Spatial Price Integration in Nepal

Ram Sharan Kharel*, PhD and Tap Prasad Koirala**, PhD

Abstract

There is a large volume of literature documenting the analysis of spatial market integration based on individual commodity prices. This paper, instead, contributes to the literature by delineating the existence of spatial market integration using intra-regional price indices. In this context, we use monthly price indices for Kathmandu valley, Hill and the Terai region, which are the only available spatial indices in Nepal. Employing Johansens' bi-variate cointegrating approach for the period from August 1995 to December 2010, we found a strong proposition of Law of One Price (LOP) across the region indicating the fact that spatial markets are highly integrated albeit speed of adjustment is rather slow. This may be due to the existence of oligopolistic pricing behaviour, carteling, asymmetric market information, and syndicate in the transportation system as discussed in various literatures.

As monetary policy in many countries aims to keep inflation (i.e. changes in prices) within the target band so as to ensure economic stability and sustainable growth, it is inevitable to know the likely inflation in advance for adopting appropriate policy measures. An analysis of spatial price relationship helps to understand how price shocks in one region transmit to other regions and whether regional markets are integrated in the economy, which ultimately helps to forecast inflation in a more comprehensive way.

Spatial price relationship measures the degree to which markets at geographically separated locations share common long-run price or trade information on a homogenous product (Goodwin and Piggott, 2001). In this context, spatial markets are said to be integrated if price shocks in one market are reflected into other markets (Lohano and Mari, 2005). A poorly integrated or virtually non-integrated market conveys inaccurate price information, as price changes in one region do not necessarily reflect the relevant economic phenomena of other regions, which leads to inefficient product movements and market decision (Goodwin and Schroeder, 1991). This may be a common phenomenon in underdeveloped market where oligopolistic or monopolistic pricing behavior is more pronounced.

---

* *Deputy Director,Research Department, Nepal Rastra Bank, Central Office, Baluwatar, Kathmandu, Nepal. Email: kharelrs@nrb.org.np*

** *Assistant Director,Research Department, Nepal Rastra Bank, Central Office, Baluwatar, Kathmandu, Nepal. Email: koiralat@nrb.org.np*

Remarks: We thank to editorial team for their productive comments. The views expressed in this paper are personal and do not necessarily represent the official stance of Nepal Rastra Bank.

Competitions among arbitragers ensure a unique equilibrium price in spatially integrated markets where the spatial prices differ only by transfer and transaction costs (Rapsomanikis et. al., 2003). The premises of fully integrated spatial market correspond to those of the standard competition model characterized by frictionless undistorted world or the Law of One Price (LOP) where pricing along the production chains depend on production costs (Conforti, 2004). Therefore, the analysis of spatial price integration provides an important policy feedback in identifying whether spatial markets are functioning in a predictable way, and price signals are passing-through consistently in different markets (Lohano and Mari, 2005).

The existing empirical literatures focus generally on how the prices of particular commodity integrate across the region in order to analyze the proposition of market integration (see Ohen et. al, 2007, Sedaghar, 2007 and references therein). The basic motivation of this paper, unlike the existing literature on price integration, is to explore the degree of spatial market integration in Nepal using regional consumer price indices. These indices are considered to be homogeneous in terms of commodity-price baskets and expenditure weights across the regions (Annex 1 and 4). In this context, we aim to explore how regional markets are integrated and whether price shocks in one region transmits quickly to the other regions. As overall national consumer price index is the weighted average of the three regional price indices, an analysis of spatial market integration is important to establish the linkage between regional and national prices.

The objective of this paper is, therefore, to measure the degree of market integration among the three regional markets of Nepal, namely Kathmandu valley, Hill and the Terai. Following Johansen's bi-variate cointegrating method for monthly data frequency from August 1995 to December 2010, we draw a number of interesting conclusions. First, we find a strong proposition of LOP across the regions indicating the fact that regional markets are highly integrated. However, price adjustment is rather slow across the region as it has taken as long as one and half year to return to long run equilibrium after any shock arises. Second, consumer price index of Hill region is highly influenced by both the price indices of Kathmandu valley and Terai region but reverse causality is not found true. Finally, the regional price adjustment between the Terai and Kathmandu valley is found faster than that of the price adjustments between Hill and the Terai and between Hill and Kathmandu. The conclusion should, however, be taken cautiously because the entire analysis is based on monthly price index due to unavailability of high frequency price data.

The rest of the paper is organized as follows. The next section describes conceptual framework of spatial market integration followed by econometric methodology in section three. Section four discusses properties of time series variables while section five provides empirical results. Finally, the last section draws the conclusion.

II. CONCEPTUAL FRAMEWORK

An analysis of spatial price relationships, which states how prices transmit from one region to the other, is a common practice in assessing market integration. The empirical analysis generally suggests that markets are independent, or not integrated if price relationships do not exist or even exhibits negative relationships. On the other hand, markets are weakly integrated if the price movement is positive. Moreover, if the relative prices are stable in two markets, the LOP holds true (Asche et. al., 2005). We utilize this conceptual framework to analyze the extent of market integrations across the spatial region in Nepal by employing regional price indices as against the use of individual commodity prices.

Let us consider the overall price behavior in two regions as $cpi_t^K = cpi_t^T + k_t$ where cpi_t^K and cpi_t^T are consumer price indices of Kathmandu valley and the Terai region respectively at time t. These two regional markets are considered to be integrated if cpi_t^K equals cpi_t^T with some transfer costs, k_t (Tomek and Robinson, 2003). But, this may not be the case if spatial markets are not perfectly competitive in which case the trade between two regions occurs as a result of greater absolute price difference than the transfer cost, viz. $\left|cpi_t^K - cpi_t^T\right| > k_t$. This allows additional profit margin and hence motivates the trading business. However, unexpectedly high transfer costs as well as additional profit margins hinder the transmission of price signals which may prohibit arbitrage. The phenomenon of oligopolistic behavior, carteling activities, collusion among domestic traders, asymmetry of price information, syndicate in transportation, market rigidities, among others, may retain price differences significantly higher than those determined by actual transfer costs (Rapsomanikis et al., 2003).

In a more systematic way, the concept of market integration can be expressed in a simple empirical model as:

$$\log(cpi_t^K) = \alpha + \beta \log(cpi_t^T) \qquad (1)$$

Where, α is a constant term that captures transfer costs and β gives the price relationship between these two markets (Asche et. al., 2005). In this framework, if $\beta = 0$, the price change in the Terai does not affect the price change in Kathmandu valley and it implies that these two markets are independent or there is an absence of market integration. This is, in fact, seldom in modern economy as markets are associated by one means or the others. On the other hand, spatial markets are considered to be integrated or LOP holds true if $\beta = 1$ in Eq(1)

One of the popular methods of estimating spatial market integration is to test the axiom of strong and weak version of LOP. According to the strong version, spatial prices are equal and they move perfectly together if $\alpha = 0$ and $\beta = 1$ in which case the trading goods are substitutes. In real life, the strong version of LOP is seldom. The weak version is possible which states that only the price ratio may be constant but the actual spatial price level is different due to transfer costs and profit margins. The necessary condition for the weak LOP are $\alpha \neq 0$ and $\beta = 1$.

III. ECONOMETRIC METHODOLOGY

Based on the above conceptual framework and following Johansen (1988) and Johansen and Jueselius (1990), we employ a bi-variate cointegrated reparameterised vector autoregressive model of order p to investigate the spatial price relation between the price indices of (a) Kathmandu Valley and the Terai, (b) the Terai and Hill, and (c) Hill and Kathmandu Valley as follows:

$$\Delta X_t = \sum_{i=1}^{p-1} \Gamma_i \Delta X_{t-i} + \prod X_{t-p} + \mu_t + \varepsilon_t \qquad (2)$$

In Eq (2), X_t is an 2×1 vector of the first-order integrated [i.e., I(1)] variables; μ_t is an $2x1$ vector of deterministic term; ε_t is an $2x1$ vector of normally and independently distributed error terms, i.e., $\varepsilon_t \approx NP(0, \Omega)$; Γ_i are 2×2 coefficient matrix of lag variables, defined as $-\sum_{j=1+1}^{p} A_j$ and finally, $\prod$ is an 2×2 long run impact matrix, $-(I - \sum_{i=1}^{p} A_i)$ where A_i is an $2x2$ matrix of vector autoregressive of order p and I is an $2x2$ identity matrix.

The rank of $\prod$ determines the number of cointegrating vectors (r) among the variables in X_t. We expect $0 \leq r \leq 2$. In the extreme case if r=0 then we do not find any cointegrating relationships between two spatial price indices. On the other hand, if r=2 there exists a full rank, i.e there exists bio-directional causal relationship. If $\prod$ is of rank r such that $0 < r < 2$ then we can decompose $\prod = \alpha\beta^{'}$ where α is an $2 \times r$ matrix of error correction coefficients which provide the speed of adjustment towards long run equilibrium and $\beta^{'}$ is an $2 \times r$ unrestricted cointegrating vectors (Kharel and Koirala, 2010). Eq(2), then, can be re-written as:

$$\Delta X_t = \sum_{i=1}^{p-1} \Gamma_i \Delta X_{t-i} + \alpha(\beta^{'} X_{t-p}) + \mu_t + \varepsilon_t \qquad (3)$$

Testing number of cointegrating relationships, r, is an important issue in Eq(3) because the long run relationship between two price indices cannot be indentified if $r \neq 1$.

Johansen (1988) proposes two likelihood ratio tests namely eigenvalue [$\lambda_{\max}(r/r+1)$] and trace statistic [$\lambda_{trace}(r/p)$] tests for the determination of r as follows:

$$\lambda_{trace}(r/p) = -T\sum_{i=r+1}^{p}\log(1-\hat{\lambda}_i) \qquad (4)$$

$$\lambda_{\max}(r/r+1) = -T\log(1-\hat{\lambda}_{r+1}) \qquad (5)$$

where $\hat{\lambda}$ is computed eigenvalue up to p lags and p is chosen up to the level which removes serial correlation. Eq(4) tests the null hypothesis that there are at most r cointegrating vectors against k where k is number of variables used in the model, whereas Eq(5) tests the null hypothesis of r cointegrating vectors against the alternative of r +1.

Next, we impose different restrictions on cointegrating vectors, $\alpha\beta^{'}$, to test whether the LOP proposition holds and whether transfer costs exist in the spatial markets. The extended form of $\alpha\beta^{'}$ can be written as:

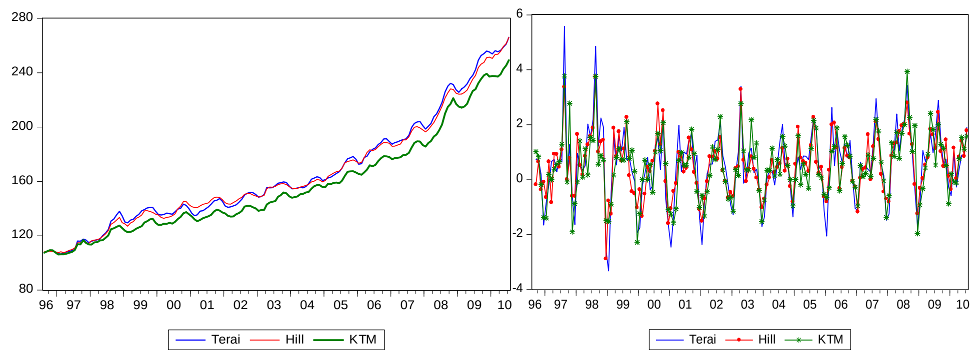
$$\prod = \alpha\beta^{'} = \begin{bmatrix}\alpha_1 \\ \alpha_2\end{bmatrix}[\,\beta_1 \quad \beta_2\,] \qquad (6)$$

If $\beta_1 = -\beta_2$ (or $\beta_2 = -1$ if β_1 is normalized to 1) in our bi-variate cointegrating space, the price relationship is proportional, i.e. LOP holds between two variables under consideration. The parameter α measures the degree of price adjustment. Accepting the restriction $a_1 = a_2 = 0$ implies that the long run relationship does not exists between two variables while $a_1 \neq a_2 \neq 0$ implies that there is no leading price in the system.

IV. THE DATA AND PRELIMINARY ANALYSIS

As high frequency price indices are desirable to investigate spatial market integration, they are unavailable in Nepal. We use monthly spatial price indices from August 1995 to December 2010, covering a total of 185 observations. Spatial price indices imply three different urban consumer price indices namely, price index for Kathmandu valley (cpi_t^K), price index for Hill (cpi_t^H) and price index for Terai (cpi_t^T). We obtain data from Quarterly Economic Bulletin (Nepal Rastra Bank) and use only log level of variables unless otherwise stated.

Figure 1: Spatial Price Indices and Monthly Inflation (Base year: 1995/96=100)



Panel A: Price Indices Panel B: Monthly Inflation rate in Percent

Figure 1 plots the variables both in level and first difference. The Panel A presents plot of spatial price indices which indicate both high correlations among the indices across the regions and auto-correlation of the indices over the years. Panel B depicts spatial inflation rates, defined as percentage change in price indices over the previous month, which shows that monthly inflation rates are highly volatile and co-related, but are stationary.

Table 1 presents the unit root tests of spatial prices indices using both the Augmented Dicky Fuller (ADF) and the Phillip Perron (PP) tests (Phillips and Perron, 1988). We confirm that price indices follow unit root process at level but they are stationary at first difference, i.e. I(1).

Table 1: Unit Root Test

Variables	Augmented Dickey-Fuller (ADF) Test				Phillips-Perron (PP) Test			
	Level		First difference		Level		First difference	
	Constant	Constant and Trend	Constant	Constant and Trend	Constant	Constant and Trend	Constant	Constant and Trend
cpi_t^K	1.401	-0.667	-7.800*	-7.666*	1.724	-0.812	-7.415*	-7.583*
cpi_t^H	1.082	-0.888	-7.114*	-7.223*	0.902	-1.197	-6.985*	-7.019*
cpi_t^T	0.579	-1.588	-7.767*	-7.802*	0.624	-1.565	-6.988*	-6.919*

*Note: Critical values for rejecting the null hypothesis at 1%, 5% and 10% significant level are -3.472, -2.880 and -2.576 respectively for the ADF test and -3.469, -2.878 and -2.576 respectively for the PP test respectively. * indicates that the variable is significant at 1% level.*

We then investigate the pair-wise correlation of price indices between (a) Kathmandu Valley and Terai, (b) Kathmandu Valley and Hill and (c) Hill and the Terai region. As expected, correlation coefficients are found to be more than 0.99 in all combinations. This implies that price linkages across the regions are very strong (Table 2). However, the correlation coefficients of monthly inflation rates depict some interesting results. Geographically, as Kathmandu valley is surrounded by Hill and Hill is attached to Terai, one may expect a high correlation between the inflation of Kathmandu and Hill, and Hill and Terai but this is not the case. As such the correlation coefficient of inflation rates between Kathmandu valley and Hill is slightly lower (0.81) than both Kathmandu and Terai (0.82) and Hill and Terai (0.85). We believe that a relatively low correlation between Kathmandu Valley and Hill is due mainly to lack of effective transportation and communication system between these regions.

Table 2: Correlation Coefficients

Type\region	cpi_t^K **and** cpi_t^H	cpi_t^K **and** cpi_t^T	cpi_t^H **and** cpi_t^T
Price index (in log level)	0.9971	0.9974	0.9984
Monthly inflation*	0.8145	0.8224	0.8582

** Defined as percentage change of indices over previous month.*

The Granger causality tests as shown in Table 3 provide further insights to spatial price linkages. We find that cpi_t^K Granger causes cpi_t^T and cpi_t^H. Similarly cpi_t^H Granger causes cpi_t^T. This implies that price movement of Kathmandu Valley determines the price movements of both the Terai and Hilly regions. Similarly, price movement of Hill causes the price movement of the Terai region.

Table 3: Granger Causality Test

Direction of causality	**F-Statistics**	**Probability value**
$cpi_t^K \rightarrow cpi_t^H$ $cpi_t^H \rightarrow cpi_t^K$	14.304 0.357	0.000 0.700
$cpi_t^T \rightarrow cpi_t^K$ $cpi_t^K \rightarrow cpi_t^T$	1.120 10.476	0.328 0.000
$cpi_t^T \rightarrow cpi_t^H$ $cpi_t^H \rightarrow cpi_t^T$	1.899 6.951	0.153 0.001

Note: Variables are in log level. The Granger causality is tested using up to second lag.

V. EMPIRICAL ANALYSIS

As the objective of this study is to examine the regional market integration in Nepal by analyzing bi-variate price dynamics between (a) cpi_t^K and cpi_t^T, (b) cpi_t^H and cpi_t^T, and (c) cpi_t^K and cpi_t^H, the first step is to run Eq(3) to test whether there exists cointegrating relationship between different combinations of spatial price indices. The empirical results utilizing Johansen Maximum Likelihood procedure are presented in Table 4 where

Granger's causality test is followed to keep variables in order. We used for all variables up to second lag which satisfies both AIC and SC criterion.

Table 4 : Johansen Maximum Likelihood Procedure (p=2)

Model	Null Hypothesis	Maximal Eigen Value			Eigen-values	Trace		
		Alternative Hypothesis	Max. Eigen Statistics (λ_{max})	5% Critical Value		Alternative Hypothesis	Trace Statistics (λ_{trace})	5% Critical Value
log(cpi_t^T), log(cpi_t^K)	$r=0$	$r=1^*$	12.409	15.67	0.0724	$r \geq 1^*$	21.292	19.96
	$r \leq 1$	$r=2$	8.883	9.24	0.052	$r \geq 2$	8.883	9.24
log(cpi_t^H), log(cpi_t^K)	$r=0$	$r=1^*$	20.209	15.67	0.1152	$r \geq 1^*$	26.327	19.96
	$r \leq 1$	$r=2$	6.117	9.24	0.0363	$r \geq 2$	6.117	9.24
log(cpi_t^H), log(cpi_t^T)	$r=0$	$r=1^*$	17.450	15.67	0.1003	$r \geq 1^*$	25.709	19.96
	$r \leq 1$	$r=2$	8.258	9.24	0.0488	$r \geq 2$	8.258	9.24

*Note: r denotes the number of cointegrating vectors. The critical values are from Osterwald-Lenum (1992). *denotes rejection of the hypothesis at 5%.*

As shown in the Table 4, we reject the null hypotheses of no cointgration (i.e. r=0) for all sets of bivariate combinations using both the $\lambda_{\max}$ and λ_{trace} tests as against the alternative hypotheses of at least one cointegrating relationship (i.e. r=1). However, we reject the null hypotheses of more than one cointegrating relationship at 5 percent significant level in all cases. The Eigen value is also maximum when r=1 compared to the values when r=2. Therefore, the results of the cointegrating relationship using both the $\lambda_{\max}$ and λ_{trace} tests suggest that there is only one cointegrating relationship in each pair of (a) cpi_t^T and cpi_t^K, (b) cpi_t^H and cpi_t^K, and (c) cpi_t^H and cpi_t^T.

The error correction representation (ECR) of the cointegrating result is an important way of presenting the variables into the short run dynamics and the long run relationships into a single model (Johansen 1988). As we have single cointegrating relationship in each bi-variate model, the error correction representation of the estimates can be presented as follows:

$$\Delta \log(cpi^H) = \underset{4.84}{0.57}\Delta \log(cpi_{t-1}^H) + \underset{2.54}{0.33}\Delta \log(cpi_{t-2}^H) + \underset{1.24}{0.14}\Delta \log(cpi_{t-1}^K) - \underset{2.66}{0.15}\Delta \log(cpi_{t-2}^K)$$

$$- \underset{3.37}{0.08}(cpi_{t-1}^H - \underset{34.59}{1.05}cpi_{t-1}^K - \underset{1.09}{0.17}) \qquad (7)$$

$$\Delta\log(cpi^{H}) = 0.36\Delta\log(cpi^{H}_{t-1}) + 0.30\Delta\log(cpi^{H}_{t-2}) + 0.12\Delta\log(cpi^{T}_{t-1}) - 0.29\Delta\log(cpi^{T}_{t-2})$$

2.71 2.20 1.15 2.69

$$-0.07(cpi^{H}_{t-1} - 1.00\Delta cpi^{T}_{t-1} - 0.02) \tag{8}$$

2.89 37.25 1.17

$$\Delta\log(cpi^{T}) = 0.46\Delta\log(cpi^{T}_{t-1}) - 0.02\Delta\log(cpi^{T}_{t-2}) + 0.07\Delta\log(cpi^{K}_{t-1}) - 0.08\Delta\log(cpi^{K}_{t-2})$$

3.67 2.20 1.47 0.18

$$-0.054(cpi^{T}_{t-1} - 1.11 cpi^{K}_{t-1} - 0.45) \tag{9}$$

1.05 37.57 0.05

The price dynamics between the Hill and Kathmandu valley is given in Eq(7) while Eq(8) provides the same relationship between the Hill and Terai region. Eq(9) describes the price linkages between the Terai and Kathmandu Valley. All estimates are meaningful and consistent with theories as error correction terms are significant with their expected negative sign and long run estimated parameters as well as most of the short run coefficients are significant. Our results show interesting insights of market integration across the region in Nepal.

We find that the price movement in the Hill region is explained by both the price movement in the Kathmandu Valley and the Terai as depicted in Eq(7) and Eq(8) while the price movement in the Terai is influenced by the prices of Kathmandu valley as shown by Eq(9). Thus, as a capital city with high density of population, price movement in Kathmandu valley can be an important factor determining the price movement in both the Terai and Hilly regions. Though price movement in the Terai region is highly influenced by the Indian prices due to a long open boarder as suggested by many empirical literatures, we find that price transmission from Kathmandu valley is also important for the determination of prices in Terai region.

Spatial markets are highly integrated in Nepal but the speed of price adjustments across the regions are found to be rather slow. The error correction coefficients ranging between 0.05 and 0.08 in this study depict the fact that it may take around one and half year to adjust price fully from one region to other when price shocks arises. For instance, the error correction coefficient of 0.08 in Eq(7) is interpreted as that any price shocks for the price movement in the Kathmandu valley, would be corrected by 8 percent per month to restore into long-run equilibrium. Among the three sets of bi-variate combinations, the price adjustment between Kathmandu valley and Hill is faster than that of between Terai and Kathmandu valley.

Table 5: Test of Law of One Price Across the Region (LOP)*

Model	$\beta_2 = -1$	$a_1 = 0$	$a_2 = 0$
log(cpi_t^T), log(cpi_t^K)	-1.11 (0.08)	3.426 (0.064)	2.766 (0.962)
log(cpi_t^H), log(cpi_t^K)	-1.05 (0.03)	7.96 (0.004)	0.35 (0.55)
log(cpi_t^H), log(cpi_t^T)	-1.01 (0.027)	0.486 (0.034)	0.24 (0.624)

* *Reported corresponding t-test statistics. Figures within parenthesis are probability values.*

The long run coefficients as depicted in all ECR equations are represented in the column (2) of Table 5 with values close to 1 and are statistically highly significant along with significant intercepts. The result implies that relative prices are constant across the regions holding LOP true throughout the regions. We carry out further tests to examine the degree of price correction resulting from price difference in specific region as indicated by α parameters in column (3) and (4) of Table 5.

The parameter α measures the degree of price adjustment. Accepting the restriction $a_1 = a_2 = 0$ implies that the long run relationship does not exist between two variables while the restriction $a_1 \neq a_2 \neq 0$ implies that there is no leading price in the system. The nonrejection of the restriction $a_2 \neq 0$ throughout the equations (in column 4) suggests that a change in the price difference corrects at least partly by a change in prices in the other market. However, the consistent rejection of $a_1 \neq 0$ in all the specifications (in column 3) implies that a change in the price difference does not correct partly by the change in the price at the same market.

Although the LOP holds, several reasons might have contributed for attaining a slow speed of adjustment in the price integration across the regions. The syndicate system in the transportation may be one of the good reasons for lack of quick prices integration as this has been the case for several years in Nepal. The oligopolistic market behavior, especially carteling, is another pertinent reason for a slow pass-through of prices across the region. The transaction as well as transportation cost throughout the regions is considerably high which also results in a slow adjustment of prices from one region to another. For instance, the price adjustment in the Hilly region as a result of price rise in the Kathmandu Valley is very slow due to the existence of Hill markets in difficult geographical location. Some strategically important department stores, wholesalers and even some retail shops play a vital role in the determination of the prices in Nepal. Such activities hinder a smooth flow of goods from one region to another, and hence distort price adjustment.

Some methodological aspects should also be considered in order to validate the slow speed of adjustment in price integration across the region. First, we employ aggregated price indices which include both more sensitive and less sensitive items in the price baskets. For example, price rise in school education in Terai does not necessarily change the same price in Kathmandu Valley. On the other hand, any price change in petroleum product in Terai will have a proportional impact in Kathmandu Valley. Second, the study use monthly price indices, a high frequency data may give a different result as price shocks may transmit quickly than the monthly interval.

VI. CONCLUSION

This paper investigates spatial market integration in Nepal analyzing monthly price indices of Kathmandu Valley, Hills and the Terai for the period from August 1995 to December 2010. Using Johansens' bi-variate cointegrating method, we find that spatial markets are integrated across the region in Nepal but the pace of adjustment is uniformly slow as it takes as long as one and half year to adjust price fully if price shock arises. A slow speed of price adjustment across the region as found in this study reveals that Nepalese market is still experiencing various structural as well as price rigidities. The oligopolistic behavior, carteling, asymmetric information, syndicate in the transportation system, among others, may have been responsible for the slow adjustment. Our findings, however, should be taken cautiously because the entire analysis is based on the monthly price indices; high frequency data may give different result. Similarly, this study used aggregated regional consumer price indices; an analysis with decomposing high sensitive and less sensitive price items may alter the result.

REFERENCE

Asche F., S. Jaffry and J. Hartmann. 2005. "Price Transmission and Market Integration: Vertical and Horizontal Price Linkages for Salmon", University of Portsmouth, Working Paper 1.

Chance, W.A. 1966. “A Note on the Origins of Index Numbers", *The Review of Economics and Statistics*, Vol. 48(1).

Conforti, P. 2004. "Price Transmission in Selected Agricultural Markets", *FAO Commodity and Trade Policy Research Working Paper*, No. 7.

Goodwin, B. K. and N. E., Piggott. 2001. “Spatial Market Integration in the Presence of Threshold Effects”, *American Journal of Agricultural Economics*. Vol. 83(2). 302-317.

Goodwin, B.K. and T.C. Schroeder. 1991. "Cointegration Tests and Spatial Price Linkages in Regional Cattle Markets", *American Journal of Agricultural Economics.* Vol. 73(2): 452-464.

Johansen, S. 1988. “Statistical Analysis of Cointegration Vectors,” *Journal of Economic Dynamics and Control* 12, 231-54.

Johansen S., and K. Juselius. 1990. "Maximum Likelihood Estimation and Inference on Cointegration with Application to the Demand for Money". *Oxford Bulletin of Economics and Statistics* 52,169-206.

Kharel, R.S and T.P. Koirala. 2010. "Modeling Demand for Money in Nepal", *Nepal Rastra Bank, Working Paper* No. 6.

Lohano, H. and F. Mari. 2005. "Spatial Price Linkages in Regional Onion Markets of Pakistan", *Journal of Agriculture and Social Sciences*, No. 1813-2235.

NRB. 1981. “Nepalma Bigat Adhi Dasakko Mulya Prabriti Tatha Mulya Niti: Yek Bibechana", Price Division, Research Department, Nepal Rastra Bank, Central Office Baluwatar, Kathmandu.

NRB. 2010. *Quarterly Economic Bulletin*, Nepal Rastra Bank, Central Office Baluwatar, Vol. 45 No. 1 and 2.

Ohen, S.B. Abang S.O. and I.C. Idiong. 2007. “Price Transmission and Market Integration: Vertical and Horizontal Price Linkages for Live Catfish in Nigeria”, *Journal of Agriculture and Social Science*, Department of Agricultural Economics, University of Calabar, Calabar Nigeria.

Phillips, P. and P. Perron. 1988. “Testing for a Unit Root in Time Series Regression”, Biometrica 75, 335-46.

Pandey, R. P. 2005. “Inflation" in *Nepal Rastra Bank in Fifty Years,* Nepal Rastra Bank, Central Office Baluwatar, Kathmandu, July.

Rapsomanikis, G., D. Hallam and P. Conforti. 2003. "Market Integration and Price Transmission in Selected Food and Cash Crop Markets of Developing Countries: Review and Applications", Commodity Market Review, FAO Commodities and Trade Division, Rome.

Sedaghar R. 2007. Spatial Price Integration for Pistachio in Iran's Tropics", *Agricultura Tropica Et Subtropica*, Vol. 40 (20).

Tomek, W. G. and K. L. Robinson. 2003. "Agricultural Product Prices", Cornell University Press. USA

Annex 1 : An Overview of Price Indices in Nepal

The history of price statistics is not very long in Nepal. The "Gorkhapatra", a daily national Newspaper, started publishing retail prices of few commodities since 1902 albeit in an irregular basis. The Kathmandu Municipality Office, then, started publishing retail price of consumers' goods in monthly basis since 1956 but it could not sustain for a long time (NRB, 1981). A systematic effort of collecting price statistics begins in Nepal since 1962 when the Central Bureau of Statistics started compiling weighted average of consumer price index for Kathmandu Valley which was continued till 1969/70.

At the same time, Nepal Rastra Bank (NRB) started compiling price statistics of essential consumer goods since its establishment in 1956. Initially, the Bank collected prices of 15 commodities in a fortnightly basis. The number of commodities in the price basket was increased to 31 in 1960 and 46 in 1965. In terms of the geographical coverage, the Bank started compiling un-weighted price index for Kathmandu valley since 1957 and extended it for compiling a separate price index for Terai region since 1962 and for Hill region since 1963 (Pandey, 2005). Following the international practice of determining weights for the price indices, Nepal Rastra Bank conducted the first household survey in 1972/73 followed by second survey in 1982/83 and the third in 1994/95. The available monthly, quarterly and annual price series by region between 1973/74 to 1982/83 are based on the fixed weights carried out from the first household survey. Similarly, the price weights between 1983/84 to 1994/95 and then 1995/96 to 2009/10 are based on the second and third household survey respectively. The current price indices are based on the fourth household survey which was conducted in 2005/06.

A continuous effort have been made to improve the price indices extending the coverage in terms of price collection area and the number of items but price indices in Nepal are still based on the selected urban areas with limited number of goods and services. This implies that current CPI in Nepal does not cover the price movement in rural and mountain areas. Even within the selected urban areas, the current annual price index of Kathmandu valley is based on the 301 price items collected from 4 urban centers whereas the price index of Terai and Hill region are based on 267 price items collected from selected 10 urban centers and 284 items collected from 7 urban centers respectively (Annex 3). The national urban consumer price index, which is popularly known as the Consumer Price Index (CPI), is, then computed as the weighted average of regional price indices where the weights assigned to regional series are based on the proportion of total population residing in the region (Annex 2).

Although regional price indices are derived independently employing Laspeyres (Chance, 1966) method including regional weights and prices, they are comparable as most of the items selected in the price basket are identical. Moreover, the weighting structure also follows the same pattern as weights given to food and beverage items in Terai region is 54.98 percent since 1995/96 whereas it is 53.04 in Hill and 51.53 in Kathmandu (Annex 4). Consequently, the remaining share goes to non-food and service items in all regions.

Annex 2 : Price Basket and Regional Weights (1995/96 to 2009/10)

Region	No. of urban centre	Name of urban Centres	Regional Average Weight
Kathmandu	*4*	Kathmandu, Lalitpur, Bhaktapur and Thimi	*0.3082*
Terai	*10*	Damak, Biratnagar, Lahan, Janakpur, Birgunj, Bharatpur, Sidharthanagar, Nepalgunj, Mahendranagar and Dhangadhi	*0.5043*
Hill	*7*	Ilam, Dhanakuta, Hetauda, Pokhara, Banepa, Dipayal and Birendranagar	*0.1875*
Overall	*21*		*1.0000*

Source: Nepal Rastra Bank, Research Department, Price Division

Annex 3 : Number of Items Selected for Price Collection (1995/96 to 2009/10)

	Total	Weekly	Fortnightly	Monthly	Quarterly	Half Yearly	Yearly
KTM	301	51	44-47	60-67	84-85	36-40	11
Terai	267	44-45	37-40	56-60	75-77	32-34	9-10
Hill	284	52-56	36-40	55-60	71-79	33-37	10-11

Source: Nepal Rastra Bank, Research Department, Price Division

Annex 4 : Weight Structure of Major Items Across the Region (in percent) (1995/96 to 2009/10)

Items\Ecological regions	Terai	Hill	KTM	Overall
All Items	***100.00***	***100.00***	***100.00***	***100.00***
Foods and beverages	***54.98***	***53.04***	***51.53***	***53.20***
Grains and cereals products	19.76	17.76	16.37	18.00
Pulses	3.35	2.66	2.14	2.73
Vegetables, fruits and nuts	7.63	7.61	8.27	7.89
Spices	2.06	2.01	1.57	1.85
Meat, fish and eggs	5.02	5.48	5.28	5.21
Milk and milk products	3.98	3.94	4.18	4.05
Oil and ghee	3.23	3.77	2.62	3.07
Sugar and related products	1.09	1.15	1..36	1.21
Beverages	2.00	2.65	2.39	2.28
Restaurant meals	6.86	6.01	7.35	6.91
Non-food items and services	***45.02***	***46.96***	***48.47***	***46.80***
Cloths, clothings and sewing services	9.16	8.94	8.67	8.92
Footwear	1.78	2.63	2.41	2.20
Housing	14.80	14.40	15.14	14.87
Transport and communication	4.16	3.31	4.21	4.03
Medical and personal care	8.04	8.39	7.86	8.03
Education, reading and recreation	5.54	7.78	8.33	7.09
Tobacco and related products	1.54	1.51	1.85	1.66

Source: Nepal Rastra Bank, Research Department, Price Division