Analysis of Beef Cattle Market Integration in the Case of Wolaita Zone, Southern Ethiopia

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Abstract:
This paper investigates spatial market integration in beef markets by using monthly data from September 2006 to September, 2012 and with the help of Cointegration and VECM and Granger causality test. The results of ADF indicate that the three variables were stationary and integrated of same order, i.e., I (1) at their first difference for both without drift and with drift Results of the Granger causality test indicate that Sodo and Boditi oxen market have bidirectional relationship. On the other hand, Addis Ababa beef market has unidirectional relationships with both Sodo and Boditi market. The findings suggests that, effective market information service has to be established to provide accurate and timely market information to producer and traders on current supply, demand and prices of beef cattle at national and regional levels.
Keywords: Market integration, market information

1. Introduction

Distortions introduced by governments are in the form of policies either at the border, or as price support mechanisms that weaken the link between the international and domestic markets. Agricultural policy instruments such as import tariffs, tariff rate quotas, and export subsidies or taxes, intervention mechanisms, as well as exchange rate policies insulate the domestic markets and hinder the full transmission of international price signals by affecting the excess demand or supply schedules of domestic commodity markets (Baffes and Ajwad, 2001; Abdulai, 2000). Apart from policies, domestic markets can also be partly insulated by large marketing margins that arise due to high transfer costs. High transfer costs and marketing margins hinder the transmission of price signals, as they may prohibit arbitrage (Sexton et al., 1991). Price transmission studies are apparently empirical that test the predictions of economic theories and provide important insights as to how changes in one market are transmitted to another, thus reflecting the degree of market integration, as well as the extent to which markets function efficiently (Rapsomanikis et. al. 2003). Even though cattle is economically and socially important, cattle marketing integration and their characteristics have not yet been studied and analyzed for the study area where great potential of cattle production (especially cattle fattening) exists. Therefore this study has the purpose of investigating cattle marketing integration in the study area which will narrow the information gap on the subject and will contribute to better understand to improved strategies for reorienting marketing system for the benefit of smallholder and cattle trader.

2. Research methodology

To analyze beef market integration Augmented Dickey Fuller (ADF) for unit root test for each price series and residuals and Vector Error Correction Model (VECM) were used to analyze the short run relationship and speed of price adjustment. The most common methodology used in the past for testing market integration involves estimation of bivariate correlation coefficient between price changes in different markets. Despite its simplicity to test market integration the method fails to recognize the possibility of spurious integration in the presence of common exogenous trends like general inflation, common periodicity (agricultural seasonality or auto correlated and heteroscedastic residuals in the regression) with non-stationary price data.

In general, if there exist a stationary linear combination of non-stationary random variables, the variables combined are said to be co integrated. Therefore, before testing for co integration it is important to test first individual time series for their order of integration. In this case, all individual variables should be stationary after first differences and non-stationary in levels, that is the variables should contain a stochastic trend (unit root). Therefore, a unit root tests were conducted on each market price before testing whether they are co integrated.

2.1. Basic Dickey-Fuller (DF) test

The procedure for this test for the order of integration of time series says Y_t is based on the following regression (assuming that the data – generating process can be represented by simple first – order autoregression):

$Y_t = \alpha + pY_{t-1} + \varepsilon_{t,\ when}$ re- parameterized this looks as follow (1)

$\Delta Y_t = \alpha + (p-1)Y_{t-1} + \varepsilon_t$ (2)

The null hypothesis is that there is a unit root in the process $\{(p-1) = 0, \Rightarrow p = 1\}$. The critical values for the t - statistic are not the standard once since non-stationarity of Y_t under the null hypothesis causes the distribution to be non-standard. One of the main difficulties with simple DF test is that it is based on the assumption that the variable follows a simple first order autoregression and that the disturbance term is independently and identically distributed (IID) and for most economic time series the problem of serial correlation is endemic.

2.2. Augmented Dickey-Fuller (ADF) test

As Gujarati (2004) argued, this is the modified DF test which takes in to account any serial correlation present by entering lagged values of the dependent variable. The general form of this test's regression looks as follow:

$$\Delta Y_{t} = \alpha + \beta t + (p-1)Y_{t-1} + \sum_{t=1}^{n} \gamma i \Delta Y_{t-1} + \varepsilon_t \quad (3)$$

Where: $Y_{t\ presents}$ a time series,

Δ implies first difference, and t is the time trend.

The null hypothesis in the ADF test is also unit root (ρ = 1). The number of lagged values (n) is chosen so as to ensure that the residuals are white noise. The null hypothesis is that the series Yt is integrated of order1, and the alternative hypothesis is that the series is order 0. To determine whether Yt is non-stationary the t-statistics for the coefficient β 1 will be compared with the critical value given by ADF tabulated.

2.3. Cointegration test

Due to non-stationary nature of many economic time series, the concept of co integration becomes widely used in econometric analysis. Cointegration is an econometric technique that allows the identification of both the degree of integration and its direction between two markets. Despite its limitations (cannot reject null hypothesis of no-co integration among three variables at any common level of statistical significance, the technique does not guarantee that any of the common factors that may exists among the variables are economically meaning full), co integration testing is still popular methodology of testing market integration. According to Thsigas (1991), integrated series move together in long run and if markets are integrated, prices in different markets have co-movements.

When the stochastic trends of two or more difference non-stationary variables are eliminated by forming a linear combination of these variables, the variables are said to be co integrated. Given the definition of co integration, the above unit roots can be applied to the residuals of the co integrating regression in order to check whether they are stationary i.e. I (0). Thus, when the series in the co integrating regression are I (1), one can apply the unit root tests to the residuals of the regression in order to check whether they are stationary.

$Y_t = \alpha + \beta X t + v_t$, with a co integration vector of [1-β] (4)

Using the DF or ADF equations for the linear combination of the two variables, we test for co integration by testing for stationarity of the residuals as follow:

$$\Delta V_t = \alpha + (\rho-1)\, V_{t-1} + \sum_{i=1}^{k} \delta_i \Delta V_{t-i} + \varepsilon_t, \quad (5)$$

Where: Y_t is the price at market Y during the period t

X_t is the price at market X during the period t.

ΔV_t is the ordinary least squares residual that can be interpreted as the deviation of Y_t from its long run path.

The null hypothesis in such procedure is that of no co integration, with the alternative hypothesis of co integration. The appropriate non-standard critical values used in the DF a ADF tests cannot be used for the unit root test on the residuals of the co integration regression, for they are applicable to the actual values of the process being tested and the residuals are estimated values. Relevant critical values for co integrating tests are available from Comprehensive Monte Carlo Simulation by Mackinnon.

2.4 Error Correction Model (ECM):

According to Thsigas (1991), the concept of co integration is related to the definition of long run equilibrium. The fact that two series are cointegrated implies that the integrated series move together in the long run. Hence, price in different markets have co movements if the markets are integrated. Therefore, testing co integration of two price series is sometimes believed to be equivalent to detecting long run market integration. Engle and Granger (1987), have developed a model known as Error Correction Model (ECM) that enabled us to differentiate between long run and short run relationships of time series analysis. As the series show long run relationship, the ECM needs to be applied to investigate further on short run (casually) interaction between variables. When non-stationary variables in a model are co integrated, the following ECM can be employed.

$$\Delta P_{1t} = \alpha + \Sigma\beta_1 \Delta P_{1t-k_1} + \delta\Delta e_{t-1} + \Sigma\beta_2 \Delta P_{2t-\kappa} + \beta_3 \Delta P_{2t} + \varepsilon_t \quad (6)$$

Where: β_1, β_2, and β_3 = the estimated short run counterparts to the long run solution,
K= the lag length of time,
δ = the speed of adjustment parameter,
ε_t = stationary random process capturing other information not contained in either lagged value of p_{it} and p_{jt}

2.5 Johansen and Juselius Cointegration Test: the Maximum Eigen value test and the Trace test (Johansen, S. and K. Juselius, 1990) are used as procedures to determine the number of Cointegration vectors. The Maximum Eigen value statistic tests the null hypothesis of r cointegrating relations against the alternative of r+1 co-integrating relations for r = 0, 1, 2…n-1. This test statistics are computed as:

$$LR\left(\frac{r}{n+1}\right) = -T * log(1 - \hat{\lambda}) \quad (7)$$

Where $\hat{\lambda}$ the estimated Maximum Eigen value and T is stands for the sample size. The main difference between the two test statistics is that the trace test is a joint test, whereas the maximum Eigen value test conducts separate tests on the individual Eigen values. Trace statistics examines the null hypothesis of r cointegrating relations against the alternative of n cointegrating relations, where n is the number of variables in the system for r = 0, 1, 2…n-1.

Its equation is computed according to the following formula:

$$TR\left(\frac{r}{n}\right) = -T * \sum_{i=r+1}^{n} log(1 - \hat{\lambda} i) \quad (8)$$

The results of trace test should be chosen where Trace and Maximum Eigen value statistics may yield different results in some case (Alexander, 2001). During the 1990s, a maximum likelihood estimation procedure proposed by Johansen (1995) has been frequently used in estimating long-run equilibrium relationships. In contrast to single-equation methods, the procedure efficiently includes the short-run dynamics in the estimation of the long-run model structure.

The main advantage of the Johansen's vector autoregressive estimation procedure is, however, in the testing and estimation of the multiple long-run equilibrium relationships. Also, the testing of various economic hypotheses via linear restrictions in cointegration space is possible when using Johansen's estimation method (Johansen and Juselius, 1995). The main weaknesses in Johansen's modeling approach are its largely unknown small sample properties. Higher requirements in Johansen's estimation method for the number of observations than in the Engle-Granger procedure usually necessitates the use of quarterly or monthly time series data, which are not always readily available. Problems in identifying (multiple) cointegration vectors with theoretical economic relationships are also possible when using the Johansen method (Johansen and Juselius, 1995).

2.7. Vector Error Correction Model (VECM)

If a VECM is used to estimate price adjustment, one implicit assumption must be noted. Adjustment of prices induced by deviations from the long-term equilibrium (ECT) is assumed to be a continuous and linear function of the magnitude of the deviation from long-term equilibrium. Thus, even very small deviations from the long-term equilibrium will always lead to an adjustment process in each market. If time series data are cointegrated this implies that there exists a long-term equilibrium relationship between them so VECM can be applied to evaluate the short run properties of the cointegrated series. If Cointegration is not detected between series VECM is no longer required and Granger causality tests are directly applied to see causal relationship between variables. A specification of a VECM is given in the following equation:

$$LnYt = \delta + A_1 lnY_{t-1} + A_2 lnY_{t-2} + , \ldots , + A_{p-1} lnY_{t-p+1} \quad (9)$$

Where Yt is an (n x 1) vector of endogenous variables(Ln of prices), δ is an (n x 1) vector of parameters, **y** and $\mathbf{y}_{t-p}$ are lagged values of prices; Ai represents (n x n) matrices of parameters, and εt is an (n x 1) vector of random variables. In this model, the price series for the three oxen markets were endogenous variables and as such no exogenous variable was used. To test the hypothesis of integration and Cointegration in equation (6), we transform it into its vector error correction form.

$$\Delta lnYt = \mu + \Gamma 1\Delta lnY_{t-1} + \Gamma 2\, \Delta lnY_{t-2}, \ldots, + \Gamma k + 1\, \Delta lnY_{t-k+1} + \pi lnY_{t-k}\, t \quad (10)$$

Where y_t =[P1t, P2t]', vector of endogenous variables, which are I(1), Δ yt= yt- y_{t-1}, μ is a (2×1) vector of parameters, Γ_1,..., Γ_{k+1} and π are (2×2) matrices of parameters, and εt is a (2×1) vector of white noise errors.

3. Results

The study employed Johannes Cointegration tests for analysis of sample market integrations. The data used in market integration analysis are monthly fattened oxen price of three markets: Addis Ababa, Sodo and Boditi cattle markets. The data covered the period from September 2006 – August 2012 and was collected from Woreda office of agriculture, CSA and LINKS (Livestock Information Knowledge and System). The analysis focused on only fattened oxen due to only fattened oxen are reached Addis Ababa terminal market.

Stationarity Test: For co-integration analysis, it is important to test the unit roots with the help of the Augmented Dickey- Fuller (ADF) at the beginning to check whether modeled variables I (0) at levels and I (1) at first differences were stationary or non stationary. The tests were applied to each variable over the period of 2006-2012 without and with drift at the variables level and at their first difference. The result in Table 1 indicated that the null hypothesis of no unit roots for all the time series were rejected at their levels. On the other hand, the three variables were stationary and integrated of same order, i.e., I (1) at their first difference for both without drift and with drift, which means unit roots in the first differences were rejected at 1 percent. Therefore, the results allow to proceed for co-integration tests for the testing the long run equilibrium relationship.

Table 1: ADF unit root test results for oxen prices

Fatten oxen price(Ln)	Without drift			With drift		
	Lag length	ADF statistics		Lag length	ADF statistics	
Levels			p-value			p-value
Sodo price(LnP1)	1	1.798	0.983	1	-0.929	0.779
Boditi price(LnP2)	1	2.373	0.996	1	-2.960	0.038
Addis Ababa price(LnP3)	1	1.730	0.980	1	-2.265	0.183
First difference						
Sodo price(LnP1)	1	-3.437***	0.0006	1	-3.682***	0.0043
Boditi price(LnP2)	1	-3.467***	0.0005	1	-3.993***	0.0014
Addis Ababa price(LnP3)	1	-3.470***	0.0005	1	-3.993***	0.0014

Note: *** indicates that unit root in the first differences are rejected at 1% significance levels.
Source: Computed data from Central Statistic Agency (CSA) of Ethiopia and LINKS

Moreover, according to Mesike *et al*., (2010), any endeavor to determine the dynamic function of the variable in the level of the series based on results of the variables are I (1) and I (0) will be inappropriate and may lead to problems of spurious regression. The econometric results of the model cannot be used for prediction in the long-run in that level of series because it will not be ideal for policy making (Yusuf and Falusi 1999). Johansen Cointegration test therefore becomes appropriate for assessing the existence of long-run relationships among variables. In this study, the optimal number of lag for the VAR model was determined using minimum value of Akaike criterion (AIC), Schwarz Bayesian criterion (BIC) and Hannan-Quinn criterion (HQC). Thus, result indicates that one lag was included into the model (Table 2)

Table 2: Lag-order selection criteria

Selection order criteria					
Sample: 2006:09-2012:09			No of observation =72		
lags	loglik	p(LR)	BIC	AIC	HQC
1	69.57783		-1.693466	-1.301788*	-1.538271*
2	80.53759	0.00914	1.751106*	-1.065669	-1.479515
3	88.59912	0.06436	-1.723504	-0.744309	-1.335517
4	97.31051	0.04249	-1.715015	-0.442062	-1.210632

Endogenous: Lnp1 lnp2 lnp3
Exogenous: constant

Source: Computed data from Central Statistic Agency (CSA) of Ethiopia and LINKS.

Johansen's the trace and $\hat{\lambda}$-max tests rejected first hypothesis (r = 0) of no cointegrating vector at 1% level of significant; Johansen trace statistic rejected third hypothesis(r=2) at 5% level of significant and the second hypothesis (r = 1) were accepted by both tests. In other words, this trace test result rejected the null hypotheses (, r = 0, r = 2) because these two variables were co-integrated (Table 3).

Table 3: Results of Johansen cointegration test for three market prices

Sample : 2006:10 - 2012:08		No of observation =71 Lag=1	
Maximum rank	Eigen value	Trace statistic	P value
0	0.37727	48.162***	0.0009
1	0.12243	14.533	0.2602
2	0.071421	5.2611**	0.0447
Maximum rank	Eigen value	Lmax statistic	
0	0.37727	33.628***	0.0005
1	0.12243	9.2723	0.4174
2	0.071421	5.2611	0.2648

Note: *** and ** indicate that no cointegrating vectors are rejected at 1% and 5% significance levels respectively.
Source: Computed from data in Central Statistic Agency (CSA) of Ethiopia and LINKS.

When Sodo market is the dependent variable, a smaller percentage (7%) of its price was explained by the current and previous prices in Boditi and Addis Ababa as well as its previous prices as opposed to Boditi or Addis Ababa as the dependent variable.

Table4: Cointegrating and adjustment vectors of VEC model results

Price(LN)	Cointegrating vectors (β)		Adjustment vectors (**α**)		Adjusted R^2	Durbin Watson
Default 1						
Sodo price(LnP_1)	1.00	0.00	-0.302** (0.116)	0.135 (0.143)	0.068	2.39
Boditi price(LnP_2)	0.000	1.00	0.025 (0.119)	-0.458*** (0.148)	0.128	2.40
Addis Ababa price(LnP_3)	-0.609 (0.162)	-0.779 (0.076)	-0.159 (0.135)	0.419** (0.168)	0.057	2.38
Default 2						
Addis Ababa price(LnP_3)	1.00	0.000	-0.229** (0.113)	-0.159 (0.135)	0.057	2.38
Sodo price(LnP_1)	0.000	1.000	0.079 (0.097)	-0.302** (0.116)	0.067	2.39
Boditi price(LnP_2)	-1.283 (0.119)	-0.782 (0.157)	0.341*** (0.0998)	0.025 (0.119)	0.128	2.40

Log-likelihood = 65.418255
Determinant of covariance matrix = 3.1788723e-005

Note: *** and ** indicate, respectively, for 1% and 5% significance levels (standard errors in parenthesis).
Source: Computed from data in Central Statistic Agency (CSA) of Ethiopia.

About 13% and 6% of the variation, respectively of Boditi and Addis Ababa market was explained by the model, suggesting that the VEC representation of the three markets was weak (Table 4)

Vector Error Correction Model: The presence of Cointegration between variables suggests a long term relationship among the variables under consideration. The coefficient of price adjustment with negative sign, indicating a move back towards equilibrium; a positive sign indicates movement away from equilibrium.

The coefficient should lie between 0 and 1, 0 suggesting no adjustment one time period later, 1 indicates full adjustment. The long run relationship between Sodo market, Boditi market and Addis Ababa market for two cointegrating vector for the period 2006-2012 is displayed in Table 4.

The coefficients of the error correction term show the speed of convergence to the long run equilibrium as a result of shock of their own prices. The estimate of the error correction coefficients for the selected oxen markets indicate that the Sodo market is significant at 5 percent with a correct sign (negative) indicating any disequilibrium in the long run producer price would be corrected in the short run thus, the short run price movements along the long run equilibrium path may be stable (see Table 4). The coefficient of adjustment vector (**α_2**) for Boditi was significant at 1 percent with the correct sign. The coefficient of adjustment vectors (**α_2**) for Addis Ababa market has a wrong sign (positive) and significant at 1% level showing that the short run price movements along the long run equilibrium path may be unstable. About 30 percent of the disequilibrium corrected for each month in Sodo market is by changes in its own prices and the remaining influenced by other internal and external market forces. Accordingly, 46 and 42 percent of disequilibrium corrected for each month in Boditi and Addis Ababa market respectively are by changes in their own prices and the remaining influenced by other internal and external market forces. The speed of adjustment of 30% from the short run to the long run equilibrium in the Sodo market is relatively lower as compared to other markets. However, the speed of adjustment of 46% and 42% for Boditi and Addis Ababa markets is relatively moderate as compared to a perfect adjustment.

Table 5: Cointegration regression

Variables	coefficient	std. error	t-ratio	p-value
Constant	1.70460	0.514215	3.315	0.0015 ***
Lnp2	0.666551	0.128124	5.202	1.92e-06 ***
Lnp3	0.150894	0.104246	1.447	0.1523
R-squared	0.718837	Adjusted R-squared	0.710688	
Log-likelihood	11.39002	Akaike criterion	-16.78004	
Schwarz criterion	-9.950038	Hannan-Quinn	-14.06099	
rho	0.697993	Durbin-Watson	0.600814	

Note: *** and ** indicate, respectively, for 1% and 5% significance levels (standard errors in parenthesis).
Source: Computed from data in Central Statistic Agency (CSA) of Ethiopia.

$$Lnp1 = 1.7046 + 0.66655 lnp2 + 0.150894 lnp3 + \epsilon$$
$$(0.5142)(0.1281) \quad (0.1042)$$

Where, Lnp_1, lnp_2 and lnp_3 denote Sodo, Boditi and Addis Ababa oxen price respectively.

From rule of thumb Durbin Watson statistic value that ranges from1.5 to 2.5 is free from auto correlation. Thus, we can conclude that there is no autocorrelation between time series data, because Durbin Watson values in Table 28 found within this range. This implies the VECM is free from autocorrelation problem. In Table 5 Sodo market was significantly co-integrated with Boditi market at 1% level of significance. The appreciation of the Sodo market was related to both markets. Thus, 1% increase in price of Boditi oxen market was likely to increase price of Sodo by 0.67 and this estimate was significant. For 1% increase in Addis market, Sodo market was increased by 0.15, this coefficient was not significant at 1% level of significance. Generally, the result of the Sodo market equation as shown above has positive sign with both markets. Granger causality is also estimated between pairs of oxen markets. Granger causality means the direction of price formation between two markets and related spatial arbitrage, i.e., physical movement of the commodity to adjust for these prices differences.

Table 6: Granger causality from Error Correction Model

Causality	F-Statistics	P-Value	Direction
Sodo Market → Boditi Market	11.3112***	0.00127	Bidirectional
Boditi Market → Sodo Market	6.85207**	0.01090	
Sodo Market → Addis Ababa Market	14.6147***	0.00029	Unidirectional
Addis Ababa Market → Sodo market	3.23004	0.07674	
Boditi Market → Addis Ababa market	14.9764***	0.00025	Unidirectional
Addis Ababa market → Boditi Market	0.19482	0.66034	

Note: *** and ** indicate, respectively, for 1% and 5% significance levels
Source: Computed from data in Central Statistic Agency (CSA) of Ethiopia.

Table-6 gives the results of the Granger causality test which show that, in one cases, i.e., Sodo and Boditi there exists bidirectional causality. On the other hand, the Sodo Granger causes price formation in the concerned Boditi oxen markets which in turn provide feedback to the Sodo base market as well. On the other hands, Addis Ababa has unidirectional relationships with both Sodo and Boditi base market. This implies that the Sodo and Boditi market Granger causes price formation in Addis Ababa market but it does not provide any feedback to the Sodo and Boditi base market.

4. Conclusions

This paper investigates spatial market integration in oxen markets by using monthly data from September 2006 to September, 2012 and with the help of Cointegration and VECM and Granger causality test. The results of ADF indicate that the three variables were stationary and integrated of same order, i.e., I (1) at their first difference for both without drift and with drift. Johansen's the trace and $\hat{\lambda}$-max tests rejected first hypothesis (r = 0) of no co integrating vector at 1% level of significant. In addition, the vector error correction model proved that most of the disequilibrium in the market is corrected within month. Prices correct a very small percentage of the disequilibrium in the markets with the greatest by the external and internal forces. This necessitates the need for future research, to investigate the influence of external and internal factors such as market infrastructure, government policy and self sufficient production, product characteristics and utilisation towards market integration. Results of the Granger causality test indicate that Wolaita Sodo and Bodit oxen market have bidirectional relationship. On the other hand, Addis Ababa oxen market has unidirectional relationships with both Wolaita Sodo and Bodit market.

5. Recommendation

The finding indicates that Addis Ababa oxen market are not well integrated with other Wolaita Sodo and Bodit oxen markets may be for various reasons such as transportation costs, imprecise price information, lack of good government policies, infrastructural and institutional arrangement. So government should create conducive policy environments that improve good flow of price information; work on infrastructural accessibility and institutional arrangement to reduce transaction costs.

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