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SPATIAL PRICE INTEGRATION AND PRICING EFFICIENCY OF EXPORT MARKETS LEVEL: A CASE OF BANGLADESHI EXPORTABLE FRESH VEGETABLES MARKETS

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ABSTRACT

The paper examined the pricing efficiency of exportable fresh vegetables markets in Bangladesh and its export markets by using Engle-Granger (EG) test, Cointegration Regression for Durbin Watson (CRDW) test and Error Correction Methods (ECM). For the test of pricing efficiency of exportable fresh vegetables markets, the monthly export earnings data were used to test cointegration from July 2004-05 to July 2006-07 yielding a total of 36 observations. Engle-Granger test was used to estimate the integration among the fresh vegetables exports markets in Bangladesh. In the cointegrating set up, error correction method estimated the long-run relationship between Bangladesh and selected export markets. The vegetables export markets of UK-Saudi Arabia, UK-UAE markets and UK-Singapore markets are not integrated and these markets prices were non-responsive. Bangladesh-UK; Bangladesh-UAE; Bangladesh-Singapore; UAE-Saudi Arabia and UAE-Singapore markets are highly integrated due to having the facility of information technology, which closely connected the markets to each other. Bangladesh-UK; Bangladesh-Saudi Arabia; Bangladesh-UAE, Bangladesh-Singapore and Saudi Arabia-UAE markets are found strong form of market integration due to congenial atmosphere existed in these markets. The rest combinations of markets do not support the strong form of market integration because of complication of export procedures, lack of bi-lateral agreement. The speed of price adjustment (8) ranges from 9% to 66 % indicating that price adjustment takes around 3 to 20 days in transmitting information from one market to the others export markets. The highest percentage speed of adjustment was found in Bangladesh and UK markets. This exhibits that if any divergence appears from the long-run equilibrium, it is adjusted towards the equilibrium value by the speed of 66% or 20 days. Price adjustments among the selected export markets were found to be quicker in Bangladesh-United Arab Emirates market (3 days).

I. INTRODUCTION

Bangladesh is a densely populated country with a density of 916 person per square kilometer. Her population increased in 2007 by 1.42% (BBS, 2007). Per capita Gross Domestic Product (GDP) and Gross National Income (GNI) increased over time to US$ 447 and. US$ 476,

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respectively (BBS *2006)*. The agricultural sector which contributed *33.07%* of GDP at the beginning of eighties reduced to *21.11%* in *2006-07*. The growth rate of agriculture sector which mainly comprises crop sub-sectors is in increasing trend. The crop and vegetables subsectors were likely to increase by *5.03%* in real terms in *2005-06*. Vegetable sub-sector contributes *3.6%* to the GDP with a production area of less than *2%* of the total cropped area. Although the growth rate of vegetable production decreased to *3.18%* from in *2004-05*, *4.66%* from previous, the contribution of vegetable area to total cropped area increased during the same time. In the country, the consumption of vegetables is lower than their requirement.

A large number of agricultural products are being grown in Bangladesh. In view of its potential, the government of Bangladesh has taken highly ambitious steps of expanding all possible facilities and opportunities related to the export of agricultural products. The government and the exporters/producers were working together to set up "export village" for the production of quality fresh vegetables in the country. Among the agricultural products, various types of fresh vegetables are being regularly exported from Bangladesh to *31* countries of the world. The countries include the Middle East (Saudi Arabia, Kuwait, Qatar, United Arab Emirates and Oman), UK, USA and Germany (Quasem, *2003)*. Bangladesh earned US$ *82.47* and *US$ 105.40* million from exporting agricultural products in *2004-2005* and *2005-06*, which contributed *0.95%* and 1% to total export earnings, respectively.

In order to develop the sector and encourage export of such agro-based products, the government declared cash incentive in *2005/06* (EPB, *2004)*. Vegetable export contributed *1.69%* to the agricultural export in *1973/74;* it increased to *86.98%* in *1996/97*. This share decreased in the recent years and it stood at *44.52%* in *2005-06*. Therefore, vegetables sector, occupying more or less a significant position in export and helps to meet the need of foreign currency as well as ensure overall economic development. The contribution of vegetables to total export earnings is accelerative (Saha, *2000)*. The most remarkable contribution was found in the period of *1985-86* to *1987-88*, due to adopting trade liberalization policy in Bangladesh. In *2005/06*, Bangladesh earned US$ *46.92* million from export of vegetables. The earnings contributed *0.45%* to total exports earnings. So, the annual change of export earnings from vegetables was *8.28%* in *2005/06*, while Hoq *(2006)* estimated *75.43%* during *2003-04* to *2004-05* as annual change of export earnings from vegetables. Therefore, Bangladesh has immense prospects for earning foreign currency by exporting vegetables to the world markets.

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 market 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. 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.

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 the 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.

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 market integration in many countries including Bangladesh [see, for example, Asche *et al*. (1999), Ismet *et al*. (1998), Baulch (1997), Goletti *et al*. (1995), Dercon (1995), Alexander and Wyeth (1994), Dahlgram and Blank (1992), Goodwin and Schroeder (1991), Faminow and Benson (1990)].

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 changes in different markets. 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 or autocorrelated and heteroscedastic residuals in the regression with nonstationary 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) 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. A relatively less restrictive approach to market integration has been to employ cointegration and error correction techniques Alexander and Wyeth (1987). This study attempts to estimate market integration of exportable vegetable market in Bangladesh using cointegration technique. Market integration test has traditionally been estimated using bivariate correlation model where it was assumed that the underlying time series are stationary. In fact, this is not the case and as a result, the conventional hypothesis testing procedure based on t, F and chi-square tests are not valid. A cointegration analysis of time series leads to the construction of error correction models that enable separately the characterization of short-term relationships. In this study, cointegration test of local markets and selected export markets of vegetables have been estimated and interpreted with these frameworks using weekly wholesales price series data between 1993/94 and 200V06 for domestic markets and monthly vegetables export earnings data were collected from 2004 to 2006 for related export markets. Thus the study deals with the following main steps: (i) to perform the informal and formal tests for stationary of each of the series used in the analysis,

(ii) to identify the cointegrated set and (iii) to develop the cointegration and EC models for selected fresh vegetable markets in Bangladesh and international export markets.

Market integration

The basic idea behind the measurement of market integration is to understand the interaction among prices in spatially separated markets (Goletti and Babu, 1994). Thus integrated markets are defined as markets in which prices of differentiated products do not behave independently (Monke and Petzel, 1984). Independent markets were studied in a disaggregate manner, while integrated markets were amenable to aggregate analysis (Kumar and Sharma 2000; p.90). If price movements of a commodity in one market are completely irrelevant to forecast price movements of the same commodity in other markets, the markets are characterised as segmented (Kumar and Sharma 2003). Market integration was defined as a situation in which arbitrage causes prices in different markets to move together. Thus, more specifically, two markets were said spatially integrated, whenever trade takes place between them and if the price differential for a particular commodity equals the transfer costs involved in moving that commodity between them. 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 (Behura and Pradhan, 1998, pp.344-46).

Spatial price relationships have been widely used to indicate overall market performance. 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 price change in one market was fully transmitted to the other markets. The present study empirically evaluates market integration of fresh vegetables export market of Bangladeshi. In order to do this it is necessary to compare market prices of vegetables in one market with prices of comparable others exportable fresh vegetables. We intend to show that the selected exportable fresh vegetables markets are closely interrelated, that is price formation in one market is fully reflected in the prices of other international markets. In other words, in Bangladesh exportable fresh vegetables, prices do not diverge and the markets are fully integrated. In this study, 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

Cointegration method

In the last few years, a large volume of literature and some specialized books e. g. Granger (1986),.Hendry (1986), Engle and Granger (1987), Stock and Watson (1988), Johansen and Juselius (1990), Johansen (1991), Pearman (1991), Banerjee, Dolado, Galbraith and Hendry (1993), Hargreaves (1994), Hatanaka (1996) etc. have been published where the issue of estimatingg and testing of long-run relations under the notion of "cointegration" has been addressed. Several economists have point out the inappropriateness of applying regression

models to nonstationary data because of so-called problem of "spurious relationship". Specifically, OLS regression technique might give misleading results in two respects. Firstly, it might show a significant relationship among variables in term of high R^2 even if not such relationship exist, and a low Durbin-Watson statistic (d), and secondly the usual t-statistic for individual regression coefficients does not possess even a limiting distribution and is expected to diverge to infinity under the assumption of independence of nonstationary regression and regressand. Thus, models incorporating series, which are nonstationary, might be misspecified and standard regression estimation and testing procedures become invalid. To overcome such problems, some researchers have suggested differencing the data to overcome random walk and trend-like components. The concept of cointegration was considered as a means of affecting a resolution of such debate. Indeed, the cointegration technique appears to offer a means of identifying and hence avoiding the spurious regression so obtained by regression unrelated nonstationary time series variables (Granger and Newbold, 1974, Philips, 1986).

Stationarity

Empirical work based on time series data assumes that the underlying time series is stationary. In regressing a time series variable on another time series variable(s), one often obtains a very high R^2 (in excess of 0.9) even though there is no meaningful relationship between the two. This situation exemplifies the problem of spurious or nonsense regression. This problem arises if both the time series involved exhibit strong trends; the high R^2 observed is due to the presence of the trend, not to a true relationship between the two (Gujarat, 2003) .

Unit root and cointegration test

Test of stationarity (or nonstationarity) that has become widely popular is known as the unit root test (Gujarati, 2003). The easiest way to introduce this test is to consider the following model:

$$Y_t = Y_{t-1} + u_t \quad \text{..... (1)}$$

where u_t is the stochastic error term that follows the classical assumptions, namely, it has zero mean, constant variance σ^2, and is nonautocorrelated. Such an error term is also known as a white noise error term (Gujarati, 2003). Therefore, if runs the regression

$$Y_t = \rho Y_{t-1} + u_t \quad -1 \leq \rho \leq 1 \quad \text{..... (2)}$$ and actually 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) (Gujarati, 2003). For theoretical reasons, we manipulate equation (2) as follows: Subtract Y_{t-1} from both sides of (2) to obtain

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

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

which can be alternatively written as $\Delta Y_t = \delta Y_{t-1} + u_t$ ..... (4), where $\delta = (\rho - 1)$ and where Δ is the first-difference operator. Note that $\Delta Y_t = (Y_t - Y_{t-1})$.

Therefore, instead of estimating (2) , we estimate (3) and test the (null) hypothesis that $\delta = 0$. Before we proceed to estimate (4), it might be noted that if $\delta = 0$, (4) will become.

$\Delta Y_t = (Y_t - Y_{t-1}) = u_t$ ..... (5) Since u_t is a white noise error term. Under the null hypothesis that $\delta = 0(\rho = 1)$, the conventionally computed t statistics is known as the τ (tau) statistic, whose critical values have been tabulated by Dickey and Fuller on the basis of Monte Carlo simulations. In the literature the tau statistic or test is known as the 'Dickey-Fuller (DF) test, in honour of its discoverers (Gujarati, 2003).

For theoretical and practical reasons, the Dickey- Fuller test is applied to regressions run in the following forms: Y_t is a random walk : $\Delta Y_t = \delta Y_{t-1} + u_t$ ..... (6)

Y_t is a random walk with drift : $\Delta Y_t = \beta_1 + \delta Y_{t-1} + u_t$ .....(7)

Y_t is a random walk with drift around a stochastic trend : $\Delta Y_t = \beta_1 + \beta_2 t + \delta Y_{t-1} + u_t$ .....(8)

where t is the time or trend variable. In each case the *null hypothesis* is that $\delta = 0$; that is, there is a unit root-the time series is nonstationary. In conducting the DF test as in (6), (7), or (8), it was assumed that the error term u_t was uncorrelated. But in case the u_t are correlated, Dickey and Fuller have developed a test, known as the augmented Dickey-Fuller (ADF) test. The ADF test here consists of estimating if the error term u_t is autocorrelated, one modifies (8) as follows:

$\Delta Y_t = \beta_1 + \beta_2 t + \delta Y_{t-1} + \alpha_i \sum_{i=1}^{m} \Delta Y_{t-i} + \varepsilon_t$ ..... (9) where ε_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 (Gujarati, 2003). To examine the price relation between two markets, the following regression model has been used:

$Y_{it} = \alpha_0 + \alpha_1 Y_{jt} + \varepsilon_t$ ..... (10)

where, Y_i and Y_j are price series of a specific commodity in two markets i and j, and ε_t is the residual term assumed to be distributed identically and independently. The test of market integration is straightforward if Y_i and Y_j are stationary variables. Thus before proceeding with further analysis, the stationarity of the variables needs to be checked (Granger and Newbold, 1977).

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

$$\Delta Y_t = \beta_0 + \beta_1 Y_{t-1} + \sum_{k-1}^{N} \delta_K \Delta Y_{t-k} + \eta_1 \qquad \text{..... (11)}$$

where $\Delta Y_t = Y_t - Y_{t-1}$ and η_t is the residual term. The test statistic is simply the t-statistic, however, under the null hypothesis it is not distributed as student-t, but the ratio were compared with critical values tabulated in Fuller (1976). In estimating equation (11), the null hypothesis is H_0 : Y_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 could also be carried out for the first difference of the variables. That is, the estimate the following regression equation:

$$\Delta^2 Y_t = \theta_0 + \theta_1 \Delta Y_{t-1} + \sum_{k-1}^{N} \phi \Delta^2 Y_{t-k} + \mu_t \quad \text{.....(12)}$$

where the null hypothesis is H_0:Y_t is I(2), which is rejected in favour of I(1) if θ_1 is found to be negative and statistically significant. The definition of cointegration used here is that of Engle and Granger (1987) and is defined as follows; consider a pair of variables Y_i and Y_j, each of which is integrated of order d. Their linear combination, that is,

$$\varepsilon_t = Y_{it} - \alpha Y_{jt} \quad \text{.....} \quad (13)$$

were generally be I(d). However, if there is a constant α, such that ε is I(d-b), where b>0,Y_j and Y_i are said to be cointegrated of order d,b and the vector (1,-α) is called the cointegration regression. The relation $Y_i = \alpha Y_j$ might be considered as long run or equilibrium relation (Engle and Granger,1987a, b), and ε is the deviation from the long-run equilibrium. Comparing equation (11) and (13), equation (13) represents a 'strong-form' test of market integration, where under the null, parameter α_o should be equal to zero, while α_1 should be equal to one. On the other hand, if $\alpha_0 \neq 0$ and $\alpha_1 = 1$, than the 'weak-form' test for market integration persists (Buongiomo and Uusivuori, 1992, Zanias, 1993, Palakas and Harriss 1993). However, in most applications, the 'weak-form' test for market integration is usually employed in empirical analysis. Therefore, the role of the constant term α_0, in equation (11) is to absorb the influence of these factors.

According to Granger (1986), a model specified by equation (11) does not make sense unless Y_i and Y_j are of the same order of integration. Thus a necessary condition for Y_i and Y_j to be cointegrated is that they must be integrated of the same order.Testing whether the variables are cointegrated in merely another unit root test on the residual in equation (11). The test involved regression the first-difference of the residual lagged level and lagged dependent variables (Engle-Granger and augmented Engle-Granger test) is as follows:

For Engle-Granger (EG) test, $\Delta\varepsilon_t = \gamma_1 \varepsilon_{t-1}$ and

For Augmented Engle-Granger (AEG) test, $\Delta\varepsilon_t = \gamma_1 \varepsilon_{t-1} + \sum_{k=1}^{N} \varphi_k \Delta\varepsilon_{t-k} + \upsilon_t$ ..... (14)

Again the test statistics is the t-statistics of γ_1. The critical values are tabulated in Fuller (1976). The null hypothesis is H_0: Y_i and Y_j are not cointegrated.The null hypothesis is rejected if estimated γ_1 is negative and found to be significantly different from zero (Behura and Pradhan,1998 and Baharumshah and Habibullah, 1994).

The Error Correction Mechanism (ECM) first used by Sargan and later popularized by Engle and Granger corrects for disequilibrium (Gujarati, 2003). An important theorem, known as the Granger representation theorem, states that if two variables, Y and X (say,) both are I(1) and also cointegrated in the long-run, in this case were applied an Error Correction Model (ECM) for x and y as: $\Delta Y_t = \alpha + \beta \Delta X_t + \delta e_{t-1} + u_t$ ---------- (15) 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. Since δ is expected to be negative, the term $\delta\mu_{t-1}$ is negative and, therefore, ΔY_t will be negative to restore the

equilibrium. That is, if Y_t is above its equilibrium value, it will start falling in the next period to correct the equilibrium error, hence the name ECM (Gujarati, 2003).

The Augmented Engle-Granger (AEG) as a test for cointegration, Engle and Granger (1987a,b) have recommended the usage of the following Cointegrating Regression Durbin Watson (CRDW) statistics where cointegration is rejected if the ordinary Durbin Watson statistics is too low: $$CRDW = \left[\sum_{t=2}^{N} (\varepsilon_t - \varepsilon_{t-1})^2\right] / \left[\sum_{t=1}^{N} \varepsilon_t^2\right] \text{ ------- (16)}$$

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

Data and Markets Description

The data set used in the cointegration exercise consists of monthly vegetables export earnings data from 2004 to 2006 were gathered from the selected export markets Export Promotion Bureau (EPB), Hortex Foundation in Bangladesh and by internet searching. Bangladesh, UK, Saudi Arabia, UAE export markets were considered for the study.

III. RESULTS AND DISCUSSION

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 exportable vegetables 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 vegetables price series data were non-stationary. 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.

Unit root and cointegration tests for exportable fresh vegetables markets of Bangladesh and exporting country's markets

Testing a null hypothesis of non-stationarity against an alternative hypothesis of stationarity, the results of the unit root tests relating to Bangladesh vegetables and exporting country's market price both at level and first difference are presented in Table 1. The findings reveal that all prices are non-stationary at level but stationary in their first differences.

Table 1. Unit root test for Bangladesh markets and exporting country's markets price

Markets	Level				First difference			
	DF	P values	ADF	P values	DF	P values	ADF	P values
Bangladesh	-0.31	0.75	-0.57	0.58	-6.00	0.00	-4.31	0.00
United Kingdom (UK)	-0.85	0.40	-0.28	0.78	-6.59	0.00	-3.85	0.00
Saudi Arabia	-0.68	0.50	-0.78	0.44	-5.59	0.00	-3.33	0.00
UAE	-0.83	0.41	-1.18	0.25	-5.91	0.00	-4.26	0.00
Singapore	-0.47	0.64	-0.63	0.53	-5.48	0.00	-5.18	0.00

DF= Dickey-Fuller, ADF= Augmented Dickey-Fuller,

Table 2. Results of cointegration test for Bangladesh vegetables markets and selected export markets, sample period 2004 to 2006

Markets details	CRDW	EG	P values	AEG	P values	Decision
Bangladesh-UK	0.17	-6.53	0.00	-3.31	0.00	Cointegrated
Bangladesh-Saudi Arabia	0.61**	-2.86	0.00	-2.11	0.04	Cointegrated
Bangladesh -UAE	0.94**	-3.09	0.00	-2.61	0.00	Cointegrated
Bangladesh-Singapore	0.69**	-3.57	0.00	-3.33	0.00	Cointegrated
UK-Saudia Arabia	0.58**	-2.06	0.04	-1.62	0.11	Segmented
UK-UAE	0.59**	-2.01	0.05	-1.59	0.12	Segmented
UK-Singapore	0.59**	-2.03	0.05	-1.61	0.11	Segmented
UAE-Saudia Arabia	0.96**	-3.52	0.00	-3.59	0.00	Cointegrated
UAE-Singapore	0.99**	-3.50	0.00	-3.38	0.00	Cointegrated

** 1 % and * 5 % of level of significance

The cointegration tests for vegetables markets of Bangladesh and export markets are presented in Table 2.The CRDW statistics estimated that only Bangladesh-United Kingdom (UK) was not integrated but the rest of the markets were integrated.According the test of EG and AEG, the vegetables export markets of UK-Saudi Arabia, UK-UAE markets and UK-Singapore markets are not integrated. That means price of one market was non-responsive to the change in price of another market. The tau (τ) value of Bangladesh-UK,Bangladesh-UAE, Bangladesh-Singapore, UAE-Saudi Arabia and UAE-Singapore markets are negative and highly significant. Hence, these markets are integrated, implying the prediction of these markets prices with the help of other markets. This empirical finding strongly supports marketing efficiency in the selected vegetables export markets. Price move in the unison in all the markets together. Central price policy would be effective for these markets.

Cointegration test through Error Correction Model (ECM) for Bangladesh and selected vegetable export markets

The ECM enables to **analyse** the short-run dynamics present in the time-series variables. One month lag period was considered sufficient to make the error correction model free of auto correlation problems[1]. Table 3 presents the results of error-correction model for vegetable wholesales price of Bangladesh and other selected export markets. In the cointegrating set up, error correction method estimates the long-run relationship between the variable as well as fluctuation in the short-run. The test statistics (τ) obtained for wholesale prices and all

export market are found highly integrated. It revealed from the table that the tau (τ) value of Bangladesh wholesale market and others selected export markets are negative and statistically significant which implies that there exists short-run dynamics with the 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.

Table 3. Results of Error Correction Model (ECM) of selected vegetables export markets sample period 2004 to 2006

ΔY_t	$=\alpha$	$+\beta\Delta X_t$	$+\delta e_{it-1}$
$\Delta Bangladesh$	=403.57** (94.98)	+0.001 $\Delta United\ Kingdom$ (0.01)	-0.66** δe_{it-1} (0.16)
$\Delta Bangladesh$	=331.84** (96.24)	+0.08 $\Delta Saudi\ Arabia$ (0.04)	-0.22** δe_{it-1} (-0.06)
$\Delta Bangladesh$	=424.03** (99.34)	+0.02 $\Delta United\ Arab\ Emirate$ (0.03)	-0.09** δe_{it-1} (0.032)
$\Delta Bangladesh$	=198.33 (108.41)	+0.15** $\Delta Singapore$ (0.05)	-0.35** δe_{it-1} (0.35)
$\Delta United\ Kingdom$	=-447.68 (1253.52)	+1.13 * $\Delta Saudi\ Arabia$ (0.57)	-0.19* δe_{it-1} (0.08)
$\Delta United\ Kingdom$	=404.40 (1201.95)	+0.26 $\Delta United\ Arab\ Emirate$ (0.34)	-0.22 δe_{it-1} (0.09)
$\Delta United\ Kingdom$	=-112.81 (1454.61)	+0.30 $\Delta Singapore$ (0.65)	-0.26* δe_{it-1} (0.13)
$\Delta Saudi\ Arabia$	=703.03 (295.08)	+0.28 $\Delta United\ Arab\ Emirate$ (0.09)	-0.30** δe_{it-1} (0.08)
$\Delta United\ Arab\ Emirate$	=217.13 (531.09)	+0.78** $\Delta Saudi\ Arabia$ (0.25)	-0.42** δe_{it-1} (0.15)
$\Delta United\ Arab\ Emirate$	=1054.13 (629.37)	-0.22 $\Delta Singapore$ (0.29)	-0.15** δe_{it-1} (0.032)
$\Delta Singapore$	=1316.57** (316.56)	-0.02 $\Delta United\ Arab\ Emirate$ (0.09)	0.38** δe_{it-1} (0.05)

Note: Figures in parenthesis indicated Standard Error,** and* indicate 1% and 5% level of significance

[1]We tried various lag periods but the results essentially remain the same. The ECM models were tested for the serial correlation and the results were found satisfactory exhibiting the right specification of the error-correction models.

Strong forms of market integration

For testing strong form of selected vegetable export market integration, the null hypotheses were applied to find export market integration against alternate hypotheses where export markets might not be integrated. The result of strong form of market integration in selected

markets is given in Table 4. It is seen from Table 4 that strong form of market integration was observed between Bangladesh-UK; Bangladesh-Saudi Arabia; Bangladesh-UAE, Bangladesh-Singapore and Saudi Arabia-UAE markets respectively. It seems that congenial atmosphere existed in these markets. Other pairs of markets such as UK-Saudia Arabia; UK-UAE; UK-Singapore; UAE-Singapore do not support strong form of market integration because of inadequate communication facility, complication in export procedures, lack of bi-lateral agreement of fresh vegetable export policy.

Table 4. Testing strong form of integration ($\beta = 1, \alpha = 0$) in wholesale markets, sample period 2004 to 2006 ($\Delta Y_t = \alpha + \beta \Delta X_t + \delta e_{t-1} + u_t$)

Dependent variable (ΔY_t)	Independent variable (ΔX_t)	When If $\beta = 1$, Then : $\Delta Y_t - \Delta X_t = \alpha + \delta e_{t-1} + u_t$				t-value for $\alpha = 0$
		Coefficient e_{t-1}	Standard Error	t-value for $\beta = 1$	P values	
ΔBangladesh	*ΔUnited Kingdom*	1.323	0.708	1.869	0.072	1.69
ΔBangladesh	*ΔSaudi Arabia*	1.885	1.272	1.482	0.081	2.85**
ΔBangladesh	*ΔUnited Arab Emirate*	0.877	0.585	1.500	0.071	1.35
ΔBangladesh	*ΔSingapore*	2.040	2.021	1.009	0.341	-2.08*
ΔUnited Kingdom	*ΔSaudi Arabia*	-0.230	0.09	-2.56*	0.041	-2.24*
ΔUnited Kingdom	*ΔUnited Arab Emirate*	-0.256	0.078	-3.282**	0.001	-2.32*
ΔUnited Kingdom	*ΔSingapore*	-0.291	0.037	-7.864**	0.0001	-1.97*
ΔSaudi Arabia	*ΔUnitedArabEmirat*	-0.351	0.296	-1.185	0.452	-0.02
ΔUnited Arab Emirate	*ΔSaudi Arabia*	-0.422	0.391	-1.079	0.595	-2.87*
ΔUnited Arab Emirate	*ΔSingapore*	-0.354	0.108	-3.265**	0.001	-3.84**
ΔSingapore	*ΔUnitedArabEmirate*	-0.236	0.105	-2.243*	0.021	0.92

** and* indicate 1% and 5% level of significance

Speed of adjustment

The analysis of dynamic adjustments permits the study of the speed of price transmission i.e., how many days, weeks, or months are needed for price to be transmitted from one location to another (Goletti, 1995, p.191). This is an issue of concern to policy makers for reasons related to the planning of food distribution, trade policy and price stabilization. Sometimes, the speed in response of prices is related to the efficiency of the market systems. However, this assumption is not always valid. Rapid adjustments are just an indication of the flexibility of the mechanism. They do not necessarily imply well-functioning system. Within the context of this discussion, it is important to consider the speed of adjustment as just one dimension of integration. Table 6.35 shows the speed of adjustment for different markets. The speed (δ) ranges from 9% to 66 % indicating that the price adjustment takes around 3 to 20 days in

transmitting information from one market to the others markets. The highest percentage speed of adjustment was found between the vegetables export price of Bangladesh and United Kingdom markets. This exhibits that if any divergence appears from the long-run equilibrium, it is adjusted towards the equilibrium value by the speed of 66% or 20 days. Price adjustments among the selected export markets were found to be quicker in Bangladesh-United Arab Emirates market. If price of exportable vegetables rises in the United Arab Emirate markets, it is transmitted within a period of 3 days into Bangladesh. The adjustment is faster among the nearby combination of pairs markets i.e. 3 days for Bangladesh- UAE; 5 days for United Arab Emirate-Singapore; 6 days for United Kingdom-Saudia Arabia; 7 days for Bangladesh-Saudi Arabia; 8 days for United Kingdom-Singapore; 11 days for Bangladesh-Singapore and 13 days for United Arab Emirate- Saudi Arabia markets, respectively (Table 5).

Table 5. Speed of adjustment of selected vegetables export price of among the selected export markets, sample period 2004 to 2006

Dependent variable (ΔY_t)	Independent variable (ΔX_t)	Percent	Prices speed of adjustment (days)
$\Delta Bangladesh$	$\Delta United\ Kingdom$	66**	20
$\Delta Bangladesh$	$\Delta Saudi\ Arabia$	22**	7
$\Delta Bangladesh$	$\Delta United\ Arab\ Emirate$	9**	3
$\Delta Bangladesh$	$\Delta Singapore$	35**	11
$\Delta United\ Kingdom$	$\Delta Saudi\ Arabia$	19*	6
$\Delta United\ Kingdom$	$\Delta United\ Arab\ Emirate$	22**	7
$\Delta United\ Kingdom$	$\Delta Singapore$	26**	8
$\Delta Saudi\ Arabia$	$\Delta United\ Arab\ Emirate$	30**	9
$\Delta United\ Arab\ Emirate$	$\Delta Saudi\ Arabia$	42**	13
$\Delta United\ Arab\ Emirate$	$\Delta Singapore$	15**	5
$\Delta Singapore$	$\Delta United\ Arab\ Emirate$	38**	11

Conclusion

The CRDW statistics showed that eights markets are integrated. Based on EG and AEG test, the vegetables export markets of UK-Saudi Arabia, UK-UAE markets and UK-Singapore markets are not integrated and these markets prices were non-responsive. So any price support policy should be separately designed for these markets. Bangladesh-UK; Bangladesh-UAE; Bangladesh-Singapore; UAE-Saudi Arabia and UAE-Singapore markets are highly integrated due to having the facility of information technology, which closely connected the markets to each other. This empirical finding strongly supports marketing efficiency in the selected vegetables export markets. Price move in the unison in all the markets together. Central price policy making will be effective in these markets. Bangladesh-UK; Bangladesh-Saudi Arabia; Bangladesh-UAE, Bangladesh-Singapore and Saudi Arabia-UAE markets are found strong form of market integration. It seems to appear that congenial atmosphere existed in these

markets. The rest combination of markets such as UK-Saudia Arabia; UK-UAE; UK-Singapore and UAE-Singapore do not support the strong form of market integration because of inadequate communication facility, complication in export procedures and lack of bi-lateral agreement of fresh vegetable export policy. Policy should be designed for vegetable export markets development keeping eye on variation in the market linkage between European country and Middle East. Price adjustment among the selected export markets were 3 days for Bangladesh-UAE; 5 days for UAE-Singapore; 6 days for UK-Saudia Arabia; 7 days for Bangladesh-Saudi Arabia; 8 days for UK-Singapore; 11 days for Bangladesh-Singapore and 13 days for UAE-Saudi Arabia Markets. The speeds of price adjustment period are too long to export fresh vegetable. Since vegetables are perishable goods, to increase the vegetables export, policies for the development of cold storages facility by the private sector has to be encouraged and cost of storage shall have to be reduced. Moreover, market integration offered a clear picture of the process of intensive transmission across the marketing chain. This shows that commodity arbitrage is working. The results also express that the prices of vegetables tend to move uniformly across spatial markets. Importantly, distance between markets is not an impediment to ensure efficient adjustment of prices to new information. Price changes are fully and immediately passed on to the other markets. In order to achieve food sufficiency, removal of nutritional deficiency and implementation of efficient market policy central price policy are needed.

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Appendix 1. Monthly wholes sale price in Bangladesh and export markets price of vegetables (Tk/tonnes) in different export markets during 2004/05 to 2005/06

Years	Months	Time	UK	S Arabia	UAE	Singapore	Bangladesh
2004/05	July	1	96777	50163	43217	43569	10200
	August	2	83699	53447	45870	47970	10900
	September	3	90466	53729	47608	52656	11100
	October	4	91568	57273	55396	54260	11303
	November	5	91875	57326	55651	54260	11500
	December	6	92292	58157	56404	55200	11500
	January	7	92860	58447	56485	55471	11550
	February	8	93540	58940	56900	56208	11900
	March	9	103048	59316	57040	56306	12057
	April	10	106682	59362	57542	56306	12153
	May	11	106800	59526	57985	56905	12274
	June	12	100332	59962	58965	57108	12581
2005/06	July	13	97433	60123	51782	57855	12807
	August	14	99424	60255	48634	58314	12924
	September	15	105450	61896	55156	59861	12950
	October	16	80651	62350	56685	60461	13133
	November	17	78719	63361	57287	61135	13186
	December	18	75823	64042	57613	61540	13378
	January	19	86590	64077	57618	61576	13431
	February	20	84822	65009	58374	61779	13477
	March	21	84929	65800	58892	64215	13915
	April	22	78076	65875	65800	65088	14029
	May	23	74750	60622	60011	65320	14330
	June	24	87540	64770	61350	67854	14880
2006/07	July	25	88964	66484	65421	67854	15374
	August	26	94436	67465	56360	68570	15500
	September	27	83389	67760	58950	69424	15746
	October	28	85895	67848	59860	69578	18251
	November	29	81625	68457	60372	69854	18260
	December	30	85953	68550	60460	70562	19363
	January	31	87757	68550	60752	78985	19400
	February	32	88496	69614	60772	80489	19500
	March	33	91521	69857	61163	81254	19850
	April	34	99655	75204	62354	86954	21941
	May	35	100659	76540	64627	87616	23787
	June	36	111697	83794	74449	88952	24197

Sources: Export Promotion Bureau different issues.