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Measuring Price Transmission, Causality and Impulse Response: An Empirical Evidence from Major Potato Markets in India

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SUMMARY

Commodity price transmission plays a pivotal role in determining the market leader among the comparable markets and for identification of the direction of price movements. This study makes an attempt to examine the cointegration and price transmission mechanism among three wholesale potato markets in India viz., Mumbai, Agra and Burdwan, during the period from January, 2016 to December, 2018 collected from *www.agmarketnet.gov.in*. Several econometric tools viz. stationarity tests (ADF and PP test), Johansen's cointegration test, Granger's causality test, Vector Error Correction Model (VECM), Impulse response function etc. are utilized to fulfil the objectives of the study. Johansen's cointegration test establishes the presence of long run equilibrium relationship among the markets with a single cointegrating equation. The study confirmed no price transmission occurs from Burdwan to Mumbai as there exist only unidirectional causality from Mumbai to Burdwan. From the VECM, it has been observed that the speed of adjustment (error correction term) from deviation towards the long run equilibrium for Agra and Mumbai markets are significant with daily price adjustment of 4.14% and 7.10% respectively, whereas, Burdwan market fails to establish any sort of significant behaviour. The impulse response curve also fails to establish any long-run association from Mumbai and Agra market towards Burdwan market. Based on all the market responses, both Agra and Mumbai market can be realized as the price leader as they influence the prices of all other markets.

Keywords: Price transmission, Cointegration, Impulse response function, VECM.

1. INTRODUCTION

Potato (*Solanum tuberosum*) is the fourth most important food crop in the world after wheat, rice and maize and commonly regarded as 'King of Vegetables'. It serves as an important source of income for rural farmers, provides rural employment, and supply nutrients to billions of people. It was introduced to India in early 17th century probably through British missionaries or Portuguese traders. India is the second largest producer after China with 15% (approx.) share in total potato production of the world. During 2017-18 potato acreage in India was 21.42 lakh ha with a production of 51.31 million tonnes (NHB, 2018). Major potato growing states are Uttar Pradesh (30.40%), West Bengal (26.07%) and Bihar (11.79%). Indian potatoes have also great export potential and major export destinations are Bangladesh, Malaysia, Nepal, Sri Lanka, UAE etc. Indian potato has a price advantage over the European countries because of lower production cost and shorter crop duration. Besides these, high potentiality with respect to export and production, potato price varies highly over seasons due to variations in production and market arrivals. Harvesting season in growing states falls in between November- December to March- April (Rabi Season). During peak arrival period, farmers and traders store potatoes in cold stores in anticipation of selling at higher prices during lean season of April-November. Therefore the price fluctuation in potato is the major concern for both farmers and consumers. For the market participants, price signals of agricultural commodities of markets located in different locations

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play a very important role in regulating production, consumption and marketing decisions over time.In this regard, market integration and price forecasting could help in stabilising the prices by removing the market imperfections, and attain market efficiency. In literature, Granger (1981, 1986), Granger and Weiss (1983), Engle and Granger (1987), Johansen (1988, 1995 and 1996), Myers (1994) and others, established the basis for cointegration analysis in econometric modelling. Accordingly, recent research on agricultural market integration using more sophisticated econometric tools viz. cointegration test, vector error correction model (VECM), impulse response function etc., yield significant improvement in achieving the modelling faults and resulting forecast failures. Gayathri *et al.* (2018) worked on cointegration analysis and VECM for understanding the price transmission of major garlic markets of Maharashtra viz. Ahmednagar, Karad, Pune and Nagpur. Kumar and Singh (2018) investigated the market linkages and flow of price information of potato between the major potato markets viz. Agra, Farrukhabad, Kanpur and Allahabad of Uttar Pradesh. Meera *et al.* (2015) studied the extent of cointegration of wholesale prices of wheat among major markets of Sriganganagar district of Rajasthan by using Johansen test, examined the causality by granger causality tests and also captured the speed of adjustment to deviations in long run equilibrium in wheat markets by using Vector Error Correction Model (VECM). Sinha *et al.*(2015) investigated the interdependence between Indian onion markets in terms of wholesale prices by considering major onion markets in India viz., Mumbai, Nashik and Delhi. Paul and Sinha (2015) worked on market integration among major coffee markets in India. Sahu *et al.* (2019) studied cointegration and price discovery mechanism of major spices in India. Baeg and Singla (2014) investigated market integration across five major wholesale apple markets, viz. Ahmedabad, Bengaluru, Delhi, Hyderabad and Kolkata, of the country by adopting Johansen's multivariate cointegration and impulse response approach.

In this study, an attempt has been made to examine the price transmission mechanism among major Indian potato markets in a vector autoregressive (VAR) and vector error correction (VECM) modelling framework for estimating price behaviour in selected markets. In addition to that impulse response function (IRF) is also used with the VAR system to understand the spatial price transmission mechanism. The rest of the article is constructed in the following way: Section 2 presents the material and methods, section 3 includes the results and discussion followed by conclusion in section 4 and references in section 5.

2. MATERIAL AND METHODS

2.1 Data

The present study is based on daily prices of three major potato markets collected from Directorate of Marketing and Inspection (DMI), Ministry of Agriculture and Farmers Welfare, Govt. of India from January, 2016 to December, 2018. The selected markets based on their daily market arrivals are Agra (UP), Burdwan (WB) and Mumbai (Maharashtra). The daily product arrival basically depicts the market holding of that particular market. Uttar Pradesh, West Bengal and Maharashtra jointly accounts for 67.5% of country's total potato arrivals and the selected markets are the highest in their respective states in terms of market holding. Thus, it helps to understand the relative importance of the wholesale market in the price transmission process. Despite the fact that Maharashtra is not one of the top potato-producing states, Mumbai, India's financial centre and the "Gateway" for potato export, is one of the top potato markets.

2.2 Methodology

2.2.1 Test for Stationarity

As we know that, a stationary time series has constant mean and variance and the value of covariance between two time periods depends only on the distance or lag between the two time periods and not on the actual time at which the covariance is computed. On contrary to a stationary time series, a non-stationary time series has time varying mean or variance or both. In econometric analysis most often a time series is non-stationary in nature. Augmented Dickey-Fuller (ADF) test and Phillips-Perron test (PP test) can be used to check stationarity in a time series and hence can be described as follows:

2.2.1.1. Augmented Dickey-Fuller Test

For testing stationarity, Augmented Dickey-Fuller test is applied where study variable Y_t can be expressed in following manner:

$$\Delta Y_t = \alpha_0 + \alpha_{1t} + \delta Y_{t-1} + \sum_{i=1}^{m} \beta_i \Delta Y_{t-i} + \epsilon_t \quad (1)$$

where, Y_t is a vector to be tested for cointegration, t is time or trend variable, $\Delta Y_t = Y_t - Y_{t-1}$ and ε_t is a white noise error term. The null hypothesis that $\delta = 0$; signifying presence of unit root, *i.e.*, the time series is non-stationary and the alternative hypothesis: $\delta < 0$ signifying the time series is stationary, therefore, rejecting the null hypothesis.

2.2.1.2. Phillips-Perron Test

The ADF test assumes the homogeneity in the error term where as in presence of non-homogeneity and any interdependence or any non-parametric behaviour, PP test is preferred. Phillips and Perron proposed an alternative (non-parametric) method of controlling for serial correlation while testing for a unit root. The PP test is based on the statistic:

$$\hat{t}_\alpha = t_\alpha \sqrt{\left(\frac{\gamma_0}{f_0}\right)} - \frac{T(f_0 - \gamma_0)(se(\hat{\alpha}))}{2\sqrt{f_0}\, s}$$

where $\hat{\alpha}$ is the estimate, and t_α is the *t*-ratio of α, $se(\hat{\alpha})$ is coefficient standard error, and *s* is the standard error of the test regression. In addition, γ_0 is a consistent estimate of the error variance (calculated as, $\frac{(T-k)s^2}{T}$ where *k* is the number of regressors). The remaining term, f_0, is an estimator of the residual spectrum at frequency zero.

2.2.2 Vector Autoregressive (VAR) Process

The optimal lag length for an unrestricted vector auto regressive (VAR) model need to identify based on suitable information criteria by taking the non-stationarity into account. In addition to that, a simple VAR model can also help to establish the short run dynamics between both the price series when a cointegrating relationship is not found. A VAR is a simple extension of the AR(P) framework and can be written as:

$$Y_t = \delta + A_1 Y_{t-1} + A_2 Y_{t-2} + \cdots + A_k Y_{t-k} + u_t \qquad u_t \sim IN(0, \Sigma) \tag{2}$$

where, $Y_t = (Y_{1t}, Y_{2t}, \ldots, Y_{nt})'$ is $(n\times 1)$ random vector of endogenous variables, each of the A_i is an $(n\times n)$ matrix of parameters, δ is a fixed $(n\times 1)$ vector of intercept terms. Finally,

$u_t = (u_{1t}, u_{2t}, \ldots, u_{nt})'$ is a *n*-dimensional white noise or innovation process, i.e., $E(u_t) = 0$, $E(u_t, u_t') = \Sigma$ and $E(u_t, u_s') = 0$ for s≠t. The covariance matrix Σ is assumed to be non-singular.

2.2.3. Johansen Method of Cointegration

With prior knowledge of the identical order of integration and appropriate lag length Johansen and Juselius cointegration test procedure is employed to find whether there exists a long run equilibrium among the price series. Let, Y_t is a *(nx1)* vector of non-stationary *I(1)* variables, then the unrestricted vector auto regression (VAR) of Y_t up to '*k*' lags can be specified as:

$$Y_t = \sum_{i=1}^{k} \Pi_i Y_{t-i} + u_t \tag{3}$$

For *k* > *1*, this VAR in the levels always can be written

$$\Delta Y_t = \Pi Y_{t-1} + \sum_{i=1}^{k-1} \Pi_i \Delta Y_{t-i} + u_t \tag{4}$$

The matrix Π can be expressed in terms of the vector or matrix of adjustment parameters α and the vector or matrix of cointegrating vectors β as, $\Pi = \alpha\beta'$.

If the matrix Π equals a matrix of zeroes, that is, $\Pi = 0$ then the variables are not cointegrated and the relationship reduces to the vector auto regression in the first differences.

$$\Delta Y_t = \sum_{i=1}^{k-1} \Pi_i \Delta Y_{t-i} + u_t \tag{5}$$

The rank of the matrix is determined and check whether, $Rank(\Pi) = 0$ against the $Rank(\Pi) \neq 0$, where, $Rank(\Pi)$= the number of cointegrating vectors. The number of cointegrating vectors is less than or equal to the number of variables *n* and strictly less than *n* if the variables have unit roots.

Literally, Johansen and Juselius test is called as *maximum eigen value test* and *trace test.* For both the test statistics, the initial Johansen test is a test of the null hypothesis of no cointegration against the alternative hypothesis of cointegration. Both the tests differ in terms of the alternative hypothesis.

The test of maximum eigen value is a likelihood ratio test and test statistic is defined as:

$$LR(r_0, r_0 + 1) = -T \ln(1 - \lambda_{r_0+1})$$

where $LR(r_0, r_0 + 1)$ is the likelihood ratio test statistic for testing whether rank $(\Pi) = r_0$ versus the alternative hypothesis that rank $(\Pi) = r_0 + 1$.

The trace test is based on finding the rank of the matrix Π i.e., r_0. The null hypothesis is that rank $(\Pi) = r_0$ and corresponding alternative hypothesis is $r_0 < rank(\Pi) \leq n$, where *n* is the maximum number of possible cointegrating vectors. For the succeeding test if this null hypothesis is rejected, the next null hypothesis is that $rank(\Pi) = r_0 + 1$ and the alternative hypothesis is that $r_0 + 1 < rank(\Pi) \leq n$.

The likelihood ratio test statistic is:

$$LR(r_0, n) = -T \sum_{i=r_0+1}^{n} \ln(1 - \lambda_i)$$

where, $LR(r_0, n)$ is the likelihood ratio statistic for testing whether rank $(\Pi) = r$ versus the alternative hypothesis that rank $(\Pi) \leq n$.

2.2.4 Granger Causality Test

The direction of causality of several time series variables is examined by Granger causality test. A time series *X* is said to Granger-cause *Y* if it can be shown, usually through a series of t-tests and F-tests on lagged values of *X* (and with lagged values of *Y* also included), that those *X* values provide statistically significant information about future values of *Y*.

For example,

$$Y_t = \alpha_1 + \sum_{i=1}^{n} \alpha_i Y_{t-i} + \sum_{j=1}^{m} \beta_j X_{t-j} + e_t \quad (6)$$

$$X_t = \alpha_1 + \sum_{i=1}^{n} \alpha_i X_{t-i} + \sum_{j=1}^{m} \beta_j Y_{t-j} + u_t \quad (7)$$

for all possible pairs of *(x,y)* series in the group. The reported F-statistics are the Wald test statistic for the joint hypothesis:

$$\beta_1 = \beta_2 = \cdots = \beta_l$$

for each equation. The null hypothesis is that *x* does not Granger-cause *y* in the first regression and that y does not Granger-cause *x* in the second regression.

2.2.5 Vector Error Correction Model

Error Correction Model (ECM)is used to analyse the short-run and long-run dynamics in the model. It has two distinct characteristics: first, an ECM is dynamic in the sense that it involves lags of the dependent and explanatory variables; it thus captures the short-run adjustments to changes of particular adjustments into past disequilibria and contemporaneous changes in the explanatory variables. Second, the ECM is transparent in displaying the cointegrating relationship between or among the variables. This study relies on VECM approach which provides relative advantage over conventional ECM, as it is restricted to only a single equation with one variable designated as the dependent variable, explained by another variable that is assumed to be weakly exogenous for the parameters of interest. The conventional VECM for cointegrated series can be written as:

$$\Delta Y_t = \beta_0 + \sum_{i=1}^{n} \beta_i \Delta Y_{t-i} + \sum_{i=1}^{k-1} \delta_i \Delta X_{t-i} + \varphi Z_{t-1} + u_t \quad (8)$$

where, Y_t represents the price of a commodity in a particular market and X_t represent the corresponding price of the same commodity in another market and $Z_{t-1}$is the Error Correction Term (ECT) which can also be obtained from the OLS residual of the long run cointegrating regression:

$$Y_t = \beta_0 + \beta_1 X_t + \varepsilon_t \quad (9)$$

The ECT is defined as:

$$Z_{t-1} = ECT_{t-1} = Y_{t-1} = \beta_0 - \beta_1 X_{t-1}. \quad (10)$$

The coefficient of ECT, φ is used to determine the speed of adjustment as it measures the speed at which *Y* returns to equilibrium after a change in *X*.

2.2.6 Impulse Response Function

An impulse response function traces the effect of a brief input signal or shock (i.e., impulse or innovation) on the variable of interest along a specified time horizon. More specifically, an impulse response denotes the response of any dynamic VAR system in reaction to some external modifications. Thus impulse responses are calculated from the coefficients of the MA(∞) representation of a representative VAR model. Let, MA(∞) of a VAR framework is in the form:

$$y_t = \mu + \epsilon_t + \varphi_1 \epsilon_{t-1} + \varphi_2 \epsilon_{t-2} + \cdots \quad (11)$$

The coefficients of the moving average representation are estimated from eqn. 11 which represents the responses of variables contained in y_t to a shock in different time periods. The matrix of the parameters φ_s of the above equation is interpreted as $\frac{d y_{t+s}}{d \varepsilon_t}$, implying the response of variable y in the period $t + s$, when there is a unit increase in variable's innovation at time *t,* keeping all the other innovations constant.

3. RESULTS AND DISCUSSION

The present investigation has conducted on daily wholesale prices of three important markets viz., Agra (Uttar Pradesh), Burdwan (West Bengal) and Mumbai (Maharashtra) and the time plot for those market prices are reported in the Fig. 1. The visual inspection of the plot can be a meaningful source to discern about the movement of the wholesale prices of the selected markets following a comparable trend. The price behaviour of these potato markets may indicate the presence of long run equilibrium among themselves and prices of one market may influence the price of another markets.

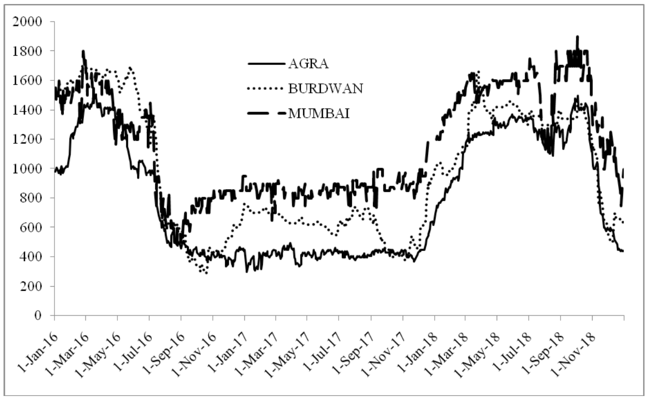

Fig. 1. Daily wholesale prices of potato in Agra, Burdwan and Mumbai market

3.1 Descriptive Statistics

The nature of the price series are represented by descriptive statistics reported in table 1. It can be seen that mean wholesale price of potato is highest in Mumbai market followed by Burdwan and Agra market respectively, during the period 2016-18. Burdwan and Agra market wholesale prices have almost similar variability (CV%) pattern as compared to the Mumbai market wholesale prices. For all the three markets, the price series show platykurtic behaviour which reveals that wholesale price of potato remained almost stable throughout the study period.

Table 1. Descriptive Statistics

Statistic	Agra	Burdwan	Mumbai
Mean (Rs./ Quintal)	912.38	972.264	1153.775
Median (Rs./ Quintal)	590	740	1000
Mode(Rs./ Quintal)	450	620	850
Maximum(Rs./ Quintal)	1510	1700	1900
Minimum(Rs./ Quintal)	300	290	500
Std. Deviation(Rs./ Quintal)	404.118	439.665	352.072
CV(%)	44.29	45.221	30.515
Skewness	0.315	0.244	0.231
Kurtosis	-1.632	-1.503	-1.401

3.2 Testing for Stationarity of Data

The ADF and PP stationary tests of wholesale potato prices for all the three markets confirm the presence of unit root (non-stationary at levels) and are integrated of order 1 i.e. I(1) (stationary at first differences), suggesting for further test of cointegration (table 2).

Table 2. ADF and PP test results

City	ADF test statistic	p-value	PP test statistic	p-value
Level				
Agra	-0.856	0.802	-1.088	0.722
Burdwan	-1.358	0.604	-1.530	0.518
Mumbai	-1.706	0.428	-2.119	0.237
First Difference				
Agra	-24.315***	<0.0001	-24.644***	<0.0001
Burdwan	-19.619***	<0.0001	-20.551***	<0.0001
Mumbai	-18.976***	<0.0001	-34.500***	<0.0001

Note: *** significant at p = 0.01

The selection of appropriate number of lags in a VAR model is important in order to maintain parsimonious nature of the model and also to conduct the cointegration procedure. The lag lengths of a fitted VAR model are determined, using several information criteria viz., Akaike Information Criteria (AIC), Schwatz Criteria (SC), Hannan Quinn (HQ) and Final Prediction Error (FPE). The values of these criteria at different lags are shown in Table 3.

Table 3. Lag Length Selection

Lag	AIC	SC	HQ	FPE
0	40.386	40.407	40.394	6.95e +13
1	30.836	30.920	30.869	4.95e +09
2	30.753	**30.900***	30.830	4.56e +09
3	**30.732***	30.941	**30.813***	**4.46e +09***
4	30.735	31.006	30.840	4.47e +09

*Note: * indicates optimum lag order selected by the particular selection criterion.*

3.3 Johansen Co-Integration Test

Both (trace test statistic and maximum Eigen value test statistic) the test statistic for identifying number of cointegration in these three potato markets, assures the rejection of H_0: r=0 i.e., no cointegration against the alternative hypothesis of existence of one or more cointegration. These tests also confirm the acceptance of r =1, i.e., one cointegrating equation at 5% level of significance (table 4). The presence of cointegrating vector implies that there exists long run equilibrium relationship among the major three wholesale potato markets of India. In this perspective, it can be assumed that information flow (i.e. price transmission) is occurring among themselves.

Table 4. Johansen Cointegration test results

Hypothesised No. of CE (s)	Trace Statistic	p-value	Maximum Eigen Statistic	p-value
r=0*	44.9561	0.0005***	29.9263	0.0022***
r≤1	15.0298	0.0586	13.4481	0.0670
r≤ 2	1.5817	0.2085	1.5817	0.2085

Note: *** significant at p= 0.01 and ** significant at p= 0.05.

3.4 Granger Causality Test

The causal relationship among the major potato markets have been assessed through Granger Causality test and reflecting the movement of information among these different marketas reported in Table 5.

Table 5. Results of pair-wise Granger Causality Test

Null Hupothesis	F-Statistic	Probability	Direction
Between Agra and Burdwan:			
Burdwan does-not Granger cause Agra	5.3271***	0.0012	**Both**
Agra does-not Granger cause Burdwan	3.9587***	0.0082	
Between Agra and Mumbai:			
Mumbai does-not Granger cause Agra	11.7546***	2.E-07	**Both**
Agra does-not Granger cause Mumbai	7.2632***	9.E-05	
Between Burdwan and Mumbai:			
Mumbai does-not Granger cause Burdwan	5.1605***	0.0016	**MB**
Burdwan does-not Granger cause Mumbai	2.6378	0.0588	

Note: *** significant at p= 0.01 and A, B and M denotes Agra, Burdwan and Mumbai respectively.

From the above table, Agra market shows bidirectional causality with both the Mumbai and Burdwan markets i.e., price transmission occurs in both the direction between these markets. The Granger causality test results on Burdwan and Mumbai markets shows that only Mumbai market granger cause Burdwan i.e., existence of unidirectional causality from Mumbai to Burdwan market, which also reveals that price information first reflected in Mumbai market and then it transmitted to Burdwan market. It can be confirmed that there exists long run bidirectional causality between Agra-Burdwan and Agra-Mumbai market and short run unidirectional causality between Burdwan and Mumbai market.

3.5 Vector Error Correction Model (VECM) estimates

The error correction term (ECT) indicates the speed of adjustment among the variables before converging to equilibrium in a dynamic model i.e., the coefficients show how quickly the variables return back to equilibrium. The speed of recovery or price adjustment from short run disequilibrium to long run equilibrium for potato price in Mumbai market is found to be 7.1% per day followed by Agra market which is 4.14% per day respectively. There is no speed of adjustment for Burdwan market as the error correction term (ECT) is not significant for the wholesale potato price of Burdwan market.

Table 6. VECM results

Error Correction	D (AGRA)	D (BURDWAN)	D (MUMBAI)
Cointegrating Equation	-0.0414 [-4.0216]***	0.0028 [1.1674]	-0.0710 [-3.2362]***
D (AGRA(-1))	0.0227 [0.5759]	0.0762 [1.9502]*	0.1342 [1.4746]
D (AGRA(-2))	-0.0107 [-0.2746]	0.0593 [1.5393]	0.2414 [2.6884]***
D (AGRA(-3))	-0.0130 [-0.3334]	0.0623 [1.6109]	0.0218 [0.2421]
D (BURDWAN(-1))	0.0642 [1.5784]	0.2301 [5.7169]***	0.1961 [2.0809]**
D (BURDWAN(-2))	0.0114 [0.2746]	-0.0669 [-1.6249]	-0.0192 [-0.1999]
D (BURDWAN(-3))	0.0845 [2.0805]**	0.0473 [1.1755]	0.0752 [0.8024]
D (MUMBAI(-1)	-0.0036 [-0.1970]	0.0004 [0.0203]	-0.2633 [-6.223]***
D (MUMBAI(-2)	0.0533 [2.9139]***	0.0277 [1.5302]	-0.1562 [-3.679]***
D (MUMBAI(-3)	0.0016 [0.0919]	-0.0004 [-0.0223]	-0.1128 [-2.7846]***
C (Residual)	-0.5809 [-0.4781]	-0.9719 [-0.8078]	-0.5480 [-0.1955]

Note: *Values in parentheses show t-statistic values; ***: significant at p = 0.01, **: significant at p = 0.05 and *: significant at p = 0.10; 'D': difference value of the price series.*

3.6 Impulse response functions

Impulse response (Fig 2.) demonstrates the market behaviour when a unit standard deviation

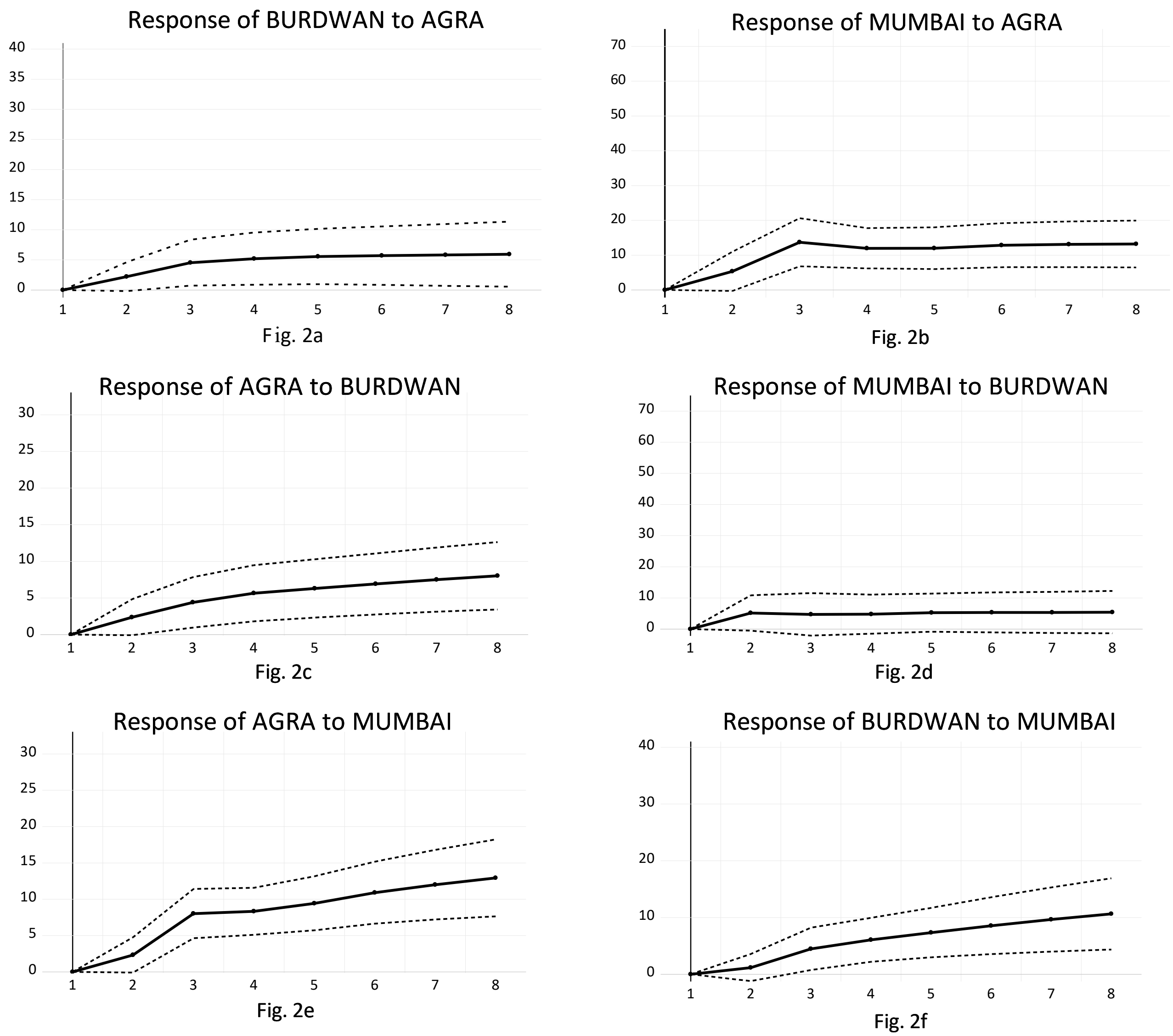

Fig. 2. Impulse Response Function between the studied markets

shock or innovation is given to a particular market. In the following figure, the response of Burdwan and Mumbai (Fig. 2a and Fig. 2b) market shows an increasing trend up to third period and moves toward equilibrium in the later periods, due to shock given in the Agra market. The response of Burdwan market due to Agra market is supported by the results of VECM (Table. 6) as there is short run effect from Agra market towards Burdwan market. The response of Mumbai market is well supported with VECM and Grangers causality test. The Agra market shows a gradual incline as a shock originated in the Burdwan market which is also supported by the results of VECM and Granger's test (Fig. 2c). The response of Mumbai market due to disturbance in Burdwan market shows little growth up to the second period, thereafter it shows a constant flat line i.e., the shock is not transmitted after the second period (Fig. 2d). The impulse response of Mumbai market may differ during first two periods but later it resembles after the Grangers causality results with no significant impact. The response of Agra and Burdwan markets (Fig. 2e and Fig. 2f) due to shock in the Mumbai market show more or less identical increasing tendencies with the exception in Agra market where the increasing trend is steeper than Burdwan market. The response of Burdwan market for the shock in Mumbai market is only assisted by the Grangers causality test (Table. 3) as the response is due to the presence of short run effects and no evidence of long run effects as shown in VECM table (Table. 6).

4. CONCLUSION

In this study an attempt has been made to examine the cointegration and price transmission mechanism among three spatially separated wholesale potato markets of India viz. Mumbai, Agra and Burdwan. It has been observed that all the different market pairs, have strong association among them. Agra and Mumbai markets are considered to be the price leaders, as they influence the prices of all other markets. This is clear from the fact that Agra is the largest potato market in India with 2.1 million tonnes of market holding and it has influence over other wholesale potato markets in India. As Mumbai market is contributing a major portion of foreign exchange earnings of India and hence influencing the prices of other related markets. VECM suggests that there is no long run association running from Agra and Mumbai to Burdwan. But, presence of short run effect is proved from the significant lagged term of Agra in the VECM and also from the impulse response of Burdwan market due to shock in Agra. Burdwan market shows no long run association with the other two markets. Short-run causality is also evident from the Granger's causality test, which is well assisted by the impulse response graph. Thus, Burdwan market gives an isolated behaviour in long-run with the other studied markets. As a result, Burdwan market fails to receive any significant price information for a long period from other major potato markets and thereby making Burdwan potato market most volatile. This study necessitates the government intervention to mitigate unexpected volatility in potato prices for smooth functioning of price transmission of major potato markets.

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