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MARKET PRICE COINTEGRATION OF TOMATO: EFFECTS TO NEPALESE FARMERS

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Abstract

Market price cointegration is a critical issue in Nepalese vegetable industry. This study intended to analyze the market price cointegration of tomato and its effect on Nepalese farmers, using secondary monthly time series of wholesale price data (since 2000 to 2010) of the Government of Nepal. The results of error correction model (ECM) showed that the series were stationary, and Kathmandu market was well cointegrated with source markets (Chitwan and Morang). Meanwhile, the vector error correction model (VECM) revealed that price adjustment process was much faster in source markets especially in negative price shocks in response to Kathmandu market, which affected the farmers for speedy price adjustment that leads to be hurt and discouraged. The study recommend policies to establish alternative vegetable markets that reduce the price dependency of farmers on Kathmandu market, encourage traders in involving vegetable marketing, and enhance effective market information services.

Keywords: *Market, price adjustment, price cointegration, tomato, Nepal.*

1. Introduction

Vegetable is an important source of income for rural farmers, provides rural employment, and supply nutrients for millions of Nepalese people. It is rapidly growing with an annual average growth rate about 10 percent, produced 5.9 million tons in 0.45 million hectares of land with yield 13.2 tons per hectare in 2010 (MOAD, 2011). Tomato is one of the important vegetable crops, cultivated throughout the year, positioned in second top rank after cauliflower in terms of area of cultivation, and highly tradable commodity that led to select tomato in this study. Shrestha and Pandey (2010) reported that agricultural marketing is quite complicated, large numbers of marketing intermediaries involved that adds the marketing cost, and eventually increases the price, which is largely implied in vegetable marketing. In general, smallholder vegetable farmers sell their products in local weekly market, and commercial farmers in distance wholesale markets via large number of commission agents.

Agriculture Perspective Plan-1995 (APP) is a guiding policy for overall agricultural development, focused on commercialization, competitiveness, and diversification in agriculture particularly vegetable crops (NPC, 1995; MOAC, 2004, 2005). One of the burning issues in vegetable sector is "higher price gap between the price received by

producer and price paid by the consumer". The price of the commodity in the production areas or in local market is low, while the consumers' price in different market hubs particularly in capital city (Kathmandu) is high. This has been a big concern among producer, consumer, Medias and policy makers. Pokhrel (2010) argued that the farmers are mandatory to sale their product whatever the price fixed by traders because of inaccessibility in marketing, perishable nature of the product, and lack of safe storage. If continuation of such problem exists in long-term, would have downbeat effect in vegetable production leading to impede in livelihood, and food and nutrition security.

Market cointegration has positive relationship with market efficiency and market competitiveness; as the market is cointegrated, it tends to be efficient, and competitive. In cointegrated markets, price differences between two markets are equal to the transaction costs between those two markets, provided that trade occurs. A price changes in one market will be transmitted on a "one-to-one" basis to the other market either instantaneously or over a number of lags (Sanogo & Amadou, 2010). In general, the major factors influencing market cointegration are inefficient marketing services, lack of infrastructures, restriction to entry firms, and ineffective information services. The previous studies mainly focused on market price cointegration (Sanogo, 2008; Sanogo & Maliki, 2010; Shrestha & Huang, 2012), and farm-retail price spread (Shrestha, 2012) of rice in Nepal. While vegetable sector has been ignored, which is more important in generating income and livelihood of rural farmers particularly in the developing economy, and the price has been fluctuating erratically. Mishra and Kumar (2013), reported that longer the distance between vegetable markets, the weaker the integration, and vice versa. In fact, none of the research has been conducted in vegetable market integration focusing to Kathmandu market and its effect on farmers, which is very important for producer, traders and consumers in long-run. Therefore, this study was carried out to analyze the market price cointegration of tomato and its effect to Nepalese farmers.

2. Materials and Methods

2.2 Study Area

The study conducted in 3 major vegetable markets; Kathamndu, Chitwan, and Morang (Figure 1). Kathmandu is the capital city, more than 2 million people reside, and where availability of vegetable for consumption is absolutely depends on importing from other districts. Kalimati Fruit and Vegetable Market (KFVMDB) is a central market located in Kathmandu operating since 1987 with daily transaction of vegetables ranges 550-650 tons in 2010 (KFVMDB, 2011). The major sources districts of vegetable in Kathmandu market are Dhading, Kavre, Chitwan, Morang Lalitpur, Dolakha, Sunsari, Dhankuta, and etc. The Chitwan is located in the central tropical region, and Morang is in the eastern tropical region, which are 146 kilometers and 239 kilometers away from Kathmandu, respectively. Both of the districts are big production and marketing hubs, which supply tomato either produced within the district or nearby districts. There is relatively a good access of transportation from these two source markets with Kathmandu, and having regular supply of tomato to Kathmandu market.

2.2 Data Sets

The study was based on secondary data source of tomato monthly wholesale price series since 2000 to 2010 of Kathmandu, Morang and Chitwan markets, published in special issue of Agribusiness Promotion and Marketing Development Directorate, Government of Nepal.

Additionally, Economic survey (2010/11) of the Ministry of Finance, Nepal Living Standard Survey (2010/11) of Central Bureau of Statistics, and Statistical Information on Nepalese Agriculture (2010/11) were used in this study. Many of the studies (Achmad, 2008; Adeoye et al., 2013; Muhammad, 2012; Reddy, 2012) used monthly time series in analyzing market cointegration of fresh vegetables. The price data set of tomato was normalized using consumer price index (CPI) deflated (2010=100) in this study.

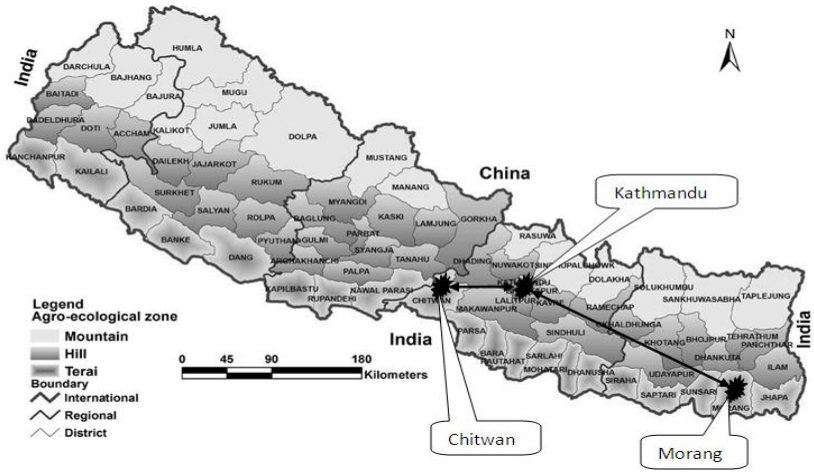

Figure 1. Map of Nepal Showing Study Areas

2.3 Analytical Framework

The error correction model (ECM) of Dickey-Fuller test, and vector error correction model (VECM) were adopted using SAS 9.1.3.exe software to analyze the market price cointegration of tomato in this study. Many of the studies (Adeoye et al., 2013; Alam, 2012; Bakucs, Fertő, & Szabó1, 2007; Basu, 2010; Ihle & Amikuzuno, 2009; Lohano, 2006; Muhammad, 2012; VanSickle, 2006; Zeng, Chang, & Lee, 2011) analyzed the market price cointegration of fresh vegetable using ECM, VECM, Ravallian, and Johansen approaches. According to Enders (2010), price cointegration of two markets can be tested if the price in one market display in same order with the other market. Ghosh (2010), and Sanogo and Maliki (2010) analyzed spatial price transmission using standard price transmission model considering bi-variate cointegration in rice. Meanwhile, market cointegration exists when the price in dependent market and independent market share similar stochastic trends, and the difference in residual are stationary. In this study, the estimated price in dependent market was considered as the function of prices at independent markets (equation 1).

$$\hat{Y}_t = \beta_1 + \beta_2 X_{it} + e_t \quad (1)$$

Where, estimated prices in Kathmandu market as dependent variable ($\hat{Y}_t$), and prices in source markets (Chitwan and Morang) as independent variables (X_{it}) at time t, and β_1, and β_2, represent intercept and coefficient, respectively, and e_t was residual term.

To test the market whether it is cointegrated, it is essential to test the series whether it is stationary. In this study, ECM of Dickey-Fuller test using Gauss Newton framework was used to test the stationary of least square residuals. The Dickey-Fuller test is the most

popular one in determining whether the series is stationary (Carter, 2011). It was assumed that if tau (τ) statistics is less than the critical value, then the series become stationary, and reject the null hypothesis for the cointegration of the markets, while if tau (τ) statistics is larger than critical value, the series become non-stationary, and fail to reject the null hypothesis of not cointegration of the markets. The three steps procedure was adopted in ECM: firstly, price difference of Kathmandu market (ΔY_t) was considered as the function of price lag at Kathmandu (Y_{t-1}), price lag at source markets (x_{it-1}), and the price difference source markets (Δx_{it}), and price difference of lag at source markets (X_{it-1}) (equation 2); secondly, the estimated lag of residuals ($\hat{e}_{t-1}$) was considered as the function of price lag of dependent market (Y_{it-1}), and price difference of lag at source markets (ΔX_{it-1}) (equation 3); thirdly, the difference in estimated residual ($\Delta \hat{e}_t$) was considered as the function estimated lag of residuals ($\hat{e}_{t-1}$), and difference of estimated lag of residuals ($\Delta \hat{e}_{t-1}$) (equation 4). If the residuals are stationary, then two markets are said to be cointegrated, whereas if the residuals are non stationary, the result will be opposite and the relationship would be spurious. Based on the standard Dickey- Fuller model (equation 2, 3, and 4), the market price cointegration of Kathmandu-Chitwan, and Kathmandu-Morang markets were analyzed, separately.

$$\Delta Y_t = -\alpha(Y_{t-1} - \beta_1 - \beta_2 x_{it-1}) + \delta_0 \Delta x_{it} + \Delta X_{it-1} + e_t \quad (2)$$

$$\hat{e}_{t-1} = (Y_{it-1} - \beta_1 - \Delta X_{it-1}) \quad (3)$$

$$\Delta \hat{e}_t = \hat{e}_{t-1} + \Delta \hat{e}_{t-1} \quad (4)$$

The VECM is strong approach to analyze the rate of price adjustment process which has been widely used (Carter, 2011; Marks, 2010). In VECM approach, we adopted two steps procedures. First, we used ordinary least squares (OLS) to estimate the cointegrating relationship between price difference in Kathmandu market with prices in source markets (equation 5).

$$\Delta Y_{it} = \alpha_1 + \alpha_2 X_{it} \quad (5)$$

Second, the difference in estimated price of dependent market was considered as function of estimated lag of residuals at independent market. The empirical models were developed among different market sets; Kathmandu-Chitwan, Chitwan-Kathmandu, Kathmandu-Morang, and Morang-Kathmandu markets separately (equation 6, 7, 8. and 9) to analyze the speed of price adjustment.

$$\widehat{\Delta K}_t = \alpha_1 + \alpha_2 \hat{e}_{t-1} C \quad (6)$$

$$\widehat{\Delta C}_t = \alpha_1 + \alpha_2 \hat{e}_{t-1} K \quad (7)$$

$$\widehat{\Delta K}_t = \alpha_1 + \alpha_2 \hat{e}_{t-1} M \quad (8)$$

$$\widehat{\Delta M}_t = \alpha_1 + \alpha_2 \hat{e}_{t-1} K \quad (9)$$

Where, estimated price difference at Kathmandu ($\widehat{\Delta K}_t$), Chitwan ($\widehat{\Delta C}_t$), and Morang ($\widehat{\Delta M}_t$) markets, $\alpha_1 and\ \alpha_2$ for intercept, and coefficient, respectively.

3. Results and Discussion

3.1 Market Price Trend of Tomato (2000-2010)

The monthly price series of Kathmandu and Chitwan markets (figure 2), and Kathmandu and Morang markets (figure 3) showed stationary. The price series showed that there was a

higher price fluctuation; particularly price level was high during June - October and low during January - April in each year in both market sets. There could be two basic reasons for being higher price during June - October: firstly, farmers harvest vegetable and replaced by cereal crop in this season; secondly, there are many Nepalese festivals during this season that leads to increase the price of vegetable. The lower level of price during January - April because this is the main season for vegetable harvesting that affect to be lower the price level in the market; as higher the supply, lowers the price.

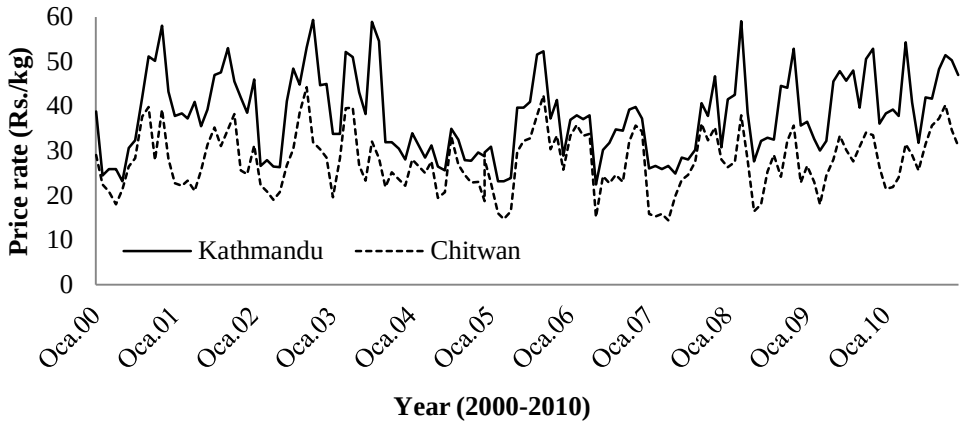

Figure 2. Wholesale Price Series of Tomato in Kathmandu-Chitwan (2000-2010)

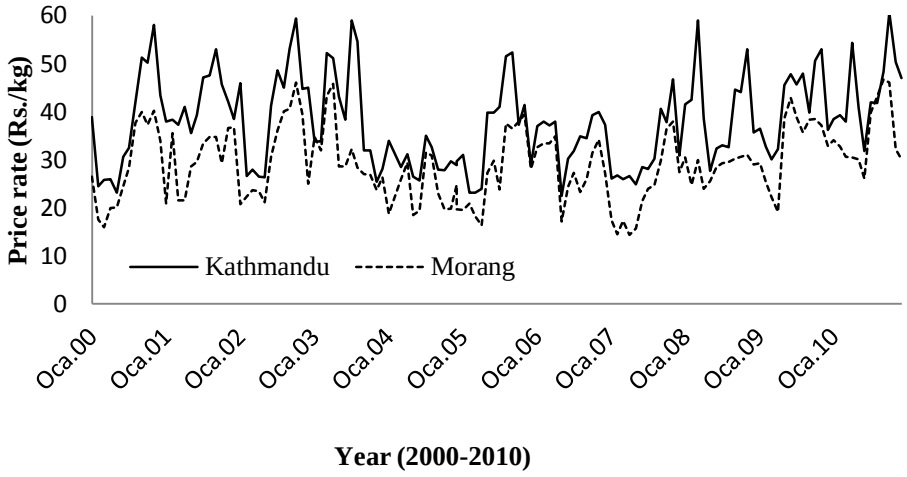

Figure 3. Wholesale Price Series of Tomato at Kathmandu-Morang (2000-2010)

3.2 Influence of Tomato Price at Kathmandu Market

The ordinary least square (OLS) estimate was adopted to analyze the influence of tomato price in Kathmandu market by the price of tomato in Chitwan and Morang markets. The result showed that the coefficient of determination found to be 0.68, revealed that the price

response model was good fit. Meanwhile the tomato price in Chitwan and Morang markets found to be significant at 1 percent level (table 1), indicated that the price prevailed in these two markets significantly influenced to the price in Kathmandu market. The elasticity in Chitwan market was much higher (0.706) than in Morang market (0.450), indicated that tomato price in Kathmandu market was more influenced by the tomato price in Chitwan market than the price in Morang market.

Table 1. OLS Estimation of Tomato Price at Kathmandu, Chitwan, Morang Markets

Variables	Regression Coefficients
Intercept	5.369 (2.021)***
Price in Chitwan market	0.706 (0.103)***
Price in Morang market	0.450 (0.090)***
R-square= 0.68 Number of Observations: 132	

Note: ***, **, * indicates the significance at 1%, 5%, and 10% level, respectively.

3.3 ECM Estimation and Price Cointegration

The market price cointegration test was carried out between Kathmandu-Chitwan, and Kathmandu-Morang markets using ECM of Dickey-Fuller test. The result of ECM estimation showed that the Kathmandu-Chitwan and Kathmandu-Morang markets were well cointegrated. The τ statistics of the estimation of one lag residual (e_{t-1}) in Kathmandu-Chitwan market found to be much smaller ($\tau = -5.560$) (table 2) than the critical value ($\tau = -3.96$)[a] in 1 % level of significance, indicated that the series was stationary, and the markets were well cointegrated.

Table 2. ECM Estimation and Price Cointegration at Kathmandu-Chitwan Markets

Parameters	Coefficients	Standard errors	tau (τ) statistics
α	-0.538	0.078	-6.935***
β_1	-2.158	4.383	-0.492
β_2 (C_{t-1})	-1.305	0.156	-8.349***
δ_0 (ΔC_t)	0.949	0.079	12.055
δ_1 (ΔC_{t-1})	-0.051	0.080	-0.629
Estimation of residual			
e_{t-1}	-0.525	0.094	-5.560***
Δ e $_{t-1}$	-0.093	0.088	-1.060
R-square	0.290		
Pr>F	<0.001		

Note: ***, **, * indicates the significance at 1%, 5%, and 10% level, respectively.
[a] We referred Hill, Griffiths, Lim (2011:table 12.4).

Similarly, the τ statistics of the estimation of one lag residual (e_{t-1}) in Kathmandu-Morang market found to be much smaller ($\tau = -7.23$) (table 3) than the critical value ($\tau = -3.96$) in 1 % level of significance, revealed that the series were stationary, and the markets showed well cointegrated.

Table 3. ECM Estimation and Price Cointegration at Kathmandu-Morang Markets

Parameters	Coefficients	Standard errors	$tau\ (\tau)$ statistics
α	-0.717	0.0857	-8.361***
β_1	-6.596	3.294	-2.002
$\beta_2\ (M_{t-1})$	-1.079	0.1101	-9.797***
$\delta_0\ (\Delta M_t)$	0.7198	0.0897	8.025
$\delta_1\ (\Delta M_{t-1})$	-0.063	0.0915	-0.692
Estimation of residual			
e_{t-1}	-0.799	0.1105	-7.230***
$\Delta\ e_{t-1}$	0.052	0.0892	0.590
R-square	0.377		
Pr>F	<0.001		

Note: ***, **, * indicates the significance at 1%, 5%, and 10% level, respectively.

The result of the coefficient of one lag residual revealed that the Kathmandu market was better cointegrated with Chitwan than Morang market. There could be two reasons; Chitwan market is relatively near and easily accessed with Kathmandu market, thereby, the Chitwan supply more quantity of tomato to Kathmandu than Morang. According to Sanoga and Amadou (2010), when price are cointegrated, the coefficient of e_{t-1} is always negative and statistically significant, thereby, the model converges to its long-term equilibrium. This coefficient is known as the attractor that helps to absorb the effects of shocks and keeps prices in a long-term equilibrium relationship. If the attractor is high, the faster is the speed of adjustment of price toward their equilibrium level. This result of better cointegration of tomato market was consistent with (Adeoye et al., 2008), where perishable vegetables have a higher percentage of market cointegration in the long-run. In this study, the attractors in both of the market models (Kathmandu-Chitwan, and Kathmand-Morang) were found to be much higher, and $tau\ (\tau)$ statistics were much lower than the critical value, and sign found negative. This indicated that there was faster speed in price adjustment towards equilibrium level.

3.4 VECM Estimation and Price Adjustment

3.4.1 Price Adjustment at Kathmandu and Chitwan Market

The results of VECM showed that the estimated error correction coefficients of residual lags ($\hat{e}_{t-1}$) in Kathmandu-Chitwan market found to be 0.438 (table 4), which was statistically insignificant. While, in Chitwan-Kathmandu market, the error correction coefficient was found to be -0.272, indicated that the speed of price adjustment process in Chitwan was more faster if the price shocks in Kathmandu market. The result revealed that the negative price adjustment process was much faster than the positive price deviation; if the price decrease in Kathmandu market, the price adjustment in Chitwan market was about 73 percent faster. This implied that when the price decrease in Kathmandu market, the traders in Chitwan market are able to adjust immediately, while the farmers would have difficult to adjust the price. This result supported the finding of Shrestha (2003) where the speed of price adjustment of tomato in the Besishahar market with response to price shocks in the Narayangarh market was about 80 percent faster in Nepal.

Table 4. VECM Estimation and Price Adjustment at Kathmandu and Chitwan Market

Variables	Coefficients	Standard errors	$tau\ (\tau)$ statistics
Kathmandu-Chitwan			
Intercept	-0.094	0.690	-0.14
$\hat{e}_{t-1}$	0.438	0.158	2.76
Chitwan-Kathmandu			
Intercept	0.111	0.547	0.20
$\widehat{e}_{t-1}$	-0.272	0.126	-2.16

3.4.2 VECM Result at Kathmandu and Morang Market

In Kathmandu-Morang market, the estimated error correction coefficient ($\hat{e}_{t-1}$) of Morang was found to be 0.605 (table 5), which was insignificant. In contrarily, in Morang-Kathmandu market, the estimated error correction coefficient was found to be -285, which was significant at 5 percent level, indicated that the price adjustment process was much faster (72%) of the deviation of M_{t-1} from its cointegrating value -0.284 K_{t-1}. It revealed that the negative price adjustment in Morang market in response to the price shocks in Kathmandu market was much faster.

Table 5. VECM Estimation and Price Adjustment at Kathmandu and Morang Market

Variables	Coefficient	Standard error	$tau\ (\tau)$ statistics
Kathmandu-Morang			
Intercept	-0.168	0.668	-0.25
$\hat{\boldsymbol{e}}_{\boldsymbol{t-1}}$	0.605	0.130	4.67
Morang-Kathmandu			
Intercept	0.136	0.537	0.25
$\hat{e}_{t-1}$	-0.285	0.104	-2.74**

Note: ***, **, * indicates the significance at 1%, 5%, and 10% level, respectively.

The results revealed that the positive adjustment in Kathmandu market in response to the Chitwan and Morang markets were insignificant. While, the negative price adjustment in Chitwan and Morang markets were 73, and 72 percent, respectively in response to the negative price shocks in Kathmandu market. The reason of insignificant effect of positive price adjustment could be the Kathmandu is very big market with huge numbers consumers; as small changes in source market would not have significant effect in the central market. The reason for speedy price adjustment could be that a small change in central market that would have greater affect to changes in the sources markets. It would be quite easy for source markets to adjust the negative price shock deviation, whereas this would be detrimental to farmers to adjust their price, eventually leading to the farmer to be discouraged. The result was consistent with the previous results of long-run market price cointegration, and the fast speed of price adjustment in negative price shocks deviation in tomato (Bakucs et al., 2007; Jordan & VanSickle, 1995).

The implications of negative price shocks in Kathmandu market would be: i) the traders in the source markets are well informed with the price movement in Kathmandu market, and able to adjust quickly of the price shocks that helped them to be able to prevent from the possible losses; ii) the farmers nearby source markets have problem to adjust the price shocks, and more possibility of losing a large quantity of vegetable since they have already harvested or about to harvest the crops; iii) the vegetable production nearby source markets

are mostly dependent to sell their product in Kathmandu market. Consequently, the farmers would be in immense losses because of the negative price shocks deviation in Kathmandu market.

4. Conclusions and Policy Recommendations

The market price cointegration of tomato between three markets; namely Kathmandu, Chitwan and Morang were analyzed using error correction model, and vector error correction models. The price series of all the markets in the study areas were found to be stationary, and revealed that Chitwan and Morang markets were well cointegrated with Kathmandu market. The price adjustment process in source markets was very fast, especially when the negative price shocks deviation in Kathmandu market, indicated that the tomato farmers in Chitwan and Morang districts were absolutely dependent on Kathmandu market. It would be quite easy for source markets to adjust the negative price shock, whereas more difficult to adjust by farmers, eventually leading to the farmer to be hurt and discouraged.

The study suggests the policy makers should focus on: i) to explore and establish alternative vegetable markets, ii) encourage traders to be involved in the source markets that improve market competitiveness and; iii) enhance effective market information services towards farmers, traders and consumers. The study also recommends for further studies on; determine the other possible factors that could correct the negative price shocks adjustment in Chitwan and Morang market, and analyze the market price cointegration among Kathmandu and other major vegetable sources markets.

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