# ANALYAIS OF SPATIAL CO-INTEGRATION OF TWO MAJOR VEGETABLES MARKETS IN EASTERN ETHIOPIA

## **1. INTRODUCTION**

Markets are important for economic growth and sustainable development of a given country, but, emphases in development policies in agrarian countries have usually been placed on increasing agricultural production to serve as a base for rural development. In the absence of well-functioning markets, agricultural production can experience several drawbacks (Belay, 2009).

In Ethiopia, particularly the eastern Hararghe zones have good potential in horticultural crop production for which smallholder farmers have diversified from staple food subsistence production to more market-oriented and higher value commodities. Despite this production potential and importance of horticultural crops for the country as well as the study area, there has been limited study with regard to the performance of vegetable markets and challenges faced in marketing vegetable products.

Market integration is considered an important determinant of food flow, availability, accessibility and price stability. As Nyange (1999), puts it, the extent to which markets make food available and accessible, and keep price stable, depends on the degree of market integration across a region. Goletti and Tsigas (2000), define integrated markets as markets in which price of comparable goods do not move independently. According to the Law of One Price (LOP), if two markets are integrated, change in price in one market due to excess demand or supply shocks will have an equal impact in the related market price. If this equilibrium condition holds, the two spatially separated markets are said to be integrated. In other words, the Law of One Price prevails between the two markets (Zanias, 1999; Sexton *et al*., 1991) or the two markets are spatially price efficient (Tomek and Robinson, 1998). Otherwise, markets may have some constraints on efficient arbitrage such as barriers to entry and information asymmetry (Barrett, 2001) or imperfection competition in one or more markets (Faminow and Benson, 1990). Hence, the study of spatial market relationships provides the extent to which markets are related and efficient in pricing.

The notion of market integration is often associated with the degree of price transmission, which measures the speed of traders’ response in moving vegetables to where it is highly demanded. A number of factors that lead to market integration have been identified (Rapsomanikis *et al*., 2003; Timmer, 2009). Among the key factors, weak infrastructure and large market margins that arise due to high transfer costs have been asserted as the main factors that partly insulate domestic market integration. Especially in developing countries, poor infrastructure, transport and communication services gives rise to large marketing margins due to high costs of delivering locally produced commodities to the reference market for consumption. High transfer costs and marketing margins hinder the transmission of price signals, as they may prohibit (Sexton *et al*., 1991; Bernstein and Amin, 1995). As a result, change in reference market price is not fully transmitted to local prices, resulting in economic agents adjusting partially to shift in supply and demand.

## **2. ANALYTICAL FRAMEWORK**

The concept of market integration has retained and increased its importance over recent years particularly in developing countries where it has potential application to policy questions regarding government intervention in markets (Alexander and Wyeth, 1994). From the economic point of view, market integration concerns the free flow of goods and information and thus prices over space, form and time and is closely related to, but distinct from the concept of efficiency (Barrett, 1996).

An alternative definition of market integration is that when a price shock takes in one location, it will be perfectly transmitted to the other if and only if the two markets are integrated. Therefore, prices in the two regions are said to be integrated, if they exhibit one-to-one change (Goodwin and Schroeder, 1991). Analogously, efficient inter temporal market integration implies that there exists rationally speculative arbitrageurs who extinguish positive profit opportunities associated with commodity storage across periods. As a result, the price differentials between markets should be identical to the storage costs or processing costs if there is market integration across time or form (Baulch, 1997). Among the three forms of integration, measuring spatial integration causes most controversy and receives most attention in the literature (Dahlgram and Blank, 1992; Faminow and Benson, 1990; Goodwin and Schroeder, 1991).

Several methodologies have been proposed to examine spatial price relationships. However, some of the early approaches have been unreliable or inadequate to measure spatial price relationship correctly. Advances in time series econometrics over the last three decades have led to the development of models that address some of the perceived weaknesses. In what follows, we review four different methods: Simple bivariate correlation coefficients, multivariate regression methods, Ravallion method, Co-integration and Error Correction model, each of which has been widely applied to test for market integration across various goods and industries.

### 2.1. Simple bivariate correlation coefficients

Early research on market integration focused on measuring the co-movement of two price series in distinct markets. The correlation coefficient is a relative measure of the linear association between two series. Though there are some limitations in using correlation coefficient to express the relationship between time series variables, it is still one of the most popular, frequently used and easy to calculate tools (Dhalgram and Blank, 1992; Tschirley, 1991).

The coefficient can indicate the strength of the relationship between two series. A low correlation coefficient is an indicator of a weak or non-integration of the two markets. A correlation coefficient of above 60 per cent is an indicator of strong connection, between 30 and 60 per cent, a weak connection, and below 20 per cent no connection between the variables (Goetz and Weber, 1987).

The correlation coefficient is commonly used owing to its simplicity. Useful information about market integration can be obtained from the coefficient if carefully carried out and interpreted with a good knowledge of the workings of the market (Alexander and Wyeth, 1994).

Despite wide application of the bivariate correlation as an index of market integration, the approach has important weaknesses, as a tool for market integration testing. The most frequently referred drawback is the existence of common trends within price series over time. The approach produces high correlation results for markets with even no physical contact, road, or any other means of transport connection. The high correlation could be the result of the common price trends such as inflation, common seasonal variation due to similar climatic conditions, legal factors simultaneously affecting prices, or other shocks among the markets (Heytens, 1986).

### 2.2. Multivariate regression methods

A somewhat more statistically sophisticated approach uses multivariate regression methods to control for multiple prospective confounding factors at once. Say one wants to control for seasonality (represented by 12 dummy variables, dm, one per month), the general consumer price index (CPI, capturing changes in the prices of substitute and complementary consumer goods), and the price of fuel as the main cost traders incur in moving commodity across space. The basic relationship between the monthly price at time t in markets 1 and 2 can be written mathematically as:

 (1)

If one estimates the multivariate regression represented by the above equation, the estimate of the parameter ϕ is an estimate of the partial correlation between the prices in markets 1 and 2 once one controls for common exogenous factors (i.e., things correlated with the prices in both markets that don’t capture the true causal relationship in price movements between them). If the estimate of ϕ is statistically significantly different from 0 but not statistically significantly different from 1, this can be taken as a reasonable indicator of market integration. It means that when the price in market 2 changes, it tends to lead to a similar magnitude change in the price in market 1, even controlling for confounding factors, which implies a reasonably free flow of information and goods between the markets.

### 2.3. Ravallion method

In order to avoid the inferential dangers of received models using static price correlations, Ravallion (1986) developed a new approach to market integration testing. Ravallion’s model enables an investigator to distinguish between short-run (instantaneous) market integration and the long run (i.e. equilibrium) integration, i.e., the end of short-run, disequilibrium dynamic adjustment processes.

The model assumes that there are local markets from which price shocks originate and local markets linked to the central one by traders. Assuming that local market prices (Pi,..., PN) are dominated by one central market price (P1), Ravallion (1986) constructed the dynamic model as:

 (2)

Where:

j (the number of lags) = 1, 2, ---, n;

i (the number of markets) = 1,2, 3, ----, N;

t(the time period) = 1,2,3,… T;

X= other factors,

aij and bij are parameters to be estimated, eit are error terms.

Assume there are a total of N markets including the central market. The idea behind Ravallion model is to regress the current local market price on its own lagged prices and present and past prices from the central market as well as on common trend variables like inflation and seasonality. The central market price is taken as an exogenous variable in predicting the local markets’ prices.

The relevant hypotheses of relationships tested are:

**a. Market segmentation:** central market prices do not influence prices in the ith local market.

This happens if bij =0, for j= 0, 1, ---, n.

**b. Short-run market integration:** A price increase in central market will be immediately passed on to the local market price if bio = 1. There will also be lagged effects on future prices unless, in addition to equation (b), aij=bij=0 for j= 1, 2, ---, n, and

**c. Long-run market integration:** Long run equilibrium is one in which market prices are constant over time, undisturbed by any local stochastic effects. That is,

 (3)

### 2.4. Co-integration and Error-correction model

Due to non-stationary nature of many economic time series, the concept of co-integration has become widely used in econometric analysis. The concept of co-integration is related to the definition of a long-run equilibrium. The fact that two series are co-integrated implies that the integrated series move together in the long run (Golleti and Tsigas, 1991).

Testing co-integration of two price series is sometimes believed to be equivalent to detecting long-run market integration. The co-integration-testing framework has been well developed by Engle and Granger; Engle and Johansen. To use the co-integration procedure, several steps needed to be carried out on the price series under examination. Before proceeding to the different steps, consider the following basic relationship between two markets.

 (4)

Where:

Pit and Pjt, are price series in two markets i and j at time ‘t’

a= represents domestic transportation, processing, storage costs, etc.

b= the coefficient,

a and b are parameters to be estimated, and

et= residual term assumed to be distributed identically and independently at time t.

The first step is to pre-test the integrating orders of the series, i.e., each price series is tested for the order of econometric integration, that is, for the number of times the series need to be differenced before transforming it into a stationary series. A series is said to be integrated of order ‘d’, I (d), if it has to be differenced ‘d’ times to produce stationary series.

The most commonly employed test for stationary and order of integration is the Augmented Dickey Fuller (ADF) test.

 (5)

The test t- statistics on the estimated coefficient of Pit-1 is used to test the null and alternative hypotheses. The null hypothesis is that the series Pit is integrated of order 1 and the alternative hypothesis is that the series is of order 0. In short, H0: Pit is I (1) Versus H1: Pit is I (0). If the t-statistics for the coefficient b0 is greater in absolute value than a critical value given by the ADF critical value, then the null hypothesis is rejected, and the alternative hypothesis of stationary is accepted. If the null hypothesis is not rejected, then one must test whether the series is of order of integration higher than just 1, possibly of order 2. In this case, the same regression equation is applied to the second difference, i.e. the test will be repeated by using (ΔPit in place of Pit) i.e. by applying the regression:

 (6)

Where:

2 Pit= denotes second deference.

The ADF statistic therefore, tests the following hypotheses. H0: Pit is I (1) versus H1: Pit is I (0) i.e. H0: Pit is I (2) versus H1: Pit is I (1), respectively. If the ADF statistic is not large and negative, H0 is not rejected.

The second step is to estimate the long-run equilibrium relationship of the two time series, which are of the some order of integration (co-integrating regression). That is,

 (7)

Where, et is the deviation from equilibrium and this equilibrium error in the long-run tends to zero. This equilibrium error of the co-integration equation has to be stationary for co-integration between two integrated variables to hold good.

Hence, the third step is to recover the residual from the co-integration regression and to test their stationary. The most commonly employed test for stationary is the Augmented Dickey Fuller (ADF) unit root test. To perform the ADF test, the auto regression equation must be estimated.

 (8)

Where,  is the first stage estimate of the residual for the co-integrating regression and et is the error term of equation.

The null hypothesis of the ADF test is a1=0. Rejection of the null hypothesis is that the series is non-stationary in favor of the negative one sided alternative hypothesis means the two series are co- integrated of order (1, 1) provided both series are I (1), i.e., the ADF test statistic is the t-ratio of the coefficient of .

The other alternative test for stationary (Co-integration) is the standard Durbin Watson test statistic from the first stage ordinary least square (OLS) estimate of the co-integrating regression.

It is designated as:

 (9)

The null hypothesis of no co-integration is rejected for values of CRDW, which are significantly different from zero.

The fourth step involves the dynamic error correction representation of the co-integrated variables. If two variables are integrated of the same order and thus can be co-integrated, then there exists an error correction representation of the variables where the error corrects the long-run equilibrium. This is also known as Granger Representation Theorem (Sinahory and Nair, 1994). The dynamic model is obtained by introducing the residuals in to the system of variables in levels. Therefore, the Error Correction Model (ECM) is represented by the formula:

 (10)

It is evident from the above equation that the disequilibria in the previous period (t-1) are an explanatory variable. Here it can be said that if in period (t-1) Pj exceeds the equilibrium price, the changes in pi will lead the variable to approach the equilibrium value. The speed at which the price approaches equilibrium depends on the magnitude of a2. Hence, the expected sign of a2 is negative. This test confirms that the errors correct to the equilibrium in the long run. Therefore, the final test of market integration can be performed by testing the restriction a1 = 1, a2 = -1, and the coefficients of any lagged terms be zero using F-statistic.

Co-integration testing has some alternative features that don’t exist in the other market integration testing. First of all, a co-integration test doesn’t require the tested series to be stationary thus, the controversy surrounding pre-filtering and stationary transformations can be avoided. A co-integration test can be applied to any pair of series provided they are integrated of the same order. Co-integration testing can also provide a method of testing whether one series is exogenous or not and the direction of causality between markets, which is a problem in Ravallion’s model.

Co-integration testing, it is still a popular methodology for testing market integration in the recent literature. Co-integration tests have been applied to examine the market for food by Baulch (1997). Goodwin and Schroeder (1991) used co-integration with rational expectations to test regional U.S. cattle markets. Another study by Sinahory and Nair (1994), on pepper price variation in the international trade, found that international prices of pepper have significant influence on co- integration relations between Indian and Indonesian markets. Furthermore, co-integration tests have been used to test for market integration in some developing countries. For instance, Dercon (2004) applied co-integration testing to evaluate the effects of liberalization and war on food markets in Ethiopia. Alexander and Wyeth (1994) offer reduced form of an error correction mechanism to examine the Indonesian rice market.

In this case study, co-integration and error-correction model was used to assess cointegration relationship between Kombolcha and Jigjiga wholesale vegetable markets.

## 3. EMPIRICAL REVIEW

A study by Firdaus and Gunawan (2012) on integration among regional vegetable markets in Indonesia used co-integration approach and Ravallion model to identify whether market integration exist between four producing area in Sumatera and Java island and central market in Jakarta (PIKJ). The analysis was conducted on five vegetables namely shallot, red chilli, potatoes, cabbage and tomatoes. Their results show that cointegration model found that markets are integrated, while other does not.

Nancy *et al*. (2014) found that potato markets in Kenya are integrated and price transmission does occur; though not complete. The results showed that long run price transmission proportions range between 25 and 59 percent, implying that, the spatial arbitrage conditions are wanting in the markets that were examined.

Solomon (2004) conducted a study on integration of cattle marketing in southern Ethiopia using monthly average price data of cattle from October 1996 to September 2002 of primary markets( Yabelo and Dubluk), secondary market (Negelle) and border terminal market (Moyale) by using co-integration and error correction model. He found that there was a spatial linkage between cattle market in Borena rangeland. Moreover, he also identifies that there was no short run integration but long run integration in these sample market.

Palaskas and Harris (1993), Bahrumshah and Habibulla (1994), Alexander and Wyeth (1994) and Dercon (1995), have all applied co-integration and error correction models to test level of market integration. The price changes in one market will be fully transmitted to other markets. Markets that are not integrated may convey inaccurate price information that might distort marketing decisions and contribute to inefficient product movement (Bahrumshah and Habibulla, 1994).

Wolday (1994), Bekele and Mulat (1995) and Asfaw and Jayne (1997) had undertaken market integration studies on grain prices in Ethiopia by applying a co-integration and error correction approach and found that grain prices were strongly integrated in the long-run and markets were fully integrated in the short-run.

Admasu (1998) and Solomon (1996) conducted a study on performance of coffee marketing in Sidama, Illubabor and Jimma zones, respectively. Both studies used a cointegration and error correction approach and found that local and central coffee markets in Ethiopia were integrated in the long-run but there was no short-run and full market integration between local and central markets.

## 4. METHODOLOGY

### 4.1. Description of the Study Area

This study is undertaken in Eastern Ethiopia in major vegetable growing Woreda (namely Kombolcha Woreda of Oromia Regional State) which is known for vegetables production. Description of Woreda is given below.

Kombolcha Woreda is one of the nineteen Woredas found in East Hararghe zone of Oromia National Regional State, Ethiopia. The Woreda is composed of 19 rural Kebeles and 1 urban Kebele. Kombolcha Woreda is located about 542 kms southeast of Addis Ababa and 16 kms northwest of Kombolcha town, the capital of East Hararghe Zone of Oromia Region. The Woreda is strategically located between the two main cities Harar and Dire Dawa. In addition, due to its proximity to Djibouti and Somalia, the Woreda has access to potential markets in the area.

The Woreda had total population of about 157,444, of which 77,659 were females in 2011(CSA, 2012). About 45.1%, 53.0% and 1.9% of the total population were young, economically active and old age, respectively. Average family sizes for the Woreda was 4.9 persons per household. The crude population density of the Woreda is estimated as 517 persons per km2.

Lowland and midland agro-ecological zones characterize the Woreda’s climate. The Woreda receives mean annual rainfall of 600-900 mm, which is bimodal and erratic in distribution. The main rainy season in the Woreda is from February to mid-May and from July to end of August. The economy of the Woreda is dominated by traditional cash crop farming mixed with livestock husbandry. The major crops produced in the Woreda include sorghum, maize, vegetables (potato, cabbage, beetroot, and carrot), chat, groundnut, coffee and sweet potato (KWOoARD, 2012).

### 4.2. Data Sources and Types

For this case study, time series data on potato and cabbage obtained from CSA spanning the period from September 2010 to December 2014 were used.

### 4.3. Methods of Data Analysis

In this case study, both descriptive and econometric methods of data analysis were used. Descriptive statistical tools such as mean, standard deviation, minimum, maximum, frequency and percentages were used. As to the econometric methods, Engle and Granger test and ECM specified in section 2.4 were used to examine vegetables market integration of Kombolcha and Jigjiga markets.

## 5. RESULTS AND DISCUSSION

### 5.1. Stationarity test

Econometric analysis begins by checking the stationarity and non-stationarity of data. For co-integration relationship, one of the assumptions is that data must be integrated of same order. Unit root testing procedures like Augmented Dickey Fuller (ADF) test is then applied to test the stationarity and non-stationarity of individual series empirically. After this, co-integration techniques are used to find out if long-run relationship exists between the source and terminal markets prices.

To test the stationarity of monthly time series price data for potato and cabbage at Kombolcha and Jigjiga markets from September 2010-December 2014, Augmented Dickey Fuller (ADF) test is performed with trend. ADF tests are the most commonly used method for testing unit roots in the data. This test assumes that errors are statistically independent and have a constant variance (Enders, 1995). Therefore, the stationarity tests for cabbage and potato prices are presented in Table 1.

Table 1: Stationarity test for cabbage and potato prices at Kombolcha and Jigjiga markets at first difference

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Cabbage price | | Potato price | |
| Kombolcha market | Jigjiga Market | Kombolcha market | Jigjiga Market |
| ADF test statistic | -8.714(0.000) | -10.650 (0.000) | -7.685(0.000) | -8.965(0.000) |
| Critical v. at 1% | -3.580 | -3.594 | -3.580 | -3.580 |
| Critical v. at 5% | -2.930 | -2.936 | -2.930 | -2.930 |
| Null hypothesis | Rejected | Rejected | Rejected | Rejected |
| Stationary status | Stationary | Stationary | Stationary | Stationary |

Source: Own computation, 2015. Note: numbers in bracket indicates the significant level.

Results presented on Table 1 show that after taking the first difference of Kombolcha and Jigjiga prices for both cabbage and potato market, they became stationary as confirmed by using ADF test. Therefore, for both variables the null hypothesis of the unit root is rejected at 1% and 5% of significance level at their first difference. It can be concluded that, the unit root test reveals that the price variables used in Kombolcha and Jigjiga market for both cabbage and potato prices are stationary at the ADF unit root tests. In order to continue with the analysis, all variables in each model should be integrated in the same order which are these variables are integrated at the first order 1. Due to this reason, the analysis will continue with the co-integration technique to assess if there is long-run relationship between prices in these markets.

### 5.2. Engle-Granger test for cointegration

To test for the presence or absence of co-integration between Kombolcha price and Jigjiga regarding cabbage and potato prices in the time period considered was based on Engel-Granger method.

Before running the estimation, choosing the optimum number of lags that should be included in the model is the first task. Therefore, as indicated in Table 2, based on AIC (Akaike Information Criterion), FPE (Final Prediction Error), LIR (Sequential Modified LR test statistic) and HQ (Hannan-Quinn) information criterion, one lag I(I) is selected.

Table 2: Lag length determination for cabbage (n=43)

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Lag | LL | LR | df | P | FPE | AIC | HQIC | SBIC |
| 0 | 34.68 |  |  |  | 0.00 | -1.52 | -1.49 | -1.44 |
| 1 | 43.08 | 16.80\* | 4 | 0.00 | 0.00\* | -1.72\* | -1.63\* | -1.48\* |
| 2 | 45.12 | 4.06 | 4 | 0.40 | 0.00 | -1.63 | -1.48 | -1.22 |
| 3 | 45.68 | 1.14 | 4 | 0.89 | 0.00 | -1.47 | -1.26 | -0.90 |
| 4 | 50.15 | 8.95 | 4 | 0.06 | 0.00 | -1.50 | -1.22 | -0.76 |

Table 3. Lag length determination for potato (n=43)

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Lag | LL | LR | df | P | FPE | AIC | HQIC | SBIC |
| 0 | 47.04 |  |  |  | 0.00 | -1.92 | -1.89\* | -1.84\* |
| 1 | 51.09 | 8.09 | 4 | 0.09 | 0.00 | -1.92 | -1.83 | -1.68 |
| 2 | 56.22 | 10.25 | 4 | 0.04 | 0.00 | -1.97 | -1.82 | -1.57 |
| 3 | 57.49 | 2.54 | 4 | 0.64 | 0.00 | -1.85 | -1.64 | -1.30 |
| 4 | 66.31 | 17.64\* | 4 | 0.00 | 0.00\* | -2.06\* | -1.79 | -1.35 |

Source: own computation, 2015 S\*=recommended lag by each criteria

Since the optimum lag length for both vegetables is one as shown in Tables 2 and 3, we can run co-integration test accordingly. One of the conditions for testing co-integration for time based data is that time series must be non-stationary in nature and both series must be integrated of the same order.

It has been already seen that Kombolcha and Jigjiga markets’ cabbage and potato price series are stationary at 1% and 5% of significance levels and hence are integrated of order one. Now the long run equilibrium relationship for both vegetables at Kombolcha and Jigjiga markets are estimated by regressing the two market prices and saving the residual. This residual will also be tested whether it is stationary or not. If it is stationary, it would confirm the presence of integration between Kombolcha and Jigjiga for cabbage and potato prices in long term separately. Based on the above mentioned procedure test results are presented in Tables 4 and 5.

Table 4: The logarithmic regression of Kombolcha on Jigjiga cabbage prices

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| DlnHCabage | Coef. | Std. Err | t-value | p>|t| |
| DlnJCabage | 0.090 | 0.100 | 0.90 | 0.372 |
| Contsant | 0.008 | 0.019 | 0.42 | 0.678 |

Note: **DlnHcabage** which is a dependent variable is the lograthemic value of the price of cabage for Kombolcha market over the given period of time after first differencing while **DlnJCabagge** is the prices of cabbage at Jigjiga market.

Source: Computed from CSA monthly price data (September 2010 - December 2014).

Table 5: The logarithmic regression of Kombolcha by Jigjiga potato prices

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| DlnHpotato | Coef. | Std. Err | t-value | p>|t| |
| DlnJpotato | 0.159 | 0.107 | 1.49 | 0.144 |
| Contsant | 0.006 | 0.018 | 0.32 | 0.753 |

Note: **DlnHpotato** which is a dependent variable is the lograthemic value of the price of potato for Kombolcha market over the given period of time after first differencing while **DlnJpotato** is that for Jigjiga market.

After running the regression for both vegetables and saving the residuals, the next step is conducting stationarity test for the predicted residuals by using ADF test.

Table 6. ADF test result of the residuals for cabbage and potato

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Variable | ADF test statistic | Critical v. at 1% | Critical v. at 5% | Null hypothesis | Stationary status |
| Residual for cabbage | -10.650 (0.000) | -3.594 | -2.936 | Rejected | Stationary |
|  |  |  |  |  |  |
| Residual for Potato | -8.965(0.000) | -3.580 | -2.930 | Rejected | Stationary |
|  |  |  |  |  |  |

As can be seen from Table 6, the price of cabbage and potato for both markets were found to be significant at 1% significance level and hence residuals are stationery. This situation tells that the two markets have long-run relationship or in the long run they move together. Hence, it can be concluded that the two prices for both vegetables in the two markets are co-integrated and therefore a valid and positive long-run relationship exist between Jigjiga and Kombolcha markets for cabbage and potato prices. Therefore, the result shows that the markets found long-term equilibrium relationship and Jigjiga market price has very strong causal effect on Kombolcha cabbage market price.

### 5.3. Short run price transmission and speed of adjustment

Following the stationarity of the residuals, the short-run dynamics was analyzed using the Error Correction Model (ECM) for both vegetables. Results are resented on Tables 7 and 8.

Table 7. Error-correction model result for cabbage

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| DlnHCabage | Coef. | Std. Err. | t-value | P>t |
| DlnJCabagge | 0.22 | 0.10 | 2.14 | 0.04 |
| DlnHCabage\_01 | -0.28 | 0.14 | -2.04 | 0.047 |
| ECM | 0.78 | 1.16 | 2.41 | 0.02 |
| Constant | -0.01 | 0.02 | -0.54 | 0.59 |

Where: DlnHCabage is the logarithmic value of cabbage price at Kombolcha market after first difference; DlnJCabagge is the logarithmic value of cabbage price at Jigjiga market after first difference; DlnHCabage\_01 is the one lag logarithmic value of cabbage price at Kombolcha market after first difference and resid\_01Cabbage is the one lag value of the residual which is ECM.

Table 8. Error-correction model result for potato

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| DlnHPotato | Coef. | Std. Err. | t-value | P>t |
| DlnJPotato | 0.36 | 0.11 | -0.33 | 0.74 |
| DlnHPotato\_01 | -0.13 | 0.15 | -0.88 | 0.38 |
| ECM | 0.73 | 0.42 | 1.76 | 0.05 |
| Constant | 0.07 | 0.02 | 0.35 | 0.73 |

Where: DlnHPotato is the logarithmic value of cabbage price at Kombolcha market after first difference; DlnJPotato is the logarithmic value of cabbage price at Jigjiga market after first difference; DlnHPotato\_01 is the one lag logarithmic value of cabbage price at Kombolcha market after first difference and resid\_01Potato is the one lag value of the residual which is ECM.

Source: Computed from CSA monthly price data (September 2010 - December 2014).

Since long-run cointegration was detected for Jigjiga and Kombolcha markets, Error Correction Model (ECM) was estimated for these markets price. As indicated in Table 7, short-term price transmission of cabbage was found to be significant at 5% level of significance. Results also show that a 1 Birr increase in the Jigjiga price causes an increase of 22% of one ETB at Kombolcha market. In addition the speed of price adjustment is 78.1% per month.

Similarly, short-term price transmission of potato was found to be significant at 5% significance level. Here the degree of short-term price transmission is that a 1 Birr increase in the Jigjiga price causes an increase of 35% of one ETB at Kombolcha market. In addition, the speed of price adjustment is 73.2% per month.

## 6. CONCLUSIONS AND RECOMMENDATIONS

The study used time series monthly secondary data that contains from September 2010 up to January 2014 of 52 months to analyze the relationship between Kombolcha and Jigjiga cabbage price to identify the long run and short run market integration of the two cabbage markets. In order to answer these objectives, econometric analysis such as ADF unit root test, Engel-Granger cointegration and Error Correction Model were used to assess the long-run and short-run dynamics of vegetables prices. Results indicated that in general cabbage price in both markets have shown an upward movement trend in the study periods. Moreover, the ADF stationarity test confirmed that the prices were not stationary at levels. However, at first difference prices became stationary and leading to Cointegration and Error Correction Model (ECM) tests for assessing the long-run and short-run dynamics of vegetables prices.

The finding of this study reveals that Kombolcha and Jigjiga cabbage and potato markets have been cointegrated indicating the positive long-run relationship between the two markets. This result implies that cabbage and potato prices are determined by the level of demand created in an international market because the export market via Jigjiga is the main driving factor for cabbage and potato production in eastern Ethiopia as there is a very limited domestic use of the crops which could be affected by policy issues and other external factors. On the other hand, the speed of price adjustment for Kombolcha market is about only 40.5% per month, this indicates that price adjustment performance is low. This situation might be due to current price information distortion particularly for rural cabbage and potato markets. Finally, further research is needed on factors affecting the speed of price adjustment between different cabbage and potato markets when there are price shocks.

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