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Research Article

SPATIAL INTEGRATION OF WHOLESALE PRICES OF MAJOR POTATO MARKETS OF UTTARAKHAND

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Abstract: The study was undertaken to discern the nature and extent of spatial integration of wholesale prices of major potato markets of Uttarakhand using the weekly wholesale price data from 2015 to 2017. The Johannes's co-integration test was used to test for long run market integration. Dynamics of short-run price responses were examined by using Vector Error Correction Model (VECM). The wholesale markets of potato were shown to be integrated. However, the price transmission in short-run was insignificant. The wholesale markets of potato found to be segmented with the other markets of Uttarakhand, which signifies that the longer the distance, the lesser the integration could be observed. So, it may be concluded that while the prices are tied together in long-run, they drift apart in the short-run because of paucity of availability of information and lack of dissemination of available information. The co-integration analysis among the major potato markets of Uttarakhand reveals that the significant short-run association was missing in Rudrapur market so there is a weak association between the markets in short-run.

Keywords: *Spatial integration, Potato prices, Potato markets, Uttarakhand*

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Introduction

The performance of any agricultural commodity market is assessed by spatial market integration. Markets are integrated when prices in different markets move together in response to change in demand, supply and other factors. Spatial market integration refers to a situation in which prices of a commodity in spatially separated markets move together after accounting for transport and other value additions in the supply chain and the price information transmitted smoothly across the markets, hence used as a measure of overall market performance. Spatial market integration helps in specializing producers in specific commodities, in which they are competitive over long term. The efficiency of any marketing system is determined by the degree to which the wholesale prices of a commodity in different markets are related to one another. Analyzing such interrelationships help in understanding the efficiency of the marketing system. In order to measure supply and demand, price discovery, and the structure of competition, geographical boundaries of a market are important. The geographical integration of markets determines the extent to which weather risk is shared over space by smoothing idiosyncratic price variations. Integrated markets have limited price differences in time, form and space, to the marketing costs. Therefore, one of the common indicators of an efficient functioning of the markets is the existence of high degree of integration in them. The existence of integration in the markets influences the conduct of the firms of the market and consequently the marketing efficiency. The integration among the firms is an indicator of existence of competitive conditions in the market. Market integration reveals the level of competitiveness in trade between the markets. The success of opening up of trade between the regions will depends on the strength of transmission of price signals among the markets in various regions of a country. Weak market integration indicates markets are not efficient. Markets that are not integrated may convey inaccurate price signals that might distort farmers marketing decisions and contribute to inefficient product movements. The present study was carried out to estimate the degree of integration in major potato markets of Uttarakhand.

Materials and Methods

The study was conducted in Dehradun, Haldwani and Rudrapur potato markets of Uttarakhand. These potato markets have been identified on the basis of maximum average monthly arrival of potato from the period 2014 to 2016. To achieve the stipulated objectives of the study the secondary time series data were used. To estimate the degree of integration of potato in major markets, weekly wholesale prices of potato were collected, for the period from 2015 to 2017 were taken from the from respective Agricultural Produce Market Committees (APMCs) of state as well as information available on Agmarknet portal of Government of India (www.agmarknet.nic.in) for the period from 2015 to 2017. Spatial Integration refers to a situation in which prices of a commodity in spatially separated markets move together and price signals information are transmitted smoothly across the markets. The extent of integration, defined as a set of markets that shares common long-run price information, and the short run relationships among markets have been tested using Johansen's co-integration approach. The main concept of co-integration analysis is that prices move from time to time, and their margins are subject to various shocks that may drive them apart or not. If in the long run they exhibit a linear constant relation, then we say that they are co-integrated. If a set of variables are co-integrated then there exists a valid error correction representation of the data and these dynamics of short-run price responses were examined by using Vector Error Correction Model (VECM).

The Johansen likelihood estimation and testing approach for market integration is based on the following Vector Auto-Regression (VAR) model.

$$\Delta x_t = \sum_{i=1}^{p-1} \Gamma_i \, \Delta x_{t-i} + \prod x_{t-p} + \varepsilon_t \qquad (1)$$

Where,

x_t = n x 1 vector of variables (x_{1t} ……. x_{nt}):[prices of n market]

p= number of lag to be determined

Γ_i, $\prod$= short run and long run parameter matrices

ε_t = error terms

The underlying principle of co-integration analysis is that, although many economic series may trend to trend upwards or downwards over time in a non-stationary fashion group of variables may drift together. Co-integration tests starts with the premise that for a long-run equilibrium relationship to exist between two variables it is necessary that they should have the same inter temporal characteristics. The first step in the analysis was to pre-test the order of integration of each variable, using Augmented Dickey Fuller (ADF) Test. The test was based on the following equation:

$$x_t = \alpha + \Upsilon x_{t-1} + \varepsilon_t \quad (2)$$

If Υ = 1, x is anon-stationary series (a random walk with drift); if the process is started at some point, the variance of x increases steadily with time and goes to infinity. If the absolute value of Υ is greater than one, the series is explosive. The test is carried out by subtracting xt-1 from both sides of the equation,

$$x_t - x_{t-1} = \alpha + (\Upsilon-1)\, x_{t-1} + \varepsilon_t$$
$$\Delta x_t = \alpha + \delta x_{t-1} + \varepsilon_t \quad (3)$$

Where, $\delta = \Upsilon-1$ and the null and alternative hypotheses are

H_0: δ = 0 (Unit root)

H_1:δ< 0

The Augmented Dickey Fuller (ADF) approach controls for higher-order correlation by adding lagged differences terms of the dependent variable to the right-hand side of the regression:

$$\Delta x_t = \alpha + \delta x_{t-1} + {}_{k=1}\sum^{p} \Upsilon_k \Delta x_{t-k} + \varepsilon_t \quad (4)$$

In taking ADF test, both a constant and trend should be included in the test regression, if the series seemed to contain a trend. If the series does not exhibit any trend and has a nonzero mean, only constant should be included in the regression. If the series seems to be fluctuating around a zero mean, neither constant nor a trend should be included in the test regression. The second step in analysis was to define the lag length. The lag length, at which the prices are mostly integrated, was defined by using VAR on the differenced series. In VAR analysis, Akaike Information Criterion (AIC) and Schwarz Criterion (SC) were used to select a suitable lag length. It is important method as inclusion of too many lagged terms may introduce the problem of multicollinearity and too few lags may lead to specification error. The lower the values of AIC and SC statistic, the better the model is. The results of co-integrating tests could be quite sensitive to these lag lengths. The VAR is commonly used for forecasting systems of interrelated time series and for analyzing the dynamic impact of random disturbances on the system of variables. This approach needs structural modeling by treating every endogenous variable in the system as a function of the lagged values of all the endogenous variables in the system. The mathematical representation of a VAR is:

$$x_t = A_t x_{t-1} + A_t x_{t-2} + \ldots\ldots\ldots + A_p x_{t-p} + E_t \quad (5)$$

Where,

x_t = n×1 vector of variables ($x_{1t}, x_{2t}, \ldots\ldots, x_{nt}$)

A_t= n×n matrix of coefficients

E_t = n×1 vector of error terms

By subtracting xt-1 from each side, equation (5) could be put into more usable form:

$$\Delta x_t = (A_t-1)x_{t-1} + A_t x_{t-2} + \ldots\ldots\ldots + A_p x_{t-p} + E_t \quad (6)$$

By adding and subtracting $(A_t-I)x_{t-2}$

$$\Delta x_t = (A_t-1)x_{t-1} + (A_2 + A_1 - I)x_{t-2} + \ldots\ldots\ldots + A_p x_{t-p} + E_t. \quad (7)$$

By continuing this fashion, we obtain equation (1)

$$\Delta x_t = {}_{i=1}\sum^{p-1} \Gamma_i \Delta x_{t-i} + \prod x_{t-p} + E_t \quad (8)$$

Where,

$\Gamma_i = {}_{j=1}\sum^{i} A_j - I$

$\prod = {}_{i=1}\sum^{p} A_i - I$

The rank ∏ of equation (8) is equal to the number of linearly independent co-integrating vectors that exist in the equilibrium system. If ∏ has full rank, all the elements of x_t are stationary. If ∏ is zero, they all are integrated. In Intermediate cases, if rank (∏) = 1, there is a single co-integrating vector and then expression ∏xt-p is error correction factor. For other cases in which 1 < ∏ < n, there are multiple co-integrating vectors.

The vector of random error was then used to construct two likelihood ratio test statistics that were used to determine the number of unique co-integrating vectors of xt. The first test statistic, known as the trace test, evaluated the null hypothesis that there were at most r co-integrating vectors and was given by

$$\lambda(trace)(r) = -T\ {}_{i-r+1}\sum^{n} ln\,(1 - \lambda_i) \quad (9)$$

Where,

λ_i= the estimated value of the characteristic roots obtained from the estimated ∏ matrix

T= the number of usable observation

The second maximum likelihood ratio test, known as the maximal Eigen value test, evaluated the null hypothesis that there were exactly r co-integrating vectors and was given by

$$\lambda(max)\,(r,r+1) = -T\ ln\,(1- \lambda_{r+1}) \quad (10)$$

Where,

In (1) =0, the expansion $\ln(1\text{-}\lambda_{r+1})$ will be zero if prices series were not co-integrated.

After the number of co-integrating vectors had been defined, restrictions on these co-integrating vectors were tested. The testing for short-run integration was incorporated in the Vector Error Correction Model (VECM) using the same price series, only when long run was observed. In the equation (8), Γ_i, the dynamics of partial short-run adjustment on the deviation from the long-run equilibrium could be estimated. For this, Johansen defined the two matrices α and β, both of dimensions (n × r), where r is the rank of ∏, such that ∏= αβ. The matrix βis the matrix of co-integrating parameters, and the matrix α the matrix of weights (the speed of adjustment parameters) with which co-integrating vector enters in the n equation of the VAR. Due to the cross –equation restriction, it will be not possible to estimate α and β using OLS. However, with maximum likelihood estimation, it is possible to (a) estimate as an error-correction model; (b) determine the rank of ∏; (c) use the r most significant co-integrating vectors to form β; (d) select α such that ∏ = αβ.

Results and Discussion

Spatial market integration refers to co-movements or the long-run relationship among prices. It is defined as the smooth transmission of price signals and information across spatially separated markets. Spatial market integration refers to a situation in which prices of a commodity in separated markets move together and price signals and information are transmitted smoothly across the markets, hence, spatial market performance may be evaluated in terms of the relationship between the prices of spatially separated markets and spatial behaviour in the markets may be used as a measure of overall market performance. Two trading markets are assumed to be integrated if price changes in one market are manifested in an identical price response in the other. The test of co-integration started with the test of stationary at levels and first difference using Augmented Dickey Fuller (ADF) test applied to potato wholesale prices in major potato markets of Uttarakhand. The following abbreviations were used for the markets: Haldwani (HLD), Dehradun (DUN), Rudrapur(RUD) of Uttarakhand. The results of unit root test are presented in [Table-1]. In the table it is shown that when the wholesale price series of potato was used as such without any differencing, the ADF test gave non-significant estimates as for each market the value of t statistic was lower than the critical value of t at 5 percent level of significance. This indicated that the data were non-stationary. Furthermore, the ADF test on first differences confirmed that the data were stationary with the order of integration for wholesale price series of all above potato markets.

Table-1 *Unit Root Test on wholesale price series of Potato in selected markets of Uttarakhand*

Markets	Unit root test on price levels				Unit root test on price differences			
	ADF	δ	t-value	p-value	ADF	δ	t-value	p-value
HLD	ADF(1)	-0.039	-1.25	0.4512	ADF(0)	-1.582	-20.4	0
DUN	ADF(0)	-0.041	-2.04	0.287	ADF(0)	-1.125	-11.25	0
RUD	ADF(0)	-0.096	-2.256	0.2156	ADF(0)	-1.084	-12.521	0

Note: In the column ADF the number of lags that was allowed for in the unit root test is indicated in brackets, based on Schwartz criterion. ADF analysis was carried out in EVIEWS, Critical value of t statistics is -2.88, 5 percent level of significance

Table-3 *Johansen's Trace test and Maximum Eigen Value Test for number of Co-integrating vectors in selected potato markets of Uttarakhand*

Null Hypothesis	Alternative Hypothesis	Maximum Eigen Statistics	5% Critical value	Hypothesized No.of Cointegrating Equation (s)	Trace Statistics	5% Critical value	Hypothesized No.of Cointegrating Equation (s)
r=0	r>0	26.5242	20.1466	None *	43.2045	28.652	None *
r=1	r>1	13.2547	14.5642	At most 1 *	16.5643	14.562	At most 1 *
r=2	r>2	2.45623	3.75462	At most 2	2.2451	3.8462	At most 2

*Note: * Rejection of the hypothesis at 5 % level of significance*

No. of Observations (N) for wholesale price series is 144 for each market

The VAR analysis of wholesale price series of potato with the suitable lag length of two lags period having minimum AIC and SC value are presented in the [Table-2]. The table consisted of only significant value at 5 percent level of significance. The table of VAR analysis indicates that the current wholesale price series of potato in HLD market was affected by its own lag two period prices and lag two period prices of RUD market.

Table-2 *VAR analysis on Potato wholesale price series in selected markets of Uttarakhand*

Market	ΔHLD (-2)	Δ DUN (-2)	Δ RUD (-2)
ΔHLD	0.32545 [3.45213]	-	0.21546 [3.25463]
ΔDUN	-	-	-
ΔRUD	-	-	-

Note: The results of VAR analysis are based on two lags (the AIC and SC were smallest). All the figures in parenthesis are t-values significant at 5 percent level of significance, non-significant values were omitted. The Johansen's method was used to test the presence of co-integrating vectors of the potato. The numbers of co-integrating vectors of potato wholesale price series are shown in [Table-3]. The result of Likelihood Ratio test showed that there was only one co-integrating vectors for the wholesale markets of potato at 5 per cent level of significance. This implied the long-run price integration among the wholesale markets of potato.

The co-integrating regressions of potato were normalized according to the rank for long-run price co-integration in selected potato markets of Uttarakhand. The results of normalized equations with respect to wholesale market prices for potato are given in [Table-4]. The table depicts that the wholesale price of potato in DUN and RUD market were integrated with HLD market.

Table-4 *Estimation of Long run price integration of potato in selected markets of Uttarakhand*

HLD = 0.25633	RUD- 1.64335	DUN [1.8653][-9.8652]*

Note: All the values in parenthesis are t-values

**Significant at 1 percent level of significance and critical t-value=2.32*

The results of error connection corresponding to the wholesale markets of potato are presented in [Table-5]. The table shows the short-run association among the potato markets for the change in price of potato. The table depicts that HLD market was the strongest follower of co-integrating equation 1 with speed of adjustment 25 percent, while DUN market was the strongest follower of co-integrating equation 1 with speed of adjustment 18 percent. High value for the speed of adjustment coefficient suggested that the time taken to return to long-run equilibrium is faster. The table further reveals that the significant short-run association was missing in Rudrapur market which indicated the presence of weak short-run association.

Table-5 *Estimation of short-run Dynamics of potato in selected markets of Uttarakhand*

Error Correction:	D(HLD)	D(DUN)	D(RUD)
CoinEq (1)	-0.256231	0.18542	0.02542
	(0.11453)	-0.06542	(0.08659)
	[-2.25646]	[2.35412]	[0.28526]

Note: All the figures in parenthesis (….) are standard error and figure in (…) are t-values.

Conclusion

The rich diversity of India in terms of agro-climatic and socio-cultural conditions provides an ideal environment for all round development of horticultural products. Potato (*Solanum tuberosum* L.) is an important horticultural crop of the world. It is an edible starchy tuber crop popularly known as 'The king of vegetables', has emerged as fourth most important food crop in India after rice, wheat and maize. Market integration has been used as an indicator of market efficiency and efficient marketing has become the key success for regional trade. The Johannes's co-integration test was used to test for long run market integration. Dynamics of short-run price responses were examined by using Vector Error Correction Model (VECM). It was observed that the wholesale markets of potato were shown to be integrated. However, the price transmission in short-run was insignificant. The wholesale markets of potato found to be segmented with the other markets of Uttarakhand which signifies that the longer the distance, the lesser the integration could be observed. So, it may be concluded that while the prices are tied together in long-run, they drift apart in the short-run because of paucity of availability of information and lack of dissemination of available information.

Application of research: The co-integration analysis among the major potato markets of Uttarakhand reveals that the significant short-run association was missing in Rudrapur market so there is a weak association between the markets in short-run. There is need to pay attention to the building of improved market information system *i.e.* able to disseminate up to date and timely market information on the regular basis so as to make proper production and marketing decision. The absence of transmission of price signals in short-run among the markets is mainly due to the lack of availability of information and lack of quicker dissemination of available information about price, demand and supply of products.

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