKA_{t-1} + 6.28\, BARISHAL_{t-1} + 16.76\, CHATTOGRAM_{t-1} - 5.42\, DINAJPUR_{t-1} - 18.47\, KHULNA_{t-1} - 2.05\, SYLHET_{t-1} + 2.72$ ………………….. (06)

The coefficients of error correction term for Barishal, Chattogram and Sylhet are negative and statistically significant indicating that there is a convergence from short run dynamics towards long run equilibrium (Table 4 and Table 5). The adjustment coefficient is 0.01 for both Barishal, Chattogram and Sylhet towards long run equilibrium in case of disequilibrium situation.

The short run dynamics of chosen variables in the study can be assessed by analyzing the significance and signs of the estimated lagged coefficients (Table 4 and Table 5). The coefficients' values suggest that there is weak transmission of price changes from one district market to another within the same week. In the short run, it is found that all the rice market is dependent significantly on its previous week's rice price. A percent increase in the Dinajpur and Sylhet's rice price is associated with 0.16 percent and 0.14 percent increase in rice price of Barishal. Chattogram's rice price is dependent significantly in the short run on the rice prices of Dhaka, Barishal, Dinajpur and Khulna. In case of Dinajpur, a percent increase in the rice price of Dhaka is linked with the decline rice price of Dinajpur by 13.62 percent. Khulna's rice price is found to be associated with the rice price of Chattaogram and Dinajpur.

Unlike the findings of Dawson and Dey (2002), this study did not find the rice markets in Bangladesh to be perfectly integrated; rather it found that the degree of integration is moderate, which is in line with the findings of Goletti et al. (1995) and Hossain and Verbeke (2010). This suggests that the interconnection between district rice markets in Bangladesh has certain constrains. Because of this, market intervention in one district market does not immediately affect other district markets and thus, national agricultural price policy also may not be sustainable. If the markets are not properly connected, it will have negative impacts on market development, increase deadweight loss of the society, and diminish overall economic efficiency (Pan, F., & Li, C. 2019).

Table 4: Results of VECM (Equations of short run estimates)

Dhaka

$$\Delta LN\_DHAKA_t = -0.007ECT_{t-1} - 0.477\Delta LN\_DHAKA_{t-1} + 0.179\Delta LN\_BARISHAL_{t-1} - 0.158\Delta LN\_CHATTOGRAM_{t-1} + 0.160\Delta LN\_DINAJPUR_{t-1} - 0.135\Delta LN\_KHULNA_{t-1} + 0.107\Delta LN\_SYLHET_{t-1} + 0.000$$

Barishal

$$\Delta LN\_BARISHAL_t = -0.011ECT_{t-1} - 0.038\Delta LN\_DHAKA_{t-1} - 0.353\Delta LN\_BARISHAL_{t-1} - 0.016\Delta LN\_CHATTOGRAM_{t-1} + 0.161\Delta LN\_DINAJPUR_{t-1} - 0.064\Delta LN\_KHULNA_{t-1} + 0.148\Delta LN\_SYLHET_{t-1} + 0.000$$

Chattogram

$$\Delta LN\_CHATTOGRAM_t = -0.013ECT_{t-1} - 0.108\Delta LN\_DHAKA_{t-1} + 0.144\Delta LN\_BARISHAL_{t-1} - 0.295\Delta LN\_CHATTOGRAM_{t-1} + 0.154\Delta LN\_DINAJPUR_{t-1} - 0.217\Delta LN\_KHULNA_{t-1} + 0.060\Delta LN\_SYLHET_{t-1} + 0.000$$

Dinajpur

$$\Delta LN\_DINAJPUR_t = 0.011ECT_{t-1} - 0.136\Delta LN\_DHAKA_{t-1} + 0.024\Delta LN\_BARISHAL_{t-1} - 0.160\Delta LN\_CHATTOGRAM_{t-1} - 0.283\Delta LN\_DINAJPUR_{t-1} + 0.021\Delta LN\_KHULNA_{t-1} + 0.270\Delta LN\_SYLHET_{t-1} + 0.000$$

Khulna

$$\Delta LN\_KHULNA_t = 0.016ECT_{t-1} + 0.001\Delta LN\_DHAKA_{t-1} - 0.055\Delta LN\_BARISHAL_{t-1} - 0.265\Delta LN\_CHATTOGRAM_{t-1} + 0.128\Delta LN\_DINAJPUR_{t-1} - 0.381\Delta LN\_KHULNA_{t-1} + 0.092\Delta LN\_SYLHET_{t-1} + 0.000$$

Sylhet

$$\Delta LN\_DHAKA_t = -0.009ECT_{t-1} - 0.075\Delta LN\_DHAKA_{t-1} + 0.120\Delta LN\_BARISHAL_{t-1} - 0.028\Delta LN\_CHATTOGRAM_{t-1} - 0.048\Delta LN\_KHULNA_{t-1} - 0.270\Delta LN\_SYLHET_{t-1} + 0.000$$

Source: Authors' Calculation

Table 5: Result of VECM (Long-run and short run estimates)

Sample (Adjusted): 1/15/2014 to 12/19/2018
Included observations: 258 after adjustments
Standard errors in ( ) & t-statistics in [ ]

Cointegrating Eq:	CointEq1
LN_DHAKA(-1)	1.00
LN_BARISHAL(-1)	**6.284327
	(2.207760)
	[2.84668]
LN_CHATTOGRAM (-1)	**16.76057
	(2.26182)
	[7.41022]
LN_DINAJPUR(-1)	**-5.419865
	(1.50983)
	[-3.58971]
LN_KHULNA (-1)	**-18.46901
	(2.08718)
	[-8.84879]
LN_SYLHET	**-2.051647
	(2.04618)
	[-1.00267]
C	2.725127

Error Correction	D(LN_DHK)	D(LN_BARISAL)	D(LN_CHTG)	D(LN_DINAJ)	D(LN_KHULNA)	D(LN_SYLHET)
CointEq1	-0.006867	**-0.010899	**-0.013302	**0.010763	**0.016269	**-0.008955
	(0.00570)	(0.00362)	(0.00238)	(0.00440)	(0.00394)	(0.00392)
	[-1.20460]	[-3.00796]	[-5.58929]	[2.44367]	[4.12566]	[-2.28610]
D(LN_DHAKA(-1))	**-0.476518	-0.038050	**-0.108034	**-0.136234	0.001042	-0.074885
	(0.06739)	(0.04284)	(0.02814)	(0.05207)	(0.04662)	(0.04633)

	[-7.07099]	[-0.88825]	[-3.83980]	[-2.61645]	[0.02234]	[-1.61632]
D(LN_BARISAL(-1))	0.179329	**-0.352892	**0.144411	0.023877	-0.054882	0.120859
	(0.10016)	(0.06366)	(0.04181)	(0.07738)	(0.06929)	(0.06886)
	[1.79049]	[-5.54306]	[3.45359]	[0.30855]	[-0.79212]	[1.75524]
D(LN_CHATTOGRAM(-1))	-0.158208	-0.015630	**-0.295235	-0.159962	**-0.265177	-0.027743
	(0.14399)	(0.09153)	(0.06012)	(0.11126)	(0.09961)	(0.09899)
	[-1.09871]	[-0.17077]	[-4.91100]	[-1.43779]	[-2.66211]	[-0.28025]
D(LN_DINAJPUR(-1))	0.159940	**0.160651	**0.154533	**-0.283230	**0.128468	0.052737
	(0.09126)	(0.05801)	(0.03810)	(0.07051)	(0.06313)	(0.06274)
	[1.75255]	[2.76940]	[4.05587]	[-4.01679]	[2.03493]	[0.84056]
D(LN_KHULNA(-1))	-0.135378	-0.063646	**-0.216560	0.021335	**-0.381388	-0.047407
	(0.11079)	(0.07042)	(0.04625)	(0.08560)	(0.07664)	(0.07616)
	[-1.22198]	[-0.90381]	[-4.68212]	[0.24925]	[-4.97647]	[-0.62244]
D(LN_SYLHET(-1))	0.106822	**0.148326	0.059650	**0.269903	0.092041	**-0.270227
	(0.10885)	(0.06919)	(0.04544)	(0.08410)	(0.07530)	(0.07483)
	[0.98136]	[2.14373]	[1.31258]	[3.20921]	[1.222321]	[-3.61103]
C	0.000398	0.000373	0.000481	0.000407	0.000477	0.000405
	(0.00060)	(0.00038)	(0.00025)	(0.00046)	(0.00042)	(0.00042)
	[0.662671]	[0.97530]	[1.31258]	[0.87644]	[1.14707]	[0.97924]
R-Squared	0.226887	0.197397	0.373531	0.211551	0.328408	0.131498
Adj. R-squared	0.205239	0.174925	0.355990	0.189475	0.309604	0.107180
Sum sq. resids	0.023156	0.009358	0.004036	0.013824	0.011081	0.010945
S.E. equation	0.009624	0.006118	0.004018	0.007436	0.006658	0.006616
F-statistic	10.48112	8.783807	21.29457	9.582623	17.46429	5.407405
Log likelihood	835.9942	952.9892	1061.352	902.5443	931.0673	932.6700
Akaike AIC	-6.418559	7.324792	-8.165522	-6.934452	-7.155561	-7.167985
Schwarz SC	-6.308390	7.214623	-8.055353	-6.824283	-7.045392	7.057815
Mean dependent	0.000282	0.000330	0.000382	0.000309	0.000317	0.000326
S.D. dependent 0.010796		0.006735	0.005007	0.008260	0.0008013	0.007002

Determinant resid Covariance (d of adj.)	1.53E-27
Determinant resid Covariance	1.27E-27
Log Likelihood	5792.779
Akaike information criterion	44.48666
Schwarz criterion	43.74301
Number of coefficients	54

Source: Authors' calculation, Note: ** denotes 5% level of significance

5. Conclusion

The term 'spatial market integration' describes how prices move together and, more broadly, how information and price signals are smoothly transmitted between markets that are geographically separated. Understanding the mechanisms of market improvement and determining whether there are any markets inefficiencies that can necessitate the intervention of the state can both be learned through the study of market integration. The efficacy of policies like market liberalization or price stabilization depends on an understanding of market integration since it provides a more thorough view of the process of transmitting incentives across the market chain. Taking into account all these benefits of the analysis of the market integration, this study examined the type and degree of market integration in Bangladesh by using latest available weekly wholesale rice price data from six regional districts of Bangladesh. The results showed that the wholesale price series of rice are stationary at first difference but non-stationary at levels, which required the adoption of an error correction model. The coefficients of error correction term for Barishal, Chattogram and Sylhet are found negative and statistically significant indicating that there is a convergence from short run dynamics towards long run equilibrium. The projected outcomes of the error correction model demonstrate that, over the long term, the rice markets in Dhaka and Barishal, Chattogram, Dinajpur, and Khulna are in equilibrium with one another. On the other hand, in the short run, the estimated co-efficient values indicate that there exists weak transformation of price changes from one district market to another within the same week. On the basic of the study findings, this study believes that inadequate infrastructure and limited transportation networks impedes flow of price change from one district market to another in the short run. Hence, this study recommends that the government should invest in improving transportation, information delivery and infrastructure facilities in order to better integrate district rice markets in Bangladesh.

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