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Price Behaviour of Major Cereal Crops in Bangladesh

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Abstract

The key concern of this research is to analyse the extent of the seasonal price fluctuation and spatial price relationship of major cereal crops viz., Boro paddy and wheat in different markets in Bangladesh. This study was entirely based on secondary data from the period of 1986-87 to 2009-10 from different sources. In estimating seasonal price fluctuation of selected crops it was found that crops prices fluctuated in different months within the year. The difference between peak and trough prices was higher for Boro paddy than wheat. Coefficient of variation was also higher for Boro paddy than wheat but these figures are decreasing gradually. The results of empirical evaluation of spatial price linkage through Engle-Granger co-integration method among regional selected markets of Bangladesh using harvest price of Boro paddy and wheat indicate that these markets were well integrated. That means, information about price changes are fully and instantaneously delivered to the other markets in Bangladesh. Price analysis and formation of policy at the aggregate level will be pertinent for policy implementation.

Keywords: Price behaviour, Cereal crops, Market integration, Unit root, Engle-Granger

1. Introduction

This paper has attempted to assess the nature of seasonal price movement and the degree of inter-relationships between price movements in two markets or market integration of selected crops. As stabilisation of prices, particularly of major food grains, is a serious concern of most developing countries, so the generated information may help government in taking appropriate decision at all. The general pattern of seasonal variation in prices, i.e., lower prices during the immediate post-harvest months and higher prices during the pre-harvest or off-season months is a normal feature of food grains and repeated year after year. This is due mainly to seasonality in supply and factors affecting the stocking decisions of traders. Production of a particular food grain is usually confined to only one season while the demand is spread throughout the year. Thus storage becomes necessary and this involves costs, resulting in seasonal price variations. The extent of seasonal price variation depends, in addition to storage cost, on the degree of seasonal concentration of sales, perishability of the product, risk involved in holding the product over time and availability of storage, warehousing and credit facilities (Acharya and Agarwal, 1994, p.82).

Again, the single market does not stand alone as a determinant of either price or quantity and the actions of buyers and sellers in a particular market. Commodity markets are always influenced to a large degree by the respective price signals and substitution possibilities in other related markets (George, 1984). A marketing system is spatially integrated when prices in each individual market respond not only to their own supply and demand but to the supply and demand of the set of all markets. In short, a local scarcity in an integrated system is less prejudicial to local consumers because it includes the arrival of products from other location. It increases supply and decrease the price. Thus, the degree of spatial price relationship is important for agricultural crops. The objectives of this paper therefore are:

1. To analyse the extent of the seasonal price fluctuation of major cereal crops in Bangladesh.
2. To study the spatial price relationships of major cereal crops in different markets with the aim to assess extent of market integration.

2. Methodology of the Study

For this study leading cereal crops, Boro paddy and wheat have been selected according to their ascendancy in agriculture in terms of production and area coverage. These crops occupy largest cultivated area (33.12 percent) together out of total cultivated area in Bangladesh (BBS, 2006 p.33). As Boro covers the major part in case of production among different rice varieties, only Boro has been selected in the study. According to the BBS, Boro production was 56.67 percent of total rice production in 2008-09.

Harvest prices of selected crops have been taken into consideration for the reason that wholesale and retail prices may not reflect what the farmers actually receive, because they are set at a considerably higher level (covering cost of storage, transportation and risk). Moreover, bulk of the agricultural produces is marketed during the harvest or immediately post harvest period. So, harvest prices are the most relevant prices for the producer farmer. Unavailability of required data is one of a major limitation of this research work. For calculating monthly prices of selected crops four weeks prices were averaged which were available in DAM weekly price bulletin.

The study makes an extensive use of secondary data on prices and quantity available of selected crops in Bangladesh for the period of 24 years from 1986-87 to 2009-10 (as the latest data available). Agricultural sector prior to eighties was highly subsidized by the Government. Withdrawal of subsidies and handing over fertilizer and irrigation equipment marketing to private sector started from the eighties.

For Boro paddy five and for wheat six district markets have been selected due to their leading growing areas. Due to unavailability of the Boro paddy price for Dhaka, Boro clean rice price was used in the analysis of market integration measurement. As the research was solely based on secondary data, these data were obtained from various publications of Ministry of Finance, Bangladesh Bureau of Statistics, FAO statistical report, various books, journals, newspapers and internet. Furthermore, district wise market prices of different crops were collected from the weekly wholesale price bulletin of Department of Agricultural Marketing (DAM).

2.1 Analytical Techniques

The seasonal pattern is analysed by construction of seasonal index numbers by applying ratio to moving average method. To avoid the problem of spurious correlation between time series variables especially price variable co-integration method which was developed by Engle and Granger (1987) for making firm decisions on market integration has been used.

A test of stationarity (or non-stationarity), that has been developed by Dickey-Fuller was applied in this study. This test is to consider the following model:

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

Where U_t is the stochastic error term that follows the classical assumptions, namely, it has zero mean, constant variance σ^2, and is non-autocorrelated. Such an error term is also known as a white noise error term. Equation (1) is a first-order, or AR (1), regression in that regress the value of Y at a time (t-1). If coefficient of Y_{t-1} is in fact equal to 1, that is known as the unit root problem i.e., a non-stationary situation. Therefore, if runs the regression,

$$Y_t = \rho Y_{t-1} + U_t \quad ; \quad -1 \le \rho \le 1 \qquad \text{................} \ (2)$$

and actually find that $\rho = 1$, then the stochastic variable has a unit root.

For theoretical reasons, the equation (2) can be manipulated as follows:

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

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

which is alternatively written as,

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

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

Under the null hypothesis $\delta = 0$, i.e., $(\rho - 1) = 0$, the conventionally computed t statistic is known as the τ (tau) statistic, whose critical values have been tabulated by Dickey-Fuller test (DF) 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, 2004, p.975).

The DF test is estimated in different forms under different null hypotheses:

Without trend, $\Delta Y_t = \beta_1 + \delta Y_{t-1} + U_t$ .... (5)

With trend, $\Delta Y_t = \beta_1 + \beta_2 t + \delta Y_{t-1} + U_t$ .... (6)

In each case, the null hypothesis is that $\delta = 0$; that is, there is a unit root – the time series is non-stationary.

The ADF test is run with the following equation,

$$\Delta Y_t = \beta_1 + \beta_2 t + \delta Y_{t-1} + \alpha_i \sum_{i=1}^{m} \Delta Y_{t-i} + U_t \quad \text{.................. (7)}$$

Where U_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. The critical values of the 't' statistic of the lagged term have been tabulated by Dickey and Fuller. Once it has been established that the order of integration is the same for each variables of interest, the second stage for testing co-integration can be undertaken only for those variables of the same order of the integration would qualify for the pair-wise co-integrating relationships. The specific linear combinations tested are the residuals from a static co-integrating regression in the levels of variables concerned. The same test statistic can be used as in testing for order of integration of individual series. The regression equation would then be as indicated below,

$$Y_t = \beta_1 + \beta_2 X_t + \varepsilon_t \quad \text{...................... (8)}$$

Where Y_t and X_t are the two price series; ε_t is the residual term.

The residual term assumed to be distributed identically and independently. The test of market integration is straight forward if Y_t and X_t are stationary variables. The DF and ADF tests in the present context are known as Engle-Granger (AG) test whose critical values are provided by Engle and Granger (Ramakumar, 1998).

However, since the Y and X are individually non-stationary, there is the possibility that this regression is spurious. But when we perform a unit root test on the residuals obtained from the equation (8) in the following way,

$$\Delta\varepsilon_t = \beta \varepsilon_{t-1} \quad \text{...................... (9)}$$

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

3. Results and Discussion

Prices observed through time are the result of a complex mixture of changes associated with seasonal, cyclical, trend and irregular factors. The most common in agricultural prices is a seasonal pattern of changes. Seasonal or intra-year price variations are regularly occurring upswing and downswings in prices that occur with some regularity during the year. Such a regular pattern might arise from seasonality in demand, seasonality in supply and marketing or a combination of both (Tomek and Robinson, 1977, p-165-166).

Efficient marketing processes get into help in checking price variation of agricultural products. A marketing system is spatially integrated when prices in each individual market respond not only to their own supply and demand, but the demand- supply forces in all other markets. The assessment of market integration is helpful in the formation of appropriate policies for increasing the efficiency of marketing process.

3.1 Seasonal Price Indices of selected crops in Bangladesh

The seasonal component is defined as the intra-year pattern of variation that is repeated from year to year. Seasonal price variations resemble a cycle covering a period of 12 months or less (Dorosh and Shahabuddin, 2002, p.9). Here the seasonal percentage spreads and coefficient of variation of the selected crops for 1980s, 1990s and 2000s were calculated and presented in separate tables.

3.1.1 Boro (HYV) Paddy

Table 1 show the seasonality index of Boro paddy price for the late 1980s, the 1990s and the early 2000s. Two major patterns in the seasonality index can be observed. First, the month of peak price of Boro paddy during the study period was March, just before the harvest period. In the late 1980s, prices continued to rise from June to next March with a small drop in November and January. In the 1990s, there was a rise in prices from June to next March and some stable prices from September to November. In the 2000s, Boro price lead a high jump from January to February. The cause of this fluctuation may be due to the fact that the supply of Boro increases during April to June. After that period supply reduces and the price of Boro increases gradually. In 2000s peak price indices prevailed in March (111.03 percent) and lowest in May (87.33), which implies that, in March price of Boro was greater than 11 percent and in May lower than 12.67 percent from the average price of Boro. Second, coefficient of variation of Boro was also found decreasing gradually . The percentage spread also showed the similar pattern.

3.1.2 Wheat

It is found from the Table 2 that, the month of peak price was February, just before the harvest period (March to mid April). In the late 1980s and 1990s, prices continued to rise from May to Next January and wheat price showed most stable period in 2000s. Highest price indices prevailed in February (103.48 percent) and lowest in June (95.05) in 2000s, which implies that, February price of wheat was more than 3.48 percent and July price was lower than 5 percent from the average price of wheat in that period. The difference between these peak and trough value was lower than Boro. Coefficient of variation of wheat was also found decreasing gradually. Thus it may be concluded that the seasonal variations in wheat price have declined in the recent years, which may impacted higher area allocation to wheat in post 2000 years.

Figure 1 show that seasonal price variation is higher in the month of February, March for Boro paddy and also this variation is higher than the season price variation of wheat from the average price.

3.2 Unit root and Co-integration Test of Selected Crops

The valuable contribution of the concepts of unit root, co-integration, is to force us to find out if the regression residual are stationary (Gujarati, 2004, p. 822). As Granger (1987) notes, “A test for co-integration can be thought of as a pre-test to avoid spurious regression situations.

3.2.1 Boro (HYV) Market

To test the stationarity of the data, at first trend line of wholesale price for different district market, and autocorrelation and partial autocorrelation function was used to get the rough idea whether time series data are stationarity, from the figures (Figure 2, 3, 4 abd 5), it can be argued that there is a strong possibility of having non-stationarity behaviour in the time series data. The DF and ADF tests for harvest period Boro (HYV) paddy wholesale prices data for Dhaka, Kishorgonj, Rajshahi, Jessore and Comilla districts were also performed to take the final decision of non-stationarity/ stationarity over 1989 to 2010 periods. ADF test was applied in case where serial correlation exists and that could be found from the Durbin Watson statistic. The estimated tau (τ) statistics of the regression coefficients of one period lagged price, DW, and decision are presented in Table 3. The tau (τ) statistics compared with absolute values (e.g., estimated t-values 1.86 and 0.06 for Dhaka market price series which are less than the critical tau values without and with trend, i.e., null hypothesis is accepted and concluded that the series contained unit roots, i.e., series is non-stationary) indicate that all the Boro paddy price series data were non-stationary, i.e., contain unit roots.

The next step is to examine whether bivariate co-integration exist among different price series. For examining this, Dhaka wholesale market was considered as reference market. As there will be different combinations of the given five wholesale markets, all combinations in a system of bivariate relationships were tried (where Dhaka wholesale market is used as a reference market). Thus, total four combinations of co-integration regression estimated and the final result are presented in Table 4. The Engle-Granger (EG) tests of residual confirmed the stationarity of the residual series. Thus DF and ADF results of unit root equation indicate that the Boro price series are non-stationary at level, EG results of residual equation indicate that the residual series (which are linear combination of Boro price series) are stationary at level I (0). Thus the findings indicate that the original price series being non-stationary and their linear combination being I (0) that the series are co-integrated without any exception (at 1 percent and 5 percent level of significance).

Since the absolute values of the estimated τ values exceeds any of these critical values, the conclusion will be that the estimated U_t is stationary (i.e., it does not have a unit root) and prices are individually non-stationary but co-integrated. Thus the relationship between Dhaka market and other markets seems significantly highly correlated during harvest season of Boro paddy.

3.2.2 Wheat Market

For testing the stationarity of wholesale price of wheat (in Dhaka, Faridpur, Rangpur, Dinajpur, Rajshahi and jessore districts), DF and ADF test were used. Trend line, autocorrelation and partial autocorrelation function also used like wholesale price of Boro paddy to observe the stationarity/non-stationarity of the data. In case of wheat second differencing was required to leave out serial correlation. The estimated tau (τ) statistics of the regression coefficients of one period lagged price, DW, and decision are presented in Table 5. As estimated tau (τ) values are less than the respective critical tau (τ) values without and with trend, i.e., null hypothesis is accepted in all cases. Thus, the series contains unit roots, i.e., wheat price series were non-stationary.

In case of wheat total five combinations of co-integration regressions were estimated (where Dhaka wholesale market is fixed as a reference market) and final results are presented in Table 6.

In Engle-Granger (EG) tests as the absolute values of the estimated τ values exceeds any of these critical values, thus the conclusion will be that the estimated U_t is stationary (i.e., it does not have a unit root) and prices are individually non-stationary but co-integrated. Thus the co-integration between Dhaka market and other markets seems significantly high (at 1 percent level of significance) during harvest season of wheat.

4. Conclusions and Policy Implications

The result of the present study revealed that price variations of selected crops show distinct features within a year. The difference between peak and trough prices and coefficient of variation were higher for Boro paddy than wheat. In addition, sharply falling prices during harvest season can undermine the confidence in markets of producers. Again, extreme high prices throughout the period also unable to gain consumer satisfaction. Thus, it is necessary to make price stable for helping both producer and consumer. From this study, it was found that, price variations are decreasing gradually which is encouraging for producers. That means, price volatility of studied crops has been decreasing gradually. Thus, policy decisions (paddy procurement, open market sale, provides massive importance on agricultural research, supply of quality seed etc.) which have recently taken should be continued. Floor/ procurement price fixation (for both paddy and wheat) by the government during high price volatility should also be continued.

The results further reveals that, the markets of Boro paddy and wheat across the location were integrated as the market price information in regional markets were transferred to other markets. This is mainly attributed to close proxy, good communication facilities especially of cell phone technology and good infrastructural availabilities among the markets in Bangladesh. Thus, it implies that, price analysis and formation of policies at the aggregate level is valid and will be pertinent for policy implementation. 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 such as procurement or open market sale of rice and wheat, in all markets. Thus national price policy should be developed rather than regional price policy in case of well integration of the markets.

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Table 1: Seasonal price indices of Boro (HYV) paddy

Month	Seasonal Index (1986-87 to 1989-90)	Seasonal Index (1990-91 to 1999-2000)	Seasonal Index (2000-01 to 2005-06)	Seasonal Index (Overall)
July	87.46	92.20	93.51	91.60
August	92.66	94.76	97.77	95.04
September	98.57	98.09	96.26	97.34
October	98.70	98.90	103.08	100.19
November	94.06	96.75	103.52	98.00
December	114.41	102.41	104.93	105.21
January	108.89	111.14	102.94	108.46
February	115.92	119.01	110.60	116.01
March	**118.73**	**120.25**	**111.03**	**117.21**
April	105.30	93.31	99.05	97.23
May	**82.60**	**85.20**	**87.33**	**85.16**
June	82.68	87.98	89.99	88.55
Peak	118.73	120.25	111.03	117.21
Trough	82.60	85.20	87.33	85.16
Percentage Spread	43.58	41.15	27.15	37.64
CV	12.69	11.34	7.46	10.07

Source: Own calculation by using data from various issues of BBS.

Table 2: Seasonal price indices of wheat

Month	Seasonal Index (1986-87 to 1989-90)	Seasonal Index (1990-91 to 1999-2000)	Seasonal Index (2000-01 to 2005-06)	Seasonal Index (Overall)
July	96.57	92.76	98.84	95.39
August	101.63	96.93	101.44	99.02
September	105.46	102.57	100.91	102.31
October	106.74	105.77	100.65	104.53
November	106.60	105.61	100.04	104.88
December	104.55	106.80	99.11	104.69

January	108.40	108.85	101.74	106.09
February	**108.47**	**109.26**	**103.48**	**106.76**
March	**87.63**	100.60	101.75	98.91
April	88.01	**89.80**	97.02	**91.92**
May	91.01	90.16	99.97	93.17
June	89.33	90.92	**95.05**	92.35
Peak	108.47	109.26	103.48	106.76
Trough	87.63	89.80	95.05	91.92
Percentage Spread	23.78	21.67	8.87	16.14
CV	8.49	7.55	2.28	5.63

Source: Own calculation by using data from various issues of BBS.

Table 3: Unit root for Boro paddy harvest price series

Markets	Method	Trend factor	Constant	Coefficient Pt-1	Coefficient (ΔPt-1)	Coefficient (t)	DW	Decision
Dhaka	DF	Without Trend	145.05	0.19 (1.86)			2.05	Non-stationary
		With trend	-131.50	-0.01 (-0.06)		22.69	1.95	
Kishore-gonj	DF	Without Trend	-82.28	0.18 (2.63)			1.86	Non-stationary
		With trend	-67.93	0.07 (0.66)		5.40	1.81	
	ADF	1 lagged difference	-52.76	0.03 (0.18)	0.14	6.30	1.97	
Rajshahi	DF	Without Trend	137.08	-0.10 (-0.64)			2.04	Non-stationary
		With trend	128.29	-0.43 (-2.03)		23.18	1.86	

	ADF	1 lagged difference	115.01	-0.43 (-1.68)	-0.02	23.83	1.88	
Jessore	DF	Without Trend	-149.90	-0.27 (1.59)			2.12	Non-stationary
		With trend	-79.42	0.01 (0.04)		10.97	1.97	
Comilla	DF	Without trend	4.05	0.06 (0.38)			2.13	Non-stationary
		With trend	97.94	-0.38 (-1.48)		18.93	1.96	

Figure in the parentheses show t-values of regression coefficient.

Dickey-Fuller critical values (τ values):

-3.75 and -3.00 at 1% and 5% level of significance respectively without considering trend.

-4.38 and -3.60 at 1% and 5% level of significance respectively considering trend value.

Table 4: Co-integration results for market pairs of Boro paddy from 1989-2010

Markets	Co-integrating regression	Co-integration Test Engle-Granger	Decision
Dhaka – Kishorgonj	$P_D = -363.83 + 2.46 P_K$ $R^2 = 0.96$, (20.93)	$\Delta U_t = -0.76 U_{t-1}$*** (-3.39)	Co-integrated
Dhaka – Rajshahi	$P_D = -84.07 + 1.89 P_R$ $R^2 = 0.83$, (9.91)	$\Delta U_t = -0.52 U_{t-1}$** (-2.40)	Co-integrated
Dhaka – Jessore	$P_D = -362.04 + 2.29 P_J$ $R^2 = 0.93$, (16.25)	$\Delta U_t = -0.81 U_{t-1}$*** (-3.48)	Co-integrated
Dhaka – Comilla	$P_D = -451.81 + 2.61 P_C$ $R^2 = 0.93$, (16.32)	$\Delta U_t = -0.83 U_{t-1}$*** (-3.77)	Co-integrated

Figure in the parentheses show t-values of regression coefficient.

Tau (τ) values are -2.66 and -1.95 at 1% and 5% level of significance respectively without constant in the equation.

*** indicates significant at 1% level.

** indicates significant at 5% level

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Table 5: Unit root for wheat harvest price series

Mark-ets	Meth-od	Trend factor	Constant	Coefficient Pt-1	Coefficient (ΔPt-1)	Coefficient (ΔPt-2)	Coefficient (t)	DW	Decision
Dhaka	DF	Without trend	146.28	-0.09 (-1.21)				2.02	Non-stationary
		With trend	187.88	-0.41 (-2.43)			19.28	1.79	
	ADF	1 lagged difference	232.82	-0.53 (-2.75)	0.19		23.86	1.73	
		2 lagged differences	159.69	-0.42 (-1.82)	0.17	0.01	21.19	1.93	
Faridpurpur	DF	Without trend	83.21	-0.02 (-0.23)				2.08	Non-stationary
		With trend	74.46	-0.26 (-1.64)			16.65	1.85	
	ADF	1 lagged difference	81.56	-0.29 (-1.60)	0.09		17.88	1.72	
		2 lagged differences	8.20	-0.15 (-0.75)	0.02	-0.24	14.39	1.84	
Rangpur	DF	Without trend	111.95	-0.05 (-0.73)				1.87	Non-stationary
		With trend	73.73	-0.29 (-1.86)			18.11	1.73	
	ADF	1 lagged	82.53	-0.34	1.68		20.08	1.85	

		difference		(-1.88)					
		2 lagged differences	27.66	-0.47 (-2.39)	0.31	0.37	28.91	2.05	
Dinajpur	DF	Without trend	129.70	-0.08 (-0.93)				2.08	Non-stationary
		With trend	135.08	-0.47 (-2.54)			24.57	1.87	
	ADF	1 lagged difference	151.51	-0.53 (-2.38)	0.10		26.83	1.68	
		2 lagged differences	53.98	-0.23 (-0.92)	-0.06	-0.42	16.30	1.73	
Rajshahi	DF	Without trend	88.93	-0.01 (-0.18)				1.94	Non-stationary
		With trend	97.57	-0.32 (-1.71)			19.75	1.74	
	ADF	1 lagged difference	97.24	-0.32 (-1.52)	0.02		20.17	1.64	
		2 lagged differences	63.08	-0.59 (-2.23)	0.40	-0.15	33.40	1.75	
Jessore	DF	Without trend	116.78	-0.05 (-0.59)				2.06	Non-stationary
		With trend	69.61	-0.31 (-1.90)			21.18	1.85	
	ADF	1 lagged difference	73.34	-0.34 (-1.85)	0.10		22.85	1.85	

		2 lagged differences	10.92	-0.29 (-1.35)	0.08	-0.08	23.39	1.97	

Figure in the parentheses show t-values of regression coefficient.

Dickey-Fuller critical values (τ values):

-3.75 and -3.00 at 1% and 5% level of significance respectively without considering trend.

-4.38 and -3.60 at 1% and 5% level of significance respectively considering trend value.

Table 6 : Co-integration results for market pairs of wheat from 1986-2010

Markets	Co-integrating regression	Co-integration Test Engle-Granger	Decision
Dhaka – Faridpur	P_D = 199.11 + 0.84 P_F R^2 = 0.95, (20.28)	ΔU_t = -0.45 U_{t-1}*** (-2.75)	Co-integrated
Dhaka – Rangpur	P_D = 274.40 + 0.76 P_R R^2 = 0.91, (15.05)	ΔU_t = -0.54 U_{t-1}*** (-3.15)	Co-integrated
Dhaka – Dinajpur	P_D = 139.89 + 0.94 P_{Di} R^2 = 0.95, (21.80)	ΔU_t = -0.49 U_{t-1}*** (-2.83)	Co-integrated
Dhaka – Rajshahi	P_D = 160.77 + 0.85 P_{Rj} R^2 = 0.94, (19.50)	ΔU_t = -0.63 U_{t-1}*** (-2.97)	Co-integrated
Dhaka – Jessore	P_D = 271.72 + 0.74 P_J R^2 = 0.94, (18.47)	ΔU_t = -0.49 U_{t-1}*** (-3.07)	Co-integrated

Figure in the parentheses show t-values of regression coefficient.

Tau (τ) values are -2.66 and -1.95 at 1% and 5% level of significance respectively without constant in the equation.

*** indicates significant at 1% level.

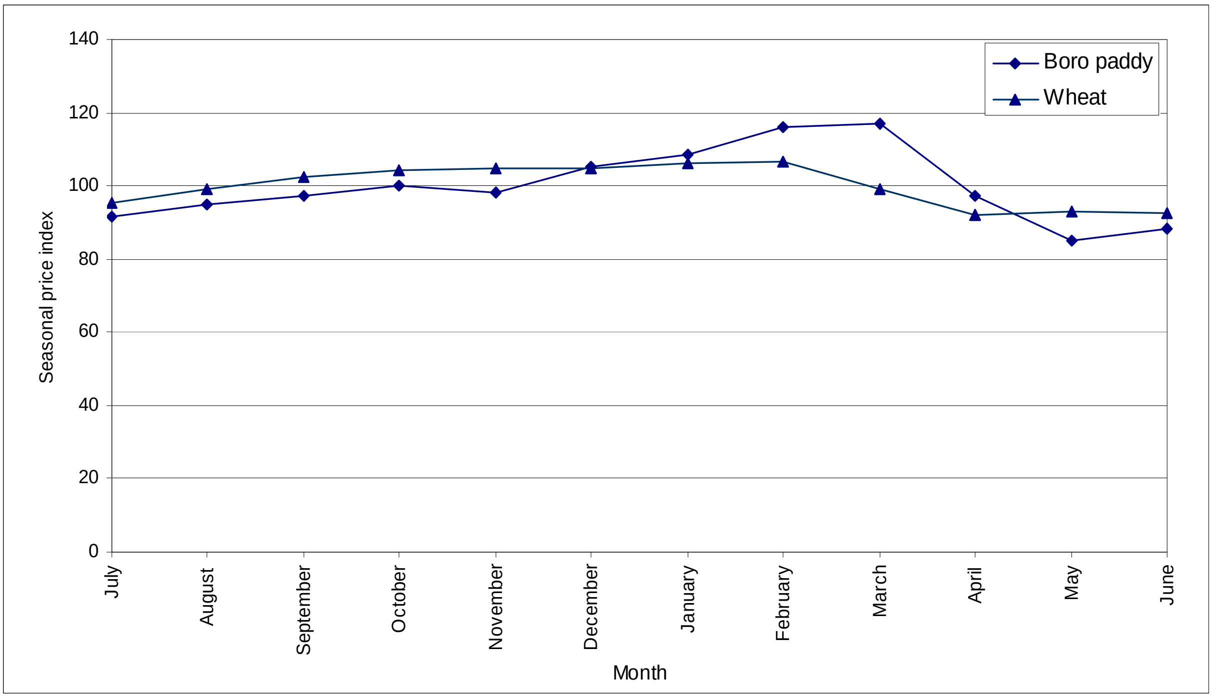

Figure 1: Seasonal price variation of Boro paddy and wheat in Bangladesh

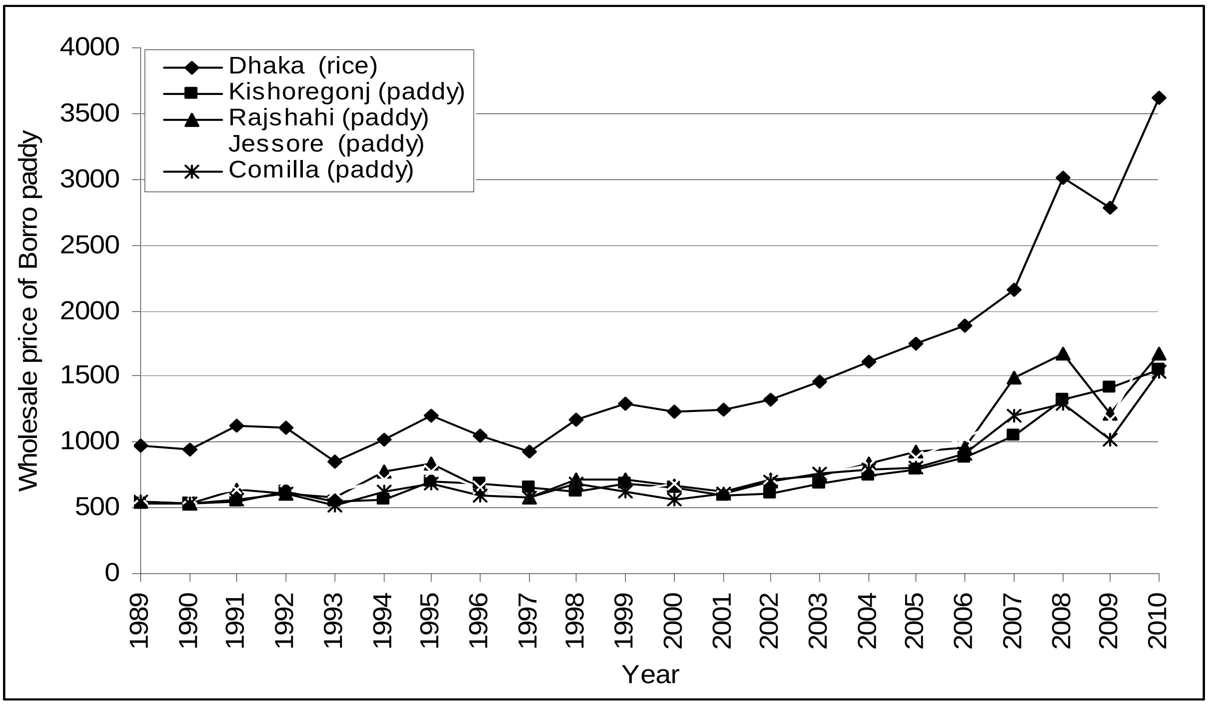

Figure 2: Trend of harvest time wholesale price (Tk./quintal) of boro paddy at different district markets in Bangladesh

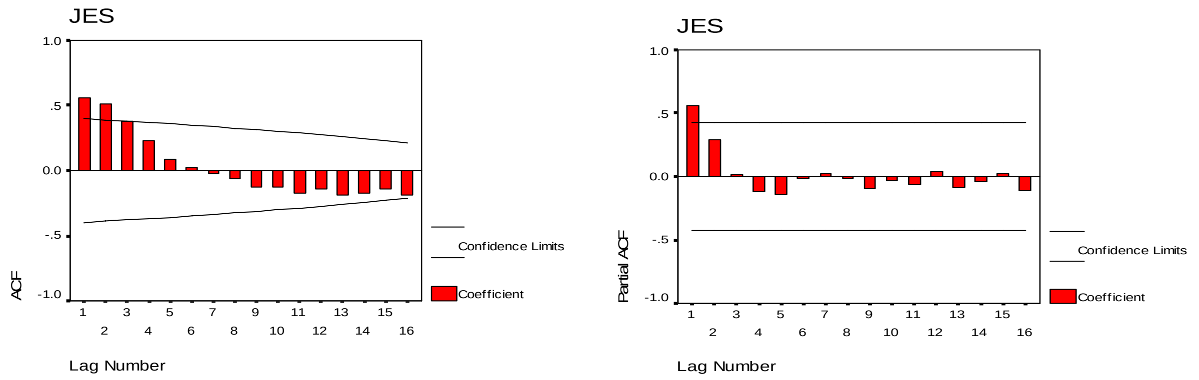

Figure 3: Autocorrelation and partial autocorrelation function of wholesale price at Jessore market

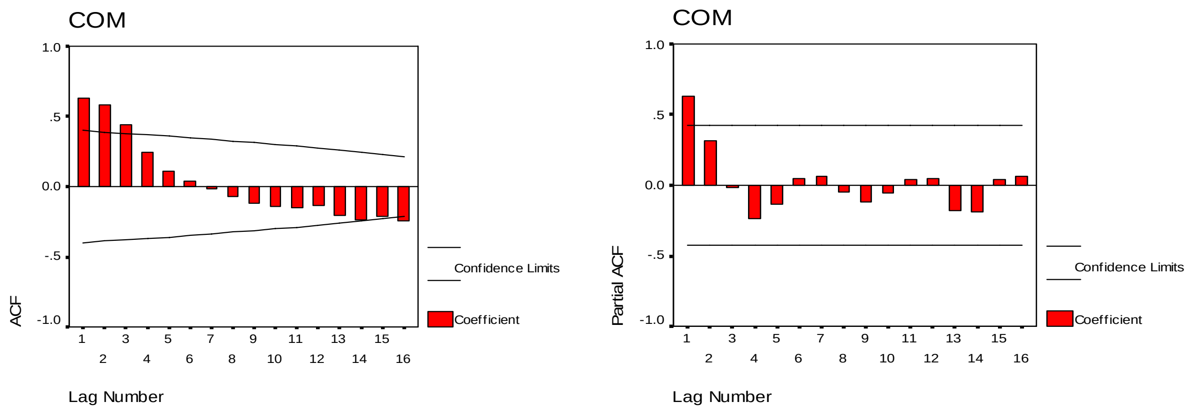

Figure 4: Autocorrelation and partial autocorrelation function of wholesale price at Comilla market