Gezira J. of Agric. Sci. 2(2): 163-175(2004)

Goats Market Efficiency in Darfur Region: A co-Integration Analytical Approach

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ABSTRACT

The objective of this study is to understand the nature of the market efficiency for goats market in Darfur region. The study was based on weekly prices of goats in six market locations, namely, Nyala, Elfashir, Umkaddada, Kutum, Mellit and Elgeneina during the period of the first week of January 1998 to the last week of March 2003. The co-integration regression analysis revealed all markets are spatially integrated and there is stable equilibrium relationship between markets, i.e. highly. co-integrated. This implies that commodity arbitrage .is working and the markets are efficient. Therefore, the study concluded that price changes in the selected markets reflect the state of market performance. This study demonstrated the importance of having reliable and timely market information for policy makers, traders, and farmers to make informed decisions.

INTRODUCTION

Goats are important and yet neglected animals in Darfur region. Recently, Sudan government paid more attention to improve goats output of milk and meat, through imported breeds of high quality goats from foreign countries to improve milk production for small families. Goats marketing in Darfur is believed to be largely traditional and informally organized. A study of goats market efficiency can provide both information and guides to the producers and merchants. So far, there is scanty knowledge on any detailed study being conducted about market integration. Such a study is important to throw light on how the domestic markets of goats are integrated in Darfur region. The concept of market integration has gained an increased importance over recent years, particularly in

developing countries where ,there is potential application to policy questions regarding government intervention in markets.

Market efficiency is seen as the crucial factor in development, furthermore, analysis of spatial market integration is confined to an indication of efficiency. In highly competitive system, spatial of arbitrage should reduce price differences between markets to the level transaction costs. This activity may seem straight, but due to the nature of production and marketing such as seasonality of supply, inadequate infrastructure, barriers of market entry, unreliable market and price information may make the process of arbitrage a complex and risky activity for traders (Van Tilburg and Lutz, 1992).

However, imperfections in the market, particularly. those arising from activities of traders are generally taken as important causes for the existence of differential price movements in different markets. It is believed that prices quoted are a reflection of the conditions prevalent in the markets. Therefore, if there are imperfections in the form of either oligopoly power among buyers (example, basing-point pricing system) or unequal information among sellers, then it is accepted that buyers will be able to reap abnormal returns and subsequently, there exists a wide intraregional price differential in the market (Habibullah and Baharumshah (1994).

There are basically two approaches to investigate the issue of competitiveness in a market. The first is to establish whether the structure of the market tends to conform with the general criteria for a competitive market. The second is to determine whether price movements reflect state of competitiveness in the market (Farahain, 2002). In this study the second approach is used to test for market efficiency.

The test of market integration is supposed to give insight in the market structure and clarify, where government intervention in commodity marketing might lead to improvements and where it might be harmful (Durojaiye and Aihonsu, 1988). On the other hand, spatial market integration is essential to guarantee the smooth transfer of food from a surplus to a deficit region. Wyeth (1992) stated that using price

integration studies. vulnerable regions can be identified. During the last decade co-integration analysis technique has become widely used for the analysis of economic series. Co-integration analysis had been used by several authors (Aredeni, 1989: Goodwin and Schroeder, 1991; Alexander and Wyeth, 1992) to study market integration. The use of co-integration analysis has been prompted by the recognition that earlier generally ignored or misrepresented the time series properties of the price series.

The objective of this paper is to determine whether prices of goats in a market are in parity with prices in other markets. Co-integration tests are applied to spatial price relationship among regional goats markets. The hypothesis that regional markets for goats in Darfur region are closely interrelated. that is, price formation in one market is fully reflected in the prices of other markets (testing market efficiency by using price data). In other words, Darfur regional goats prices do not diverge and the markets are fully integrated. The null hypothesis then is, goats markets in Darfur region are well integrated, i.e long-run integration exists among different markets.

MATERIALS AND METHODS

i- Source of data

The co-integration technique discussed above was applied to weekly goats prices for six regional markets in Darfur. One important characteristic of the goats is that they are relatively homogeneous with little variation in quality (i.e. goats are of the same breed). The sales of goats are for meat and milk purposes. The six major towns in Darfur region selected for the analysis were Nyala, El fashir, Umkaddada, Kutum, Mellit, and Elgeneina. All the six markets are held all week and organized and run by the local council and located in the main goats producing areas. Markets in Darfur are nothing more than an open space and there are very little physical infrastructure involved in the marketing of livestock besides the market enclosure (*Zariha*). Cattle, sheep, goats, camels, horses and donkeys are sold in these markets. The majority of the buyers in these markets are butchers, local consumers and small traders. In these markets there are large

numbers of sellers and buyers. In all markets barriers to entry are very low. Little is required in the way of capital, administration or technical skill to start as buyer of goats. Markets are characterized by inadequate transportation network, absence of weighing system and market news are mainly obtained through personal contact. Most of the producers and small traders depend upon information passed around by the word of mouth. The period of data collection extended from the first week of January in 1998 to the last week in March 2003, yielding a total of 252 observations per series for the analysis. The data were mainly obtained from the files and reports of the Save Children Fund (Elfashir office).

ii- Methods of analysis

Spatial price relationship have been widely used to indicate overall market performance. The usual definition in the literature is that integrated markets are those where prices are determined interdependently (Habibullah and Bahgrumshah,1994). This has generally been assumed to mean that the price changes in one market will be fully transmitted to the other markets. Markets that are not integrated may convey inaccurate price information that might distort marketing decisions and contribute to the inefficient product movements.

Several analytical techniques have been developed and used to measure market integration. Examples are: Correlation analysis (Harriss,1979؛Blyn, 1973), regression analysis that analyze the dynamic price adjustment patterns (Ravallion,1986; Heyetens,1986). However, Ardeni (1989)argued that these analytical techniques ignored the time series properties of price data and the results obtained might be biased' and inconsistent. More important, the results tend more often to reject the null hypothesis of market integration, indicating that the markets are not efficient although these markets appear to operate competitively.

In this study, we employed the co-integration procedure to test spatial market integration, that is, a methodology developed by

Granger (1986) and Engle and Granger (1987). In short, if markets are efficient then prices it) different markets must be co-integrated.

The econometric term co-integration is a property of two or more variables which already have been shown to be integrated and which، though trending, cannot differ too far apart. Since they are 'tied together in some0sense, a long-run equilibrium will exist in a model based on such variables. When two price series are co-integrated it follows that the markets are integrated (in the economic sense) in the long-run. Co-integration between two price series requires the satisfaction of two conditions:

i- The data series for the two markets must have similar basic statistical properties, in particular, they must be integrated in the same order.

ii- There should exist some linear combinations of the two series for P and R such as؛

$P_t\ a_o+\beta R_t+ \mu$ (1)

P_t price in the peripheral market at time (t).

Rŧ : price in the reference market at time (t).

Where P_t and R_t are price series of a specific commodity in two markets. μ is the residual term assumed to be distributed identically and independently. Parameter $a_0$will represent domestic transportation costs, processing costs, sales taxes, etc..

The test of market integration is straightforward if P_t and R_t are stationary variables, however, economic variables are often non-stationary in which case the conventional tests are biased towards rejecting the null hypothesi.

Thus, before proceeding to further analysis, it is important Jo check for the stationarity of the variables (Granger and Newbold, 1987).

Stationary series is defined as one in which the parameters that describe the series (namely the mean, variance and autocorrelation) are independent of time, or rather exhibit constant mean and variance and have autocorrelation that are invariant through time. Once the non-stationarity status of the variables is determined (order of integration), the next step is to test for the presence of co-integration

(long-run equilibrium) relationships between the variables. Augmented Dickey - Fuller (1979) test (ADF - test) is used to determine the stationarity of a variable. The test is based on the t-statistic of (II given by the following equation:

$\Delta P_t = a_o + a_1 p_{t-1} + \sum N\text{E } k=l\text{Ø}k\Delta P_{t-k} + + \mu_t \quad (2)$

Where $\Delta P_t = P_t - P_{t.1}$ The test statistic is simply the t-statistic, under the null hypothesis it is not distributed as student- t, but this ratio can be compared with critical values tabulated in Fuller (1976). In estimating equation (2), the null hypothesis is $H_o : P_t$ is 1(1), which is rejected (in favour of 1(0)) if a_1 is found to be negative and statistically significant. The above test can also be carried out for the first-difference of the variable. That is estimating the following regression equation:

$\Delta^2 p_t = \theta_0 + \theta_l \Delta P_{t-l} + \sum^N k = {}_t \varphi_k \Delta^2 p_{t-k} = \mu_t \quad (3)$

where:

Δ^2 : denotes second difference

θ_0 θ_1 θ_k are parameters

μ_t : error term

k : indicates lag

N : number of observations

Where the null hypothesis is H_o: P_t is 1(2), which is rejected (in favour of 1(1)) if θ_1 is found to be negative and statistically significant. In general, a series P_t is said to be integrated of order d, if the series achieved stationary after differencing d times, denoted $P_t \sim l$ (d). Consequently. if P_t is stationary after differencing once we may denote $P_t \sim l(1)$ and $P_t \sim l$ (0). However, in most applied work the procedure is terminated after the first or second difference.

Having. established that the variables are non-stationary in levels then test for co-integration. Only variables that are of the same order of integration constitute a potential co-integration relationship. The definition of co-integration used here is that of Engle and Granger (1987). and is defined as follows: Consider a pair of series P_t and R_t each of which is integrated of order d. Their linear combination, that is,

$p_t - aR_t = \mu_t$

will generally be I(d). However, if there is a constant a, such that μ_t is I (d-b), where b>0 then P and R are said to be integrated of order d, b the vector (l- a) is called the co-integration regression. The relation P= aR may be considered as long-run or equilibrium relation (Engle and Granger, 1987), and g is the deviation from the long-run equilibrium When P and R are co-integrated, the long-run relationship P - aR = 0 will tend to be restablished after a stochastic shock. Thus, while the individual price series may be characterized by dominant long swings or wander aimlessly, their difference rarely drift from some "equilibrium" level, that is, they move together in the long-run. However, deviation from the long-run relationship may occur because of delivery lags and other impediments to regional trade (Habibullah and Baharumshah, 1994).

Comparing equation (l) and (4), equation (4) represents a 'strong-form test of market integration, where under the null hypothesis, parameter a_1 should be equal to zero, while should be equal to one. On the other, hand if we have the 'weak-form' test for mark hand, if $a_0 \neq 0$ and $a_1 = 1$, we have 'weak- form' test for market integration (Palakas and Harriss, 1993). However, in most application the 'weak-form' test for market integration is usually employed in empirical analysis. This is because information on domestic transportation costs, processing costs, sales taxes, etc.. is not available. Therefore, the role of the constant term (10 in equation (l) is to absorb the influence of these factors.

Nevertheless, before proceeding to test for market integration using the approach of co-integration analysis, we need to determine the nature integration of the variables. According to Granger (1986), a model specified by equation (l) does not make sense unless P and R are of the same order of integration. Thus, a necessary condition for P and R to be co-integrated is that they must be integrated of the same order. Testing. whether the variables are co-integrated is merely another unit root test on the residual in equation (l). The test involved

regressing the first-difference of the residual series on residual lagged level and lagged dependent variables as follows:

$$\Delta \mu_t = \gamma_1 = \mu_{t-1} + \sum^{N}_{k=1} \pi k \, \Delta\mu_{t-k} + vt \qquad (5)$$

Where:

μt residual term

K: indicates lag

γ_1 πk : are parameters to be estimated

N : total number of observations.

Again the test statistic is the t-statistic of γ_1The critical values are tabulated in Fuller (1976). The null hypothesis is H_o: P and R are not co-integrated. The null hypothesis is rejected if estimated γ_1 is negative and found to be significantly different from zero.

It has been argued in the literature that the Dickey-Fuller test loses Power if the length of the lag length N in equation (2), (3) and (5) are larger than necessary, so that several of the coefficients, øk, φ_k and πk are not significantly different from zero. In that case, the null hypothesis tends to be accepted too often, when in fact it should be rejected (Habibullah and Baharumsha, 1994).

To overcome the problem, the optimal lag length chosen say N, is the one that minimized Akaike's (1969) information criterion. The Akaike's (1969) final prediction error (FPE) criterion is basically a step-by-step procedure. Accordingly, we first regress ΔP_t , that is;

$$\Delta P_l = \Phi_0 + \Phi_1 p_t + \sum^{N}_{k=1} \psi k \, \Delta P_{t-k} + v_t \qquad (6)$$

Where:

Δ : first difference

P_t : price series of a specific commodity

Φ_0, + Φ_1, ψk t : are parameters

K: indicates lag

By using the order of lags from one to twelve, we compute the FPE of P, in each case using the following formulation:

$$FPE(N) = \{ (T+N+2)/(T-N-2)\} x \{SSR(N)/T\} \qquad (7)$$

Where T is total number of observations, N is the number of lags and SSR the sum of squared residuals. We choose that order of lags, say N, that yield the smallest FPE.

Apart from using ADF as a test for co-integration, Engle and Granger (1987)have recommended the use of the following co-integration regression Durbin-Waston (CRDW) statistic.

CRDW = $\{\sum_{Nt=2}(é_1 - é_{t-1})^2\}/\{\sum^{N}_{t=1} é^2t\}$

Where:

CRDW: co-integration regression Durbin-Waston

ét : residual term

The null hypothesis of no co-integration is rejected for values of CRDW which are significantly different from zero. The critical values for CRDW are tabulated in Engle and Yoo (1987).

RESULTS AND DISCUSSION

The first step in using the methodology introduced above is to determine whether the goats price series chosen in this way are already stationary and, if they are not, to investigate their order of integration. In all cases calculations are carried out on logs of the prices since they are proved to give better results. We use ADF tests as described above‹ with two lags and Table l, reports the resulting $ADF_{(2)}$ statistics. All of them in the first six rows of the first column of the table are too small to allow rejection of the null hypothesis that they are integrated of order l. Hence, none of the goats price series is stationary. The second column shows results from the test for integration of order 2. The null hypothesis is rejected at one percent in all cases, indicating that all the goats price series are 1(1) processes.

Table l. Stationarity test of the price series.

Market	1(1) vs 1(0)	1(2)vs 1(1)
Nyala	-0.86	-19.29
EIFashir	-2.13	-22.55
Umkaddada	-l .57	-19.98
Kutum	-2.04	-23.77
Mellit	-l .76	-18.95
EIGenina	-l .59	-18.86

Critical values: (from Engle and Y 00, 1987)

Significant levels	10%	5%	1%
ADF	-2.58	-2.89	-3.51

The next stage is to look for co-integration of order (1,1) between each pairs of price series by running co-integration regressions. Detailed results of these regressions are reported in Table(2).

Table 2. Co-integration tests among specified price series.

	Independent variables				
Statistics	EIFashir	Umkaddada	Kutum	Mellit	Elgenina
i-Nyala (dependent variable) Constant					
	3.86	3.08	4.10	3.47	4.06
	(0.41)	(0.11)	(0.06)	(0.01)	(0.14)
β	1.15	0.91	I .35	0.79	I .02
	(2.15)	(5.69)	(1.41)	(3.21)	(1.91)
R^2	0.81	0.21	o. 80	0.40	0.41
CRDW	0.75	0.89	0.74	0.81	0.76
ADF	-7.52	-8.45	-7.48	-7.93	-7.57
Lag	5	2	3	1	4
ii-Elfashir (dependent variable Constant					
		2.68	2.97	2.39	3.51
		(0.52)	(0.21)	(0.12)	(1.02)
β		0.93	0.38	0.47	1.11
		(2.18)	(1.10)	(0.67)	(2.16)
R^2		0.71	0.17	0.51	0.10
CRDW		0.62	0.54	0.58	0.52
ADF		-6.82	-6.31	-6.53	-6.26
Lag		2	3	1	1
iii- Umkaddada (dependent variable)Constant					
			2.31	I .77	3.31
			(0.10)	(0.71)	(0.12)
β			0.49	0.61	1.09
			(I .66)	(0.92)	(2.10)
R2			0.35	0.26	0.17
CRDW			0.57	0.60	0.43
ADF			-6.51	-7.03	-3.47
Lag			2	2	2
(iv- Kutum (dependent variable) constant					
				2.71	2.11
				(0.09)	(0.21)
β				0.37	0.50
				(1.78)	(1.22)
R2				0.65	0.38
CRDW				0.18	0.30
ADF				-3.93	-4.63
Lag				3	1
v- Mellit (dependent variable)constant					
					3 .60
					(0.10)
β					1.23
					(0.86)
R2					0.86
CRDW					0.67
ADF					-7.14
Lag					2

Figures in paranthesis indicate t- values. critical values: (From Engle and Yoo,1987)

Significant levels	10%	5%	1%
CRDW	0.32	0.39	0.51
ADF	-3.03	-3.37	-4.07

Table (2) summarizes the results of the tests for the six major markets in Darfur region. Using ADF, in general, the results presented in Table (3) showed that markets are strongly co-integrated at 1% level with exception of connection between Kutum and Mellit and Umkaddada and Elgeneina which were significant at 5% level. This high significant levels of co-integration can largely be attributed to the arbitrage process of the traders between markets. The critical values for the ADF statistics for testing the null hypothesis that P and R are not co-integrated are tabulated in Fuller (1976). On the other hand, the CRDW statistics also showed that the null hypothesis of no co-integration are rejected in most of the cases. The CRDW as a measure of co-integration test between Kutum and Mellit and Klitum and Elgeneina is not significant. This is due to the fact that CRDW is not a powerful measure of co-integration when compared to ADF test (Engle and Granger, 1987).

Table 3. Significance levels of co integration tests.

Dependent Variable	Independent variable					
	Nyala	Elfashir	Umkaddada	Kutum	Mellit	Elgeneina
			ADF test			
Nyala		1%	1%	1%	1%	1%
Elfashir			1%	1%	1%	1%
Umkaddada				1%	1%	1%
Kutum					5%	5%
Mellit						1%
			CRDW test			
Nyala		1%	1%	1%	1%	1%
Elfashir			1%	1%	1%	1%
Umkaddada				1%	1%	5%
Kutum					--	--
Mellit						1%

Source: Obtained from Table (2). indicates not significant

The results also showed that there is relatively low level of significance between Kutum and Mellit when using ADF test, but when using CRI)W est the connection between Kutum and Mellit and Kutum and Elgeneina is not significant. This is due to the characteristics and nature of harsh roads between these markets, the reason that restricted the trade relationship

between them. Umkaddada, which is separated by a long distance from Elgeneina, was found to be connected to Elgeneina at 5% level. this result can be attributed to the trading relationship between Umkaddada and Elfashir and between Elgeneina and Elfashir. In this connection, Harris (1979), argued that " markets may not trade with each other at all but may be highly correlated via the price and trading relationship of a joint destination market".

Thus the hypothesis that prices are not co-integrated Was rejected in almost all cases for the sample period of 1998-2003. The results in Table (3) imply that regional goat markets in Darfur are spatially integrated, that is, the markets are efficient.

CONCLUSION

In this study, the co-integration method developed by Engle and Granger (1987) is used to analyse the long-run relationship between goat prices in different markets in Darfur region. The results indicate that the goat prices series are co-integrated and there is a stable equilibrium relationship between variables, that is, the market is spatially integrated. The empirical results suggest that regional goat markets in Darfur are highly co-integrated. This implies that commodity arbitrage is working. Therefore, it is concluded that price changes are fully and immediately transmitted to the other markets (i.e. indicating market efficiency). The high degree of market integration observed in this study is consistent with the view that goat market are quite competitive. The government can use results from market integration analysis to improve livestock market efficiency in markets that have weak integration or are not integrated. The results indicated that Kutum, Mellit and Elgeneina are not co-integrated when using CRDW test.

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