An Economic Analysis of Price Behaviour of Kinnow Market in North-Western India (Punjab)

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ABSTRACT

The study focused on assessing the spatial price behaviour between kinnow markets pairs in Punjab state of India using weekly kinnow price series of six markets from 2010-2016. The paper has applied time series model to investigate the market integration among different markets. The study has shown that there exists strong cointegration among the markets. Different causal relationships have been found between different markets. The application of vector error correction model (VECM) has indicated that all the error correction terms (ECTs) are negative and most of these terms are statistically significant, implying that the system once in dis-equilibrium tries to come back to the equilibrium situation. The study has also used Impulse response analysis which shows that change in price of one market will cause change in prices in other markets. The paper has concluded that price signals are transmitted across regions indicating that price changes in one market are consistently related to price changes in other market and are able to influence the prices in other market. However, the direction and intensity of price changes may be affected by the dynamic linkages between the demand and supply of kinnow. The study has provided an interesting insight for policy makers, and for contributing to improve the information precision to predict the price movements used by marketing operators for their strategies and by policy makers for designing the suitable marketing strategies to bring more efficiency across the markets.

***Key words** : Kinnow; Market integration; Co-integration; linkage;*

Recent challenges of climate change, deteriorating soil health and depleting groundwater in the North West India has posed stiff challenges to sustain the crop production, and farming income.Moreover the stagnation in the productivity of irrigated crops in the region has now forced the farmers to look for alternate cropping systems (*Gottipalliet al, 2021*). Now, largely there is a consensus among thescientific community and policy planners that climate change is a reality, and will have an adverse impact on crop production, and moreover, its impact is going to be compounded in near future. For instance, the central Indian Punjabis expected to have 2.2-2.8 and 4.7-5.5°C increase in average temperatures; 159-354 mm more rainfall during mid-century (2020-2050) over the present situation (*Jalotaet al., 2014*). In the view of climate change, diversification can be a centerpiece of mechanism to stabilize the farm income and improving the livelihood of farmers. Moreover, diversification can be vital strategy to reduce the soil fatigue, created by rice–wheat crop rotation system. For the diversification, therefore, fruit cropsare the ones, which can be good option for diversifyingcrop production in the state like Punjab, Haryana and parts of the Rajasthan.Further these crops have been identified as an ideal method of achieving sustainability of small holdings, increasing employment, improving environment, providing enormous export potential and above all, achieving nutritional security (*Hall et al., 2001; Romana and Sachdeva, 2015*). India is the second largest producer of fruits in the world after China with share to the tune of 10.9 per centofworld fruit production. In India, fruits occupy an area of 7.21 million hectares with an annual production of 88.97 million tonnes during the year 2013-14. Major fruits cultivated in India are mango (36.7%), citrus (13.6%) and banana (10.3%).Area under citrus fruits in India has increased from 90 thousand hectares in 1960-61 to 1077.7 thousand hectares in the year 2013-14 (NHB-2015). In the corresponding period, the production increased from 823 to 11147.10 thousand metric tonnes. Though various species of citrus are grown in the country but in northern region, mostly kinnow species of mandarin (santra) and malta species of sweet orange are being grown along with lemon group of citrus fruits.Kinnow cultivation is one of such important crops which has obtained the status of independent citrus industry in Punjab, Rajasthan and Haryana and is credited to bring golden revolution in the state.Cultivation of the fruit being a new enterprise, involves new package of practices for obtaining higher yield, better quality of fruit and increased shelf life. The farmers know well about how to produce good quality fruit but sometimes fail to get good returns due to lack of knowledge of proper marketing practices. This increase in production posing serious problems of postharvest losses due to crash in prices in the given situation of lack of infrastructure for storage and processing and also marketing. Small growers are unable to market their fruit at retail level neither they have capacity to bear risk of marketing produce at distant markets. They have to sell produce at whatever price traders offer in such a glut situation.

In spite of these challenges in the kinnow value chain, to date, there is no empirical research evidence ofwhat extent price transmission can be considered as efficient across different kinnow district markets andhow these markets are integrated. This research therefore seeks to find out how Kinnow markets in North Western India are integrated or not and price behavior of kinnow.

METHODOLOGY

The secondary data of kinnow weekly price are collected from different source like Agmarknet, NHB website. The Major markets are selected on the basis of higher quantity arrival and number of day's arrivals.

The major market of north western market was chosen for the study of market integration analysis. In addition, Delhi market was selected because the majority of the pre-harvest contractors and wholesalers of kinnow sold their fruit in this market. Delhi markets are the highest consuming markets in the North of India. Abohar market is used as production market whereas the rest were used as consumption markets for the market integration analysis. The data cover weekly kinnow prices from January 2010 to December 2016. The data set covers peak periods of kinnow i.e. January, February, March, November and December of each year. In all they were cumulative 140 observations. In addition, the wide data were selected to increase the potency of the models used in the analysis and also represent the availability of kinnow market price series for various markets. The price series are in rupees per quintal for all the markets and years.

Market integration is generally is assumed to mean that prices 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 (*Muhammad, 2004*). Several empirical techniques have been developed and used to investigate spatial market integration. Example is: the simple one-to-one correlation analysis (*Lele, 1971; Blyn, 1973*). According to *Blyn (1973)* a pioneer of the correlation method, high price correlations between markets are assumed to indicate market integration and the reverse stands for market segmentation. The model has short falls for instance; the prices in different markets might be highly correlated even if markets donot trade with each other. This can be because of common destination or common factors influencing prices. The correlation method also fails to capture time lag in price transmission.

To examine the price co-movements between two markets, the following approach was used to test theexistence of market integration. This approach was adopted from *Abdulai (2007); Mafimisebiet al. (2014);Kwasi and Kobina (2014), Banor and Madhu(2015)*.

$$P_1 = b_0 + a_2 P_2 + \varepsilon_t$$

Where P_1 and P_2 are price series of a specific kinnow in two the consuming market and the producing markets (1 and 2), and ε_t is the residual term assumed to be distributed independently. Parameter b_0 indicates transportation, handling and markets costs etc. The test of market integration is straightforward if P_1 and P_2 are stationary variables. Often, however, economic variables are non-stationary. A stationary series is one with a mean value which will not vary with the sampling period. In contrast, a non stationary series will exhibit a time varying mean (*Juselius, 2006*). Before examining integration relationships between or among variables, it is essential to test for unit root and identify the order of stationarity, denoted as I(0) or I(1). This is necessary to avoid spurious and misleading regression estimates.The framework of ADF methods is based on analysis of the followingmodel.

$$\Delta P_t = \alpha + \beta P_{t-1} + 1 + \gamma T + \sum_{k=1}^{n} \delta_k \Delta P_{t-k} - k - u_t$$

Here, *p* t is the kinnow price series being investigatedfor stationarity, Δ is first difference operator, *T* is time trend variable, u_t represents zero-mean, serially uncorrelated, random disturbances, k is the lag length; α, β, γ and δ_k are the coefficient vectors. Unit root tests is conducted on the β parameters to determine whether ornot each of the series is more closely identified as being I(1) or I(0) process. Test statistics is the t statistics for b. The test of the null hypothesis of equation (1) shows the existence of a unit root when b≠ 1. The nullhypothesis of non-stationarity is rejected when theabsolute value of the test statistics is greater than thecritical value. When *pt* is non-stationary, it is thenexamined whether or not the first difference of P_t is stationary $\Delta Pt - \Delta Pt-1 \approx (1)$ by repeating theabove procedure until the data were transformed to induce stationary.

DF-GLS test for a unit root in a time series is deployed in addition to Augmented Dickey Fuller (ADF) and Philips-Perron (PP) test. It performs the modified Dickey– Fuller t test (known as the DF-GLS test) proposed by *Elliott, Rothenberg and Stock (1996).* Essentially, the test is an Augmented Dickey–Fuller test, similar to the test performed by Stata's duller command, except that the time series is transformed via a generalized least squares (GLS) regression before performing the test. Later studies have shown that this test has significantly greater power than the previous versions of the augmented Dickey–Fuller test.

The Philips-Perron (PP) test is similar to the ADF test. PP test was conducted because the ADF test losesits power for sufficiently large values of "k", the number of lags. It includes an automatic correction to the Dickey- Fuller process for auto-correlated residuals. The regression is as follows:

$$\Delta P_t = \beta_0 + \beta_1 P_{t-1} + u_t$$

Where P_t is the kinnow price series being investigated for stationarity, β_0 and β_1 are the coefficient vectors and u_t is serially correlated. Testing for Johansen co-integration (trace and eigenvalue tests): If two series are individually stationary at same order, the Johansen co-integration model can be used to estimate the long run co-integrating vector using a Vector Auto regression (VAR) model of the form:

$$\Delta P_t = \alpha \sum_{i=1}^{k-1} \Gamma i \Delta P_{t-1} + \cap \Delta P_{-1t} + u_t$$

Where P_t is a nx1vector containing the series of interest (kinnow price series) at time (t), Δ is the first difference operator and ∩ are nxn matrix of parameters on the i^{th} and k^{th}lag of,

$$p_t \, \Gamma i = \left[\sum_{i=i,Ai}^{k}\right] - I_g \prod = \left[\sum_{i=i,Ai}^{k}\right] - I_g I_g$$

Ig is the identity matrix of dimension g,á is constant term, "is nx1 white noise error vector. Throughout, p is restricted to be (at most) integrated of order one, denoted I(1), where I(j) variable requires *j*th differencing to make it stationary. Equation (2) tests the co-integrating relationship between stationary series. *Johansen and Juselius (1990)* and *Juselius (2007)* derived two maximum likelihood statistics for testing the rank of Đ, and for identifying possible co-integration as the following equations show:

$$\lambda_{trace}[r] = -T \sum_{i=r+1}^{m} ln(1-\lambda)$$

$$\lambda_{max}[r, r+1] = -T ln \sum_{i=r+1}^{m} ln(1-\lambda)$$

Where r is the co-integration number of pair-wise vector, λ_t is i^{th} eigen value of matrix D. *T* is the number of observations. The λ_{trace} is not a dependent test, but a series of tests corresponding to different *r*-value. The λ_{max} tests each eigenvalue separately. The null hypothesis of the two statistical tests is that there is existence of r co-integration relations while the alternative hypothesis is that there is existence of more than r co-integration relations. This model was used to test for; (1) integration between pair-wise price series of local kinnow prices in the selected markets in the state.

Impulse response function is a shock to both VAR and ECM models used in the analysis. Impulse responses identify the responsiveness of the dependent variable which is (endogenous variables) in the models when a shock is put to the error term. A simplified model of impulse response function forAbohar against Delhi market prices can be written as:

$$Abohar\ r_t = \beta_0 + \beta_t Delhi_{t-1} + \cdots + \beta_h Abohar_{t-h} + U_t$$

Where U_t is error term or impulse or shock. Hence the model will give us the effect on the VAR system when a unit shock is applied to variables. After undertaking co-integration analysis of the long run linkages of the various market pairs, and having identified the market pair that are linked, an analysis ofstatistical causation will be conducted. The causality test uses an error correction model (ECM) of the following form:

$$p_t^i = \beta_0 + \beta_i\, p^i(t-1) + \beta_2\, p^i(t-1) + \sum_{k=1}^{m} \delta\, k\Delta p^i(t-k) + \sum_{k=1}^{m} \Delta\ \sigma h \Delta p^i(t-h) + u_t$$

Where m and n are number of lags determined by Akaike Information Criterion (AIC).If the null hypothesis that prices in market j do not Granger cause prices in market i is rejected (by a suitable F-test) that $\sigma_h = 0$ for h = 1, 2….n and β=0, this indicates that prices in market j Granger-cause prices in market i. If prices in i also Granger cause prices in j, then prices are said to be determined by a simultaneous feedback mechanism (SFM). This case is then referred to as bi-directional Granger causality. If the Granger-causality is in only one direction, it is called uni-directional Granger causality and the market which exhibited sufficient strength to have Granger-caused the other is referred to as the exogenous market (*Mafimisebiet al., 2012*).

RESULT S AND DISCUSSION

The Kinnow mandarin is major fruit crop in Punjab. It is grown most in Fazilka, Hoshiyarpur, Bathinda and Mukatsar district of Punjab. Kinnow is the most prevalent varieties covering an area 0.48 lakh ha with production 11.09 lakh ton in 2014-15. It is presented in Table 1 that area is increasing 9.3 (compound growth annual rate) growth rates. The productivity of Kinnow also has been increased substantially from 150 quintal per hectare to 230 quintal per hectare with recording growth rate of 3.2 per cent per annum. It shows that there is a huge potential to increase the farmer's income through cultivation of Kinnow crop. The increasing area and production has created marketing problem. So the price behavior of Kinnow has been studied.

Table 1. Kinnow production and area in Punjab

Year	Area (ha)	Production (Ton)	Productivity (q/ha)
2004-05	19360	290410	150
2005-06	22887	433050	189
2007-08	31788	591319	186
2008-09	35619	706645	198
2009-10	38837	876358	225
2010-11	41204	872626	211
2011-12	42795	915005	213
2012-13	43851	988633	225
2013-14	47101	1017725	216
2014-15	48182	1108618	230
CGAR (%)	9.3	12.7	3.2
Instability	0.9	1.3	2.5

Table2. Descriptive statistics of Kinnow price series (2010-2016) (N=140 in each market)

Market	Mean	SD	Mini	Maxi	CV (%)
Abohar	1163.43	319.28	625.00	2366.67	27.44
Amritsar	1166.18	274.22	700.00	2437.50	23.51
Jalandhar	980.92	292.83	592.00	2433.00	29.85
Ludhiana	1138.84	341.83	775.00	3583.00	30.02
Khanna	1200.95	378.98	775.00	2800.00	31.22
Delhi	1980.15	663.50	860.00	5777.00	33.51

Table 2 presents the various features of kinnow market price pertaining to the period 2010-2016. The mean price of kinnow in rupees per quintalfor the six (6) markets across Punjab and one outside the state was lowest at Rs. 980.92 in Jalandhar market. The highest average was recorded at price of Rs.1980.15 in Delhi market which was as expected due to the major consuming market in the India. The minimum price was recorded in Jalndhar and Abohar market, at price of Rs. 592and Rs. 625. Also the maximum was price recorded in Delhi market, at price of Rs. 5777. Coefficient of variance or variation which was used to measure the volatility of kinnow market prices, which indicates Amritsar market, has lowest price volatility which is represented by 23.51 per cent compared to 33.51 per cent in Delhi market, which has the highest. The high volatility in Delhi market can be attributed to a lot of things among which include the competition from Nagpur mandarin. Hence when the fruit of Nagpur mandarin is available in the market, it has a negative effect on the prices of kinnow. In addition, during the peak season of kinnow especially in the months of November to December, the weather is very cool in North India; hence consumers hesitate to take kinnow till February to March when the cool weather is quite less compared to the former. It isalso noticed that early harvesting of kinnowsometimes from early October by some pre-harvest contractors and farmers affect the quality of kinnow fruit which might not have matured enough (*Yogi et al., 2020*). The variation in kinnow arrivals to the market is also a contributing by these factors. Thus, price variation can be related to the trend of arrival levels, weather condition which shows fluctuations over time and are called as temporal variation, and the other comprises of fluctuations over the space and are called as spatial variation. These two kinds of price variations play animportant role in kinnow enterprises at farmer level which also affect the cropping pattern of the farmers' aswell as in the stability of income of the farmers.

Large fluctuations in the prices of a commodity may result in switching over of farmers to some othercrops and stable price level of kinnow will provide incentives to the farmers to increase the production and adapt to new technology which stabilize the farm income. In generally, agricultural commodities have high price volatility especially fruits which are highly perishable compared to manufactured goods hence the price fluctuations are expected. However, the volatility of kinnow prices is below 50 per cent i.e. low to medium price variation indicating normal volatility in prices of agricultural commodities. The results agree with *Chand Ramesh (2001), Banor and Madhu (2015)* and *Wani et al, (2015)* which argued that there is evidence of a much lower degree of agricultural price variability.

The Table 3 shows the unit root testing of all the market prices to be used for market integration analysis. The study first examined each variable time series for evidence of non stationary in order to proceed with co-integration approach. At level 0, we have found that all the major kinnow market price series in Punjab and Delhi were not stationary according to the Augmented Dickey Fuller (ADF) and Philips-Perron (PP) results as indicated in table. It indicates that series has timedependent statistical properties which may be stochastic or deterministic. The results of unit root testing of all the kinnow market price series at first difference is presented in table. Augmented Dickey Fuller (ADF) and Philips-Perron (PP) showed that the price series is become stationary whenfirst differences are done. It shows that the stationary series which had a constant mean and a constant finite covariance structure. So the series did not vary systematically with time, but tended to return frequently to its mean value and fluctuated around it within a more or less constant range. This indicated that the price series was suitable for co-integration.

Table 3. Unit root test using the augmented Dickey-Fuller and Phillip-Perron

Series		Augmented Dickey-Fuller		Phillip-Perron	
		t-stat.	Prob.	t-stat.	Prob.
Abohar	Level	-0.109	0.644	-0.0938	0.649
	1st diff	-14.276	<0.001	-14.434	<0.001
Ludhiana	Level	0.0144	0.686	0.285	0.767
	1st diff	-13.790	<0.001	-17.350	<0.001
Jalandhar	Level	-0.0456	0.665	0.157	0.733
	1st diff	-9.807	<0.001	-16.455	<0.001
Amritsar	Level	0.008	0.683	0.113	0.716
	1st diff	-10.194	<0.001	-26.883	<0.001
Khanna	Level	-0.0006	0.680	0.165	0.732
	1st diff	-13.790	<0.001	-15.465	<0.001
Delhi	Level	0.108	0.715	0.407	0.730
	1st diff	-9.80	<0.001	-38.790	<0.001

diff=difference

Table 4. Lag length using Schwarz information criterion (SIC)

Abohar**vs**	2010 to 2016
Ludhiana	1
Jalandhar	1
Amritsar	1
Khanna	1
Delhi	1

To check for co-integration among different market, a test for a suitable lag length to be included in the co-integration test was performed, because the results of co-integration tests can be quite sensitive to lag length (*Hafer and Sheehan, 1991)* The number of lags is selected by applying five different multivariate lag selection criteria: the Akaike information criterion (AIC), the Hannan-Quin information criterion (HQIC), and the Schwarz's Bayesian information criterion (SBIC), FPE and LR. A Vector Autoregression (VAR) on the differenced series was conducted and lags length of the model with the least AIC, HQIC, LR and FPE values chosen as the appropriate lag length to be included in the co-integration test (*Kwasi and Kobina, 2014, Banor et al, 2015, Paul et al, 2016, Wani et al, 2015*). For example Abohar and Delhi market was taken, the pre estimation lag selection criteria indicates the average maximum lag length for the model to be used in the analysis was 1 lag i.e. 1 week. This indicates the maximum time for price to be transmitted from one kinnow market (Abohar) to the other (Delhi) in the long run or to move into long run equilibrium is about one week at most.

Table 5. Bi-variate johansen cointegration rank test (2010 to 2016)

Abohar vs	Test statistics	Critical value	Prob.
Ludhiana			
λ_{trace}			
$H_0: r = 0 vs H_1: r \geq 1$	16.839	12.320	0.0082
$H_0: r = \leq l vs H_1: r \geq 2$	0.0252	4.129	0.8967
λ_{max}			
$H_0: r = 0 vs H_1: r \geq 1$	16.814	11.224	0.0048
$H_0: r = \leq l vs H_1: r \geq 2$	0.0252	4.129	0.8967
Jalandhar			
λ_{trace}			
$H_0: r = 0 vs H_1: r \geq 1$	16.802	12.320	0.0083
$H_0: r = \leq l vs H_1: r \geq 2$	0.0102	4.129	0.9341
λ_{max}			
$H_0: r = 0 vs H_1: r \geq 1$	16.792	11.224	0.0048
$H_0: r = \leq l vs H_1: r \geq 2$	0.0102	4.129	0.9341
Amritsar			
λ_{trace}			
$H_0: r = 0 vs H_1: r \geq 1$	20.063	12.320	0.0021
$H_0: r = \leq l vs H_1: r \geq 2$	0.0019	4.129	0.9709
λ_{max}			
$H_0: r = 0 vs H_1: r \geq 1$	20.061	11.224	0.0011
$H_0: r = \leq l vs H_1: r \geq 2$	0.0019	4.129	0.9709
Khanna			
λ_{trace}			
$H_0: r = 0 vs H_1: r \geq 1$	20.056	12.320	0.0021
$H_0: r = \leq l vs H_1: r \geq 2$	0.016	4.129	0.9165
λ_{max}			
$H_0: r = 0 vs H_1: r \geq 1$	20.040	11.224	0.0011
$H_0: r = \leq l vs H_1: r \geq 2$	0.164	4.129	0.9165
Delhi			
λ_{trace}			
$H_0: r = 0 vs H_1: r \geq 1$	22.652	12.320	0.007
$H_0: r = \leq l vs H_1: r \geq 2$	0.0117	4.129	0.9295
λ_{max}			
$H_0: r = 0 vs H_1: r \geq 1$	22.639	11.224	0.004
$H_0: r = \leq l vs H_1: r \geq 2$	0.0117	4.129	0.9295

To check for co integration among different market of Punjab, the Johansen method of cointegration was applied. The results of Johansen's co-integration test for different market are presented in Table 6 using the trace statistic and maximum eigin value. The use of maximum eigen value statistic has alsoresulted in the same conclusion as that of trace statistic. The co-integration tests results as shown in Table 6 indicates Abohar-ludhiana, Abohar-Jalandhar, Abohar- Amritsar, Abohar- Khanna and Abohar – Delhi markets are integrated in the long run. In other words, there is long run relationship between production market which is Abohar and the various consumption markets used in the model. This means that, most of the kinnow market prices in Punjab move closely together in the long run although in the short run they may drift apart, which indicates high efficiency between the market pairs in the state in long run. This shows that there is horizontal co integration among the kinnow market.This also indicates that thekinnow marketing is an open market of which the forces of demand and supply are the determinant of the various market prices henceensuring high efficiencies between spatial markets.

Table 6. Estimate of long run and the speed of adjustment from ECM for different agricultural market

Model	Regressors		2010 to 2016	
Abohar vs		PE	t- test	P value
Ludhiana	ECT_{t-1}	0.3152	-4.3624	<0.001
Jalandhar	ECT_{t-1}	-0.3135	-4.7682	<0.001
Amritsar	ECT_{t-1}	-0.4203	-5.3134	<0.001
Khanna	ECT_{t-1}	-0.2201	-3.2819	<0.001
Delhi	ECT_{t-1}	-0.4315	-5.8175	<0.001

PE=Parameter estimated

Table 7. Short run causality by Wald Test

Model	2010 to 2016	
Abohar vs	X^2 value	ρ value
Ludhiana	0.2263	0.6342
Jalandhar	0.5113	0.4746
Amritsar	0.1983	0.6560
Khanna	0.3329	0.5639
Delhi	2.5985	0.1070

The result presented in the Table 9 which shows that there is no short run relationship among the Kinnow market. This is due to that in short run there is not possible to stabilize the demand and supply of Kinnow.This create risk in kinnow enterprises. These types of risk are due to there is lack of cold storage and cold chain transport in the study area (*Yogi et al.; 2019*). The short run causality analyses shows that the market is not able to response.

CONCLUSION

The study has focused on time series techniques to test for descriptive study, price volatility, market integration in major market of Kinnow in Punjab. The price volatility Analysis revealed thatthe volatility of kinnow market prices is lowest in Amritsar market (23.51%) as compared to Delhi market (33.51%) which has the highest volatility. The high volatility in Delhi market can be attributed to a lot of things among which include the competition from Nagpur mandarin. The co-integration analysis revealed high integration among important Kinnow markets of Punjab revealing prevalence of high efficiency.

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