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Research Note

PRICE INTEGRATION IN POTATO MARKETS OF BANGLADESH

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ABSTRACT

The paper examined the pricing efficiency of potato markets in Bangladesh using Engle-Granger test (EG), Cointegration Regression for Durbin Watson (CRDW) test and Error Correction Methods (ECM). For the test of pricing efficiency of potato markets, the wholesale prices were used to test cointegration using data from January 1993 to December 2005 yielding a total of 676 observations. Engle-Granger test was used to estimate the integration among the potato markets in Bangladesh. In the cointegrating set *up,* error correction method estimated the long-run relationship between reference markets (Dhaka) and selected markets. The cointegration regression for Durbin Watson test revealed that the wholesales potato markets in Bangladesh were integrated

1. INTRODUCTION

In a competitive market with free flow of information, the price difference between any two regions (or markets) will be equal to or less than transport costs between the two markets. A perfect competitive, is characterized by a large number of buyers and sellers, perfect knowledge about market conditions (prices) homogeneity of product, and free mobility of sellers and products. Thus a single price will prevail in all markets. Price differential for a particular commodity arising from place, time and form differences would correspond closely to the costs incurred in providing the respective transportation storage and processing facilities. The market will perform efficiently and there will be no scope for traders to make excessive profits. The pricing system would facilitate exchange and fully reflect the underlying supply and demand conditions.

However imperfections in the market, particularly, those arising from activities of traders are generally taken as important causes for the existence of differential price movements in different markets. It is believed that prices quoted are a reflection of the conditions prevalent in the markets. Therefore, if there are imperfections in the form of either oligopoly power among buyers (example, basing-point pricing system) or unequal information among sellers, then it is expected that buyers will be able to reap abnormal returns and subsequently, wide intra-regional price differentials exist in the market.

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There are basically two approaches to investigate the issue of competitiveness in a market. The first is to establish whether the structure of the market tends to conform to the general criteria for a competitive market. The second is to determine whether price movements reflect a state of competitiveness in the market. In this paper we employed the second approach to test for market integration.

The usual definition in the literature is that integrated markets are those where prices are determined interdependently. This has generally been assumed to mean that the price changes in one market will be fully transmitted to the other markets. Markets that are not integrated may convey inaccurate price information that might distort marketing decisions and contribute to inefficient product movements.

The recent advances in the time-series econometrics especially those related to cointegration and error correction methods have led to an explosion in the literature on testing for market integration in many countries including Bangladesh[see, for example, Asche *et al.* 1999, Ismet *et* a1.1998, Baulch,1997, Goletti *et* a1.1995, Dercon,1995, Alexander and Wyeth,1994, Dahlgram and Blank,1992, Goodwin and Schroeder,1991, Faminow and B enson,1990.

One-to-one correlation analysis (Lele, 1971; Blyn, 1973; Thakur,1974) and regression models that analyze the dynamic price adjustment patterns (Ravallion, 1986; Heytens,1986), and lead-lag relationship (Gupta and Mucller, 1982)].. However, Ardeni (1989) argued that these approaches ignore the time-series properties of price data and the results obtained may be biased and inconsistent. More importantly the results tend more often to reject the null hypothesis of market integration indicating that the markets are not efficient although these markets appear to operate competitively.

However, very little has been done in the way of empirically evaluating market integration in Bangladesh with the help of the recently developed cointegration techniques. The most common methodology used in the past for testing market integration involves estimation of bivariate correlation coefficient between price change in different markets[see, for example, Cummings, 1967, Lele, 1967& 1971. This method, despite its simplicity, came under strong criticisms from Blyn,1973, Harriss ,1979, Heytens,1986 and Ravallion,1986,1987.

The studies based on bivariate correlation were found to have involved methodological flaws, the most serious one seems to have occurred due to their failure to recognised the possibility of spurious integration in the presence of common exogenous trends (e.g. general inflation), common periodicity (e.g. agricultural seasonality) or autocorrelated and heteroscedastic residuals in the regression with non-stationary price data [for details , see Barrett(1966) and Palaskas and Harriss-White(1993), hereafter PHW].

In the mid-1980s several attempts were made to improve upon earlier methods. The most significant contribution to market integration method came from Ravallion (1986). In order to test alternative hypothesis of market integration, he proposed a dynamic model of spatial price differentials. Although this method mitigates the major methodological limitations of the bivariate correlation method, it still involves serious problems that results in inefficient estimators, which are used for testing alternative hypotheses of market integration and segmentation (see PHW, 1993). To avoid these problems. PHW proposed a new method based on Engle and Granger (1987) cointegration test for evaluating market integration. Applying this method to the weekly price data relating to three agricultural commodities (viz., rice, potato and mustard) for the period from November 1988(1) to August 1990(5) collected from three market places in Burdwan distri ct of West Bengal, they observed that the prices of the central and the peripheral markets are for most of the pairs cointegrated. a relatively less restrictive approach to market integration has been to employ cointegration and error correction techniques Alexander and Wyeth (1987). If prices in two different markets bear a long term relationship, the prices are said to cointegrated and the markets integrated. Thus, price cointegration implies market integration. The cointegration approach to market integration has been considered is an alternative to the Ravallion model.

Market Integration

The present paper empirically evaluates market integration of potato markets in Bangladesh. In order to do this it is necessary to compare market prices of potato in one market with prices of comparable varieties of potato in the reference market (Dhaka markets). Cointegration tests were applied to spatial price relationship among selected potato markets. We intend to show that the selected potato markets in Bangladesh are closely interrelated, that is price formation in one market is fully reflected in the prices of other markets. In other words, in Bangladesh potato prices do not diverge and the markets are fully integrated.

In this study, we employed alternative procedure to test spatial market linkages that is a methodology recently developed by Granger (1986) and Engle and Granger (1987 a and b). In short if markets are efficient then prices in different markets must be cointegrated.

II. METHODOLOGY

Co-integration Methodology

The fundamental insight of co-integration analysis is that although many economic time series may tend to trend upwards or downwards over time in a non-stationary fashion, groups of variables may drift together. If there is a tendency for some linear relationship to hold between a set of variable over a long period of time, then such relationships are identified with the help of co-integration technique.

Cointegration tests begin with premise that for a long run equilibrium relationship to exist between two price or any other variables, it is necessary that they have the same inter temporal characteristics. The first steps, therefore, requires testing the stationarity of the variables.Integration tests are prerequisite for co-integration. To determine the order of integration, one should note that a time series (P_t) is stationary if the joint distribution of (P_t) and P_{t+T} is independent of time (t), though it does not depend on the lag (the length of which is designated by 'T'). A series, with constant mean and variance is said to be stationary. There is also a weaker definition of stationarity. 'P_t' is second order or 'weak' stationary, If the expectation of P_t is a finite constant; the variance is constant and finite; and the co-variance depends only on T. Consequently, against time, it will fluctuate around a constant mean and the amplitude of fluctuations will not vary with time.

Stationarity is an important aspect of time series analysis. Without stationarity, serious errors can be committed indrawing inferences from time series data. Note that this problem is one of testing and not of estimation. Any series, which grows over time, is non-stationary, since its mean is growing over time, regardless of the behaviour of its variance. Most of the macro-economic variables are trended and therefore, tend to be non-stationary, which can have profound implications. For example, if a structural, like real output, is truly mean and variance non-stationary, shock to that will have permanent real effects. One way of guaranteeing that P_t is stationary is to say that it is integrated of order zero (denoted P_t ~I(0)). More generally it can be said that P_t is integrated of order n (usually written P_t ~I(n) or ΔP_t ~I(0) . The Box-Jenkins methodology repeatedly differences the series to get the series stationary. If the new series, constructed by first difference of the original series, does not look stationary, then the first difference series is differenced again. If the first difference of a series is stationary , the series is said to be integrated of order one i.e. P_t ~I(1).

In this paper we applied, a newly developed test of the market integration. The test of market integration is straightforward if the prices of different markets are stationary. The stationarity of the variables are examined using unit root test. To test the null hypothesis of non-stationarity against an alternative of stationarity, we have applied both Dickey–Fuller (DF) and Augmented Dickey-Fuller (ADF) test. After examining the non-stationarity of price series, we test the market integration using the co-integration analysis. While co-integration is a necessary condition for market integration, it is not sufficient for two reasons. First, the co-integration vector must be equal to 1.0, second, the hypothesis of full market integration requires an error term to be white noise, while cointegration requires the error to be stationary. The definition of cointegration used here is that of Engle and Granger (1987).

To test the unvariate price series for stationarity, Dickey-Fuller(DF) and the Augmented Dickey-Fuller(ADF) test has been applied, which tests the null hypothesis of non- stationarity against an alternative of stationarity. The standard equation of the DF and ADF test are :

$$\Delta P_t = \beta_0 + \beta_1 t + \delta_k P_{t-1} + \mu_t \quad \text{---} \quad (1)$$

and

$$\Delta P_t = \beta_0 + \beta_1 t + \beta_2 P_{t-1} + \sum_{k=1}^{N} \delta_{k\Delta P_{t-k}+\eta_t} \quad \text{---} \quad (2)$$

Where $\Delta P_t = P_t - P_{t-1}$, the most statistic is simply the t-statistic, however, under the null hypothesis it is not distributed as student-t, but this ratio can be compared with critical values tabulated in Fuller (1976). In estimating Equation (1) and (2), the null hypothesis is H_0: P_t is I (1), which is rejected (in favour of I (0)) if β_1 is found to be negative and statistically significant. The above test can also carried out for the first-difference of the variables.

In this case, we estimate the following regression equation:

$$\Delta^2 P_t = \theta_0 + \theta_1 \Delta P_{t-1} + \sum_{k=1}^{N} \phi_k \Delta^2 P_{t-k} + \mu_t \quad \text{---} \quad (3)$$

where the null hypothesis is H_0: P_t is I(2) which is rejected (in favour of I(1)) if $б_1$ is found to be negative and statistically significant. In general a series P_t is said to be integrated of order d, if the time series achieves stationary after differencing d times , denote P_t ~I(d). Consequently if P_t is stationary after differencing once then we may denote P_t ~I(1) and ΔP_t ~I(0). However, in most applied work the procedure is terminated after the first or second differences. As a matter of fact, Nelson and Plosser (1982) have indicated that most macro economic variables are I(1) processes, that is, the variables achieved stationary after differencing once.

After identifying the time series properties (i.e. the order of integration) of individual price series, the next step is to test for cointegration between them. It is already pointed out that when two series are cointegrated, they are tied together in some way even though they are trending. The theory of cointegration is based on the idea that although two time series, say P_{it} and P_{jt} are integrated (non-stationary), their difference or some other linear combination of them stationary between the two price series after transient effects from all other factors such as local characteristics, have disappeared.

To see whether two variable are cointegrated, the Engle-Granger 'two-step' procedure is followed [*Engle and Granger,1987*]. The first step involved cointegration of the two time series say P_{it} and P_{jt} which are of the same order of integration , say I(1) and there is some linear combination of them which is I(0). This is called cointegration of order (1,1) and in this case, the cointegrating vector is the vector of coefficients of a linear combination of the series, which is stationary.

The relationship between two markets price, the following regression model considered:

$$P_{it} = \alpha_0 + \alpha_1 P_{jt} + \varepsilon_t \text{ --- (5)}$$

Where P_i and P_j are prices series of a specific commodity in two markets i and j, ϵ is the deviation from equilibrium and this equilibrium error in the long run tends to zero (i.e.its mean is zero with finite variance). This equilibrium error of the cointegration equation has to be stationary for cointegration between integrated variables to hold good. Parameter α_0 and α_1 will represent domestic transportation costs, processing cost, sales taxes, etc and cointegrating coefficient. The test of market integration is straightforward if P_i *and* P_j are stationary variables. Often, however, economic variables are non-stationary in which case the conventional tests are biased towards rejecting the null hypothesis. Thus before proceeding to further analysis, it is important to check for the stationary of the variables (Granger and Newbold, 1977).

Stationary series is defined as one whose parameters that describe the series (namely, the mean, variance and autocorrelation) are independent of time or rather exhibit constant mean and variance and have autocorrelation that are invariant through time. Once the non-stationary status of the variables is determined, the next step is to test for the presence of cointegrating (long-run equilibrium) relationships between the variables.

Having established that the variables are non-stationary in level, we may then test for cointegration. Only variables that are of the same order of integration may constitute a potential relationship. The definition of cointegration used here is that of Engle and Granger

(1987 a&b) and is defined as follows. Consider a pair of variables P_i and P_j, each of which is integrated of order d. Their linear combination that is,

$$\varepsilon_t = P_{it} - \alpha P_{jt} \quad \text{------} \quad (6)$$

will generally be I(d). However if there is a constant α such that ε is I(d-b), where b>0, then Pj and P_j are said to be co integrated of order d,b and the vector (I,- α) is called the co-integrating regression. The relation $P_i = \alpha P_j$ may be considered as long run or equilibrium relation (Engle and Granger,1987 a,b) and ε is the deviation from the long run equilibrium. When P_i and P_j are co-integrated, the long run relationship $Pj - \alpha P_i = 0$ will tend to be re-established after a stochastic shock. Thus while the individual price series may be characterized by dominant long swing or wander aimlessly, their difference rarely drift from some equilibrium level, that is they move together in the long run. However deviation from the longrun relationship may occur because of delivery lags and other impediments to regional trade.

Nevertheless before we proceed to test for market integration using the approach of cointegration analysis we need to determine the nature of integration of the definition of cointegration used here is that of Engle and Granger (1987). Before proceeding to test for market integration using the cointegration analysis , the nature of integration of the variable needs to be determined (for a discussion on this aspect , see Granger,1986, pp,262-264). According to Granger (1986) a model specified by equation (1) does not make sense unless P_i and P_j are of the same order of integration. Thus a necessary condition for P_i and P_j to be co-integrated is that they must be integrated of the same order. Testing whether the variables are co-integrated is merely another unit root test on the residual in equation (1). The test involved regressing the first-difference of the residual series on residual lagged level and lagged dependent variables is as follows:

$$\Delta\varepsilon_t = \gamma_1\varepsilon_{t-1} + \sum_{k=1}^{m} \varphi_{k\,\Delta\varepsilon_{t-k}+v_t} \quad \text{------} \quad (7)$$

Again the test statistic is the t-statistic of γ_1. The critical values are tabulated in Fuller (1976). The null hypothesis is H_0: P_i and P_j are not co-integrated. The null hypothesis is rejected if estimated γ_1 is negative and found to be significantly different from zero.

The second step involves the dynamic error-correction representation of the cointegrated variable. If two variables are integrated of the same order and thus can be cointegrated, then according to Engle and Granger two step procedure, there exists an error-correction representation of the variable where the error corrects the long run equilibrium. This is also known as Granger Representation Theorem[*Engle and Granger,1987, Banerjee et. al.,1993*]

Now, suppose two variables, x and y (say,) both are I(1) and also cointegrated in the long-run, in this case , we should apply an error correction model (ECM) for x and y as:

$$\Delta\, y_t = \alpha + \beta\Delta X_t + \delta e_{t-1} + u_t \quad \text{------} \quad (8)$$

where Δy and ΔX are first difference of the variable (y and x) respectively, e_{t-1} is the error, which occurs one period lag, and u_t is the disturbance term. If the coefficient of the error-correction term δ , is found to be statistically significant, it implies that there is disequilibrium in the long run relationship. This approach has, so far, been the standard practice in the cointegration literature. More recently, however, some economists have criticized this two step procedure. For example, Banarjee *et al.* (1986) note that the inclusion of an error correction term in the ECM model impose restriction on the coefficients. He finds serious problems of bias in the estimates of coefficients and suggests estimation of an unrestricted ECM model with lagged level variables from the cointegration equation as regressors. Mehra (1991) contends that the error-term in the cointegrating equation could be serially correlated or heteroschedasticity rendering the standard test of statistics invalid. He suggests an alternative method of estimating a combined cointegration and error-correction model instead of estimating long run (cointegrating equation) and short run (error-correction) model separately in two different stages. Mehra imposes the restriction that the estimate of long run elasticity derived from the sum of the coefficients from short run part of the model should be equal to the estimate of elasticity from the long run part of the model. In our estimation we do not impose any such restrictions and therefore our estimation procedure is similar to the unrestricted ECM estimated by Carruth and Schnabel(1990).

A part from using ADF as a test for cointegration Engle and Granger (1987 a and b) the usage of the following cointegrating Regression Durbin Watson (CRDW) statistic where cointegration is rejected if the ordinary D-W statistics is too low:

$$CRDW = \left[\sum_{t=2}^{N} (\varepsilon_t - \varepsilon_{t-1})^2 \right] / \left[\sum_{t=1}^{N} \varepsilon_t^2 \right] \quad \text{-- (9)}$$

The null hypothesis of no cointegration is rejected for values of CRDW which are significantly different from zero. The critical values for CRDW are tabulated in Engle and Yoo (1987).

Data and Markets Description

The data set used in the co integration exercise consists of weekly wholesales prices of potato (Tk./quintal) collected from Department of Agricultural Marketing (DAM) in Bangladesh. The cointegration technique discussed above was applied to weekly potato prices for 36 potato markets in Bangladesh. All the selected markets are located in the main potato producing and consuming areas. In this study the capital city of Dhaka acts as the reference market. The choice was based on location and market volume. The period of observation spans was from the first week of January in 1993 to the last week in December 2005 yielding a total of 676 observations.

III. DISCUSSIONS OF RESULTS

Before conducting cointegration test, it is needed to examine the time-series properties of the data and confirm that all the price series are non-stationarity and integrated same order.In order to test the stationary of potato price data, the DF (Dickey-Fuller) and ADF (Augmented Dickey-Fuller) test with 1 and 2 lags for all selected markets were performed over 1993 to 1995 period and the estimated tau (τ) statistics and P values in their level and first difference are presented in Table 1. The tau (τ) statistics which were compared with p values indicate that all the potato price series data were non-stationary, i.e., contain unit roots. This set of regression was run once more after differencing all the terms (Table1). The tau (τ) statistics on the lagged first-difference terms are significantly negative indicates that the series are stationary after first differencing.

Table 1. Unit root tests for potato price series

Market details	Level				First difference			
	DF		ADF		DF		ADF	
	τ- test	P-values	τ- test	P-values	τ- test	P-values	τ- test	P-values
Dhaka	-1.31	0.19	-0.61	0.53	-14.20	0.00	-9.20	0.00
Chitagong	-1.36	0.17	-1.58	0.12	-6.37	0.00	-4.45	0.00
Rajshahi	-0.66	0.50	-0.55	0.58	-5.13	0.00	-3.42	0.00
Khulna	-2.15	0.03	-2.09	0.04	-7.63	0.00	-4.34	0.00
Comilla	-0.73	0.46	-0.72	0.47	-7.96	0.00	-4.90	0.00
Narayangong	-1.49	0.13	-1.84	0.07	-6.96	0.00	-4.11	0.00
Manikgong	-0.32	0.74	-0.10	0.91	-10.66	0.00	-8.72	0.00
Savar	-1.33	0.18	-1.59	0.11	-8.03	0.00	-5.58	0.00
Narshingdi	-0.84	0.40	-0.81	0.41	-12.90	0.00	-9.43	0.00
Munshigong	-1.77	0.07	-1.87	0.06	-10.02	0.00	-6.70	0.00
Gazipur	-1.54	0.12	-0.88	0.37	-16.60	0.00	-10.92	0.00
Tangail	-1.41	0.16	-1.49	0.13	-7.55	0.00	-4.46	0.00
Jamalpur	-2.01	0.06	-1.92	0.05	-10.00	0.00	-7.08	0.00
Sherpur	-1.44	0.15	-2.19	0.04	-5.82	0.00	-3.13	0.00
Mymensingh	-1.27	0.20	-1.11	0.26	-15.12	0.00	-12.28	0.00
Kishoregong	-1.03	0.30	-0.94	0.34	-6.52	0.00	-4.19	0.00
Bhairob	-0.96	0.33	-0.43	0.66	-15.31	0.00	-13.20	0.00
Pabna	-1.61	0.11	-1.77	0.08	-8.81	0.00	-7.05	0.00
Sirajgong	-1.16	0.24	-1.23	0.22	-10.26	0.00	-7.57	0.00
Natore	-0.43	0.66	-0.44	0.65	-17.13	0.00	-10.77	0.00
Bogra	-1.44	0.15	-1.88	0.06	-4.63	0.00	-3.06	0.00
Rangpur	-1.65	0.10	-1.79	0.07	-7.25	0.00	-5.73	0.00
Dinajpur	-0.87	0.38	-0.90	0.36	-11.84	0.00	-13.65	0.00
Faridpur	-0.93	0.35	-0.28	0.77	-17.23	0.00	-11.29	0.00
Kushtia	-0.64	0.53	-0.31	0.75	-19.58	0.00	-13.71	0.00
Jessore	-1.56	0.11	-1.97	0.05	-10.57	0.00	-11.23	0.00
Barisal	-1.82	0.07	-0.76	0.44	-19.99	0.00	-12.87	0.00
Patuakhali	-0.50	0.61	-0.34	0.73	-13.85	0.00	-10.94	0.00
Netrokona	-1.26	0.20	-1.17	0.24	-12.61	0.00	-8.43	0.00
Sylhet	-0.15	0.87	-0.30	0.77	-8.39	0.00	-5.45	0.00
Habigong	-1.88	0.06	-2.11	0.03	-7.60	0.00	-4.03	0.00
Moulavibazar	-0.32	0.74	-0.27	0.78	-11.67	0.00	-7.92	0.00
Feni	-2.26	0.03	-2.48	0.02	-11.67	0.00	-5.77	0.00
Khagrachori	-0.33	0.73	-0.34	0.72	-8.19	0.00	-6.69	0.00
Rangamati	-1.33	0.18	-0.72	0.46	-14.28	0.00	-12.87	0.00
Cox's bazar	-1.09	0.27	-1.29	0.19	-11.99	0.00	-5.24	0.00

In all the cases of null hypothesis $P_t \sim$ (2) is rejected implying that the series do not require second differencing to achieve stationary. We conclude that the potato prices are stationary after differencing once that is they are all I(1) processes.

Table 2. Cointegration test result of potato price series in Bangladesh

Market details	CRDW	EG	P values	AEG	P values	ECM	P values
Dhaka-Chitagong	2.22**	-7.454	0.00	-7.645	0.00	-2.86	0.00
Dhaka- Rajshai	1.29**	-8.40	0.00	-5.131	0.00	-4.98	0.00
Dhaka-Khulna	1.05**	-2.73	0.00	-2.871	0.00	-3.65	0.00
Dhaka- Comilla	1.82**	-2.78	0.00	-2.79	0.00	-4.29	0.00
Dhaka-Narayangong	1.91**	-2.605	0.00	-2.19	0.02	-4.34	0.00
Dhaka- Manikgong	1.06**	-3.188	0.00	-3.14	0.00	-4.52	0.00
Dhaka-Savar	1.51**	-4.21	0.00	-4.18	0.00	-3.88	0.00
Dhaka-Narsingdhi	1.53**	-4.71	0.00	-5.79	0.00	-2.49	0.00
Dhaka- Munsigong	1.26**	-2.90	0.00	-2.86	0.00	-3.31	0.00
Dhaka-Gazipur	0.79**	-5.97	0.00	-6.31	0.00	-5.50	0.00
Dhaka-Tangail	0.21	-3.44	0.00	-2.40	0.01	-3.38	0.00
Dhaka- Jamalpur	1.89**	5.36	0.00	-5.26	0.00	-4.504	0.00
Dhaka- Sherpur	0.36	-2.23	0.02	-2.63	0.00	-5.526	0.00
Dhaka-Mymesingh	0.18	-2.66	0.00	-2.04	0.04	-2.70	0.00
Dhaka-Kishergong	0.61**	-5.09	0.00	-2.88	0.00	-3.74	0.00
Dhaka-Bhairob	0.23	-2.88	0.00	-2.01	0.04	-3.10	0.00
Dhaka-Pabna	1.65**	-5.91	0.00	-4.54	0.04	-2.58	0.01
Dhaka-Sirajgong	0.28	-3.54	0.00	-2.99	0.00	-3.56	0.00
Dhaka-Natore	1.18**	-8.04	0.00	-3.71	0.00	-7.56	0.00
Dhaka-Bogra	0.33	-3.79	0.00	-2.57	0.01	-3.66	0.00
Dhaka-Rangpur	0.63**	-5.37	0.00	-3.31	0.00	-5.91	0.00
Dhaka-Dinajpur	1.22**	-3.12	0.00	-3.04	0.00	-3.24	0.00
Dhaka-Faridpur	1.04**	-7.25	0.00	-4.02	0.00	-6.73	0.00
Dhaka-Kushtia	0.97**	-6.86	0.00	-4.07	0.00	-5.45	0.00
Dhaka-Jessore	0.78**	-5.68	0.00	-5.88	0.00	-5.44	0.00
Dhaka-Barishal	0.81**	-3.08	0.00	2.97	0.00	-2.74	0.00
Dhaka-Patuakhali	1.45**	-9.30	0.00	-6.17	0.00	-3.07	0.00
Dhaka-Netrokona	1.37**	-7.91	0.00	-5.93	0.00	-2.78	0.00
Dhaka-Sylhet	0.25	-2.49	0.01	-2.10	0.03	-2.53	0.01
Dhaka-Habigong	1.55**	-9.93	0.00	-6.47	0.00	-5.20	0.00
Dhaka-Moulavibazar	0.19	-2.65	0.00	-2.42	0.01	-2.20	0.02
Dhaka-Feni	0.99**	-6.84	0.00	-3.96	0.00	-2.44	0.01
Dhaka-Khagrachori	0.20	-2.90	0.00	-2.56	0.01	-2.31	0.02
Dhaka-Rangamati	0.56**	-4.65	0.00	-3.70	0.00	-3.95	0.00
Dhaka-Coxs bazar	0.20	-2.89	0.00	-2.25	0.02	-2.82	0.00

** 1 percent of level of significance, Dependent variable = Dhaka,
CRDW= Cointegrationg Regression for Durbin-Watson, EG = Engle-Granger test, AEG = Augmented Engle-Granger test, ECM = Error Correction Methods

Critical value of CRDW (Engle and Yoo, 1987)

Significance level of CRDW	
1%	0.51
5%	0.39
10%	0.32

Now, it is appropriate to proceed towards testing the cointegration among the different series for selected potato markets in Bangladesh. The tests for cointegration are CRDW, Engle-Granger (tau) and Error Correction Method (ECM). All possible pair wise combinations of series (prices) of potato have been chosen. The test statistics is presented in Table 2 and it is found that the test statistics obtained for all the pair wise markets are seen to be greater than the critical 1 percent level of significance.

In Table 2 the CRDW statistic shows that the null hypothesis of no cointegration is only rejected in 25 out of 35 cointegrating regression equation for potato. On the other hand the ADF results show that in all cases the null hypothesis of no cointegration is rejected at 1 percent level of significance. As a matter of fact in this case Engle and Yoo (1987) have cautioned the use of CRDW in testing for cointegration. From their simulation study, Engle and Yoo (1987, P.158) noted: "We have also examined the behaviour of the Durbin Watson statistic from the cointegrating regression. Unfortunately, the discrepancy between the critical values for different systems remains significant even for the sample of size 676. This is not surprising since the statistic is not asymptotically similar, as are the preceding tests. For all test, Dhaka wholesale market considered as a reference markets. So, all possible pair wise combination of series of potato has been chosen Hence this statistic does not appear to be too useful for testing co-integration. Therefore we conclude that the results in Table 2 strongly support the existence of cointegration in the potato markets in Bangladesh. According to the Engle and Granger (EG) and Augmented Engle and Granger(AEG) test Dhaka-Narayangong, Dhaka-Sherpur, Dhaka-Cox's bazar markets are significant at 2% level and Dhaka-Mymesingh, Dhaka-Bhairob, Dhaka-Pabna,Dhaka-Sylhet markets are significant at 4 and 3% level respectively The rest of the markets are significance at 1% level. Similarly the results also shows that ECM cointegration test is supported by 31 markets and the rest of the market are significance at 1 and 2 % level implying that there exist short-run dynamics with long-run equilibrium. This implies that if any divergence from long-run equilibrium occurs in period t-1, it will be adjusted towards equilibrium level in period t. Thus, potato markets in Bangladesh are shown to be integrated. This is mainly attributed to close proxy, good communication facilities especially development of cell phone technology and good infrastructure availabilities among the market centres in Bangladesh.

IV. CONCLUSION

The cointegration method developed by Engle and Granger (1987) and Error Correction Method (ECM) are used in this study to analyses the long-run relationship between prices in different markets. The cointegration theory states that although two or more variables may be non-stationary, there may exist some linear combination of them which are stationary. Intuitively, this implies that individual variables exhibit some explosive pattern over time. However, when the price differential is considered, the explosive pattern disappeared and has the tendency to return to some 'equilibrium' value (i.e, the mean). In the present context, it implies that the variables are cointegrated and there is a stable equilibrium relationship between the variables, that is, the market is spatially integrated. The empirical results suggest that urban markets of potato in Bangladesh are highly cointegrated. These results have important policy implication. In a situation when a set market is identified to be spatially integrated , then the government may think of reducing or even withdrawing its efforts to influence the price process in those markets. Since integration of markets implies that a scarcity in one market will be transmitted to other markets, it is redundant to undertake the same programme in all markets. Integration of markets ensures regional potato market security by ensuring regional balance among potato deficit and potato surplus producing markets. Moreover, since market integration offers a clear picture of the process of transmission of intensive across the marketing chain. This implies that commodity arbitrage is working. The results also show that the prices of potato tend to move uniformly across spatial markets. Importantly, the distance between markets is not an impediment to efficient adjustment of price to new information. The low transportation cost and risk associated with transportation may explain why the degree of cointegration is unaffected by distance. We conclude that price changes are fully and immediately passed on to the other markets.

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