MEASURING MARKET INTEGRATION IN MOZAMBICAN MAIZE MARKETS: A THRESHOLD VECTOR ERROR CORRECTION APPROACH

By

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Abstract:

The primary objective of this research was to measure the extent of market integration between major surplus and deficit maize markets in Mozambique namely, Chimoio-Maputo, Chimoio-Beira, Ribáuè-*Nampula, and Mocuba-Nampula. To achieve this objective, Threshold Vector Autoregressive models were applied. The choice of the model was motivated by unobservable transaction costs and the important influence that their presence may exert on equilibrium spatial price relationships. The following are some of the major findings of the study. Firstly, threshold values (i.e. estimates of transaction costs) are found to be correlated positively with distance and inversely with the condition of the roads connecting markets. Secondly, market integration analysis revealed that out of the four surplus and deficit market combinations studied, Chimoio-Maputo and Mocuba-Nampula market pairs are integrated. However, the degree of integration was found to be the strongest in the former. Finally, results from the impulse response suggested that deficit/surplus markets, in the integrated market combinations, are relatively more responsive to shocks emanating from surplus/deficit markets.*

JEL classification: C21, C22, D4, E3, Q13
Key words: Mozambique, market integration, maize market, transaction cost, threshod vecto error correction

1. Introduction

Maize is the staple food and principal marketed crop in Mozambique. Of the basic food grains, only maize is commonly marketed, with about 20 percent of the total production sold, and 21 percent of households participating in maize markets (Bias and Donovan, 2004).

For the past two decades, policy and institutional frameworks in Mozambique have gone through dramatic changes as the country moved from a government that was highly centralised to a government that is de-centralised with an open, market-oriented economy. Maize markets have been affected by these changes[4]. Theory attests that

[3] This research was supported by the Organization for Social Science Research in Eastern & Southern Africa (OSSREA).

[4] Maize markets have been liberalized since 1987 following the introduction of Economic and Social Rehabilitation Programme (ESRP).

market liberalisation improves the efficient utilisation of resources. Efficient resource utilisation in turn is affected by market efficiency which, among other things is dependant upon the level at which markets are integrated. Spatial market integration refers to co-movement of prices and more generally, to the smooth transmission of price signals and information across spatially separated markets (Goletti, Ahmed and Farid, 1995). Associated with market integration is the degree of price transmission, which may have an effect on the speed of traders' response to move food to deficit areas. The primary mechanism ensuring integration is spatial trade and arbitrage[5]. This paper sets out with the objective of measuring the extent of maize market integration between major maize markets in Mozambique.

Several studies have attempted to analyse maize market integration in Mozambique. Studies by Donovan (1996) and Abdula (2001) applied price correlations, while Abdula (2005) used co-integration analysis to measure maize market integration in Mozambique. These methods rely on price data alone and have been criticised for their ignorance of transaction costs, despite the important influence that the presence of transaction costs may exert on equilibrium spatial price relationships. The studies by Penzhorn and Arndt (2002) and Tostão and Brorsen (2005) are different from the ones by Donovan (1996) and Abdula (2001) in their consideration of data on transaction costs in their studies within the framework of the Parity Bound Model (PBM). The PBM relies on price and actual transaction costs data. The PBM has been criticised however, because of the difficulty in accurately measuring transaction costs.

In this study, a methodology commonly referred to in the literature as the Threshold Vector Autoregressive or Threshold Vector Error Correction Model (TVAR/TVECM) is applied. The method acknowledges the influence that transaction costs exert on the integration of spatially separated markets, but operates without directly relying on transaction costs data which may not have been measured accurately or be available at all, which is usually the case in developing economies such as Mozambique. In addition

[5] Spatial arbitrage efficiency requires that price spreads be equal or less than transaction costs.

to this, its advantage over the PBM arises from its ability to estimate dynamic price relationships i.e. the duration of adjustment processes following shocks.

One major weakness of Threshold models however, is the assumption that transaction costs remain constant throughout the study period (Balk & Fomby, 1997). In a country like Mozambique, where poor road conditions, especially during the rainy season, hamper free flow of maize and hence cause seasonal changes in transportation (transaction) costs, constant transaction cost assumption implied by threshold models may not be reasonable[6]. In this study, attempt is made to account for seasonal variations in transportation costs occurring as a result of the impassable nature of most roads during the rainy season with the help of seasonal dummies.

The rest of the article is structured as follows. Section two presents a discussion of maize trading and market constraints in Mozambique. Section three describes the data and methods used in this study. Section four provides a discussion of the results obtained in this study and finally, section five presents the conclusion and gives the recommendations of the study.

2. Maize trading and market constraints

In Mozambique, both formal and informal traders, who usually compete for maize (Bias and Donovan, 2004), trade maize, but most traders operate on an informal level. Formal traders hold a trading licence, but informal traders do not. Becoming a formal trader requires money, a large amount of paperwork and considerable time. In addition to being obliged to pay taxes, formal traders are subject to inspections involving the Ministries of Commerce, Health, Labour and State Administration (Tostão and Brorsen, 2005). The costs involved in formalising trading activities are believed to have triggered the emergence of informal traders. Informal traders are not officially recognised and do not pay taxes, although they pay a symbolic stall fee to municipal authorities. Informal

[6] We thank the anonymous referee for bringing this to our attention.

traders have limited access to formal credit (working capital) and the quantity of maize they transact depends mostly upon informal or family credit.

Maize is transported mainly by trucks, although only 47 percent of the roads in Mozambique are paved (The Government of Mozambique, 2001). More than half (53 percent) of the national road network is feeder roads[7]. Furthermore, most roads are impassable during the rainy season. There are three main east-west transport routes along three main corridors (Maputo, Beira and Nacala), but there is no direct road connection between the north and the centre/south of the country. The road between the maize surplus regions in the north and the maize deficit regions in the south ends at Caia on the boarder between Sofala and Zambézia provinces. A ferry crosses the Zambezi River to Zambézia, where the road resumes again. However, the ferry is not always available, particularly when the Zambezi River is in flood. In much of the rainy season road traffic between Zambézia and other regions of central Mozambique passes via Malawi (The Government of Mozambique, 2001). Maritime transport is very expensive and inefficient and domestic maritime transport is almost nonexistent. No railway lines connect the north and centre/south of Mozambique. The railway infrastructure was conceived to serve the connection within the region (SADC)[8]. The railway lines link Maputo with South Africa, Beira with Zimbabwe and Nacala with Malawi (The Government of Mozambique, 2001).

These deficiencies in the transport infrastructure result in the very high costs of supplying the centre and the south of the country and, consequently, very low prices to producers (most of them in the north) when trade does occur (Tschirley and Santos, 1999). According to Table 1 average prices in Maputo (a maize deficit area in southern Mozambique) are almost double those in central/northern Mozambique.

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[7] Unpaved roads with seasonal circulation

[8] To connect the ports with the interior, the so-called hinterland

Table 1: Descriptive statistics for monthly real maize retail prices in Mozambique (MZM[9]/Kg) between November 1992 and December 2004

Region	Market	Mean	Standard deviation	Minimum	Maximum
North/Centre	Mocuba	30.61	17.41	10.52	121.17
	Nampula	37.16	14.52	16.53	83.13
	Ribáuè	29.49	12.35	6.88	70.39
	Beira	40.71	16.78	17.42	121.27
	Chimoio	38.51	17.49	16.84	117.37
South	Maputo	60.75	17.29	30.97	161.61

Source: Authors' own computations, based on data from SIMA database

During years with normal rainfall, Southern Mozambique is supplied by the south or centre of the country and by South Africa, while central Mozambique typically feeds itself and exports surpluses to the south. The north sells to the central and southern region only every 3 to 7 years, during regional droughts and even then, producer prices are not highly attractive (Tschirley and Santos, 1999). In Niassa and parts of western Nampula, roads and markets are not able to meet consumers' needs and these regions have few market opportunities and a limited availability of consumer goods. Maize is sold to Malawian traders in exchange for consumer goods and implements (Bias and Donovan, 2004). Northern Mozambique only supplies maize to Malawi when the latter experiences a deficit (USAID, 2004).

The factors discussed above have lead to a subsistence type of production and low market participation rates. The highly dispersed population relies heavily on its own production for its consumption needs and only about 30 percent of the rural households participate in output markets, and less than 7 percent uses purchased inputs (Bias and Donovan, 2004). According to the 1995/96 farm household survey, 80 percent of maize production was for home consumption.

[9] Mozambique's currency is Metical, Meticais for plural.

3. Data and methods

3.1 The data

The analysis is based on real monthly time series price data at retail level per kilogram from January 1993 to December 2004 obtained from SIMA[10] at the Ministry of Agriculture. Owing to a large number of missing values, the study utilises only prices quoted in three surplus markets namely, Chimoio, Mocuba and Ribáuè and in three deficit markets namely, Maputo, Beira and Nampula. Even this price data were not complete, 2 values were missing for Nampula, 21 for Mocuba and 13 for Ribáuè. To estimate a missing value for a particular month, that month's data for the previous years were used to calculate an average. A trend line was then fitted over the logarithm of price data that comprised the actual values and the estimated averages for the missing values. The fitted trend line was then used to estimate the missing values, which replaced the averages which had been calculated.

3.2 The model

Engle and Granger (1987) define the dynamic long-term relationship between prices in two markets as,

$$P_t^1 = \alpha_0 + \alpha_1 P_t^2 + \alpha_2 S_t + \mu_t, \qquad [1]$$

$$\mu_t = \rho\mu_{t-1} + v_t$$

Where v_t is a random error term, P_t^1 is the maize price in the surplus market; P_t^2 is the maize price in the deficit market S_t is the seasonal dummy to account for changes in prices[11] caused by seasonal variations. It takes on a value of one during rainy season and

[10] Portuguese acronym for Agricultural Marketing Information System.
[11] There is a single rainy season in Mozambique. Therefore, there is one cropping season per year in most parts of the country (Donovan, 1996). The rainy season begins in August/September and ends in

zero otherwise. m_t is the error term. Co-integration[12] of the price variables depends on the nature of the autoregressive (AR) process for m_t. As r approaches one, the deviation from the equilibrium becomes non-stationary and prices in the two markets are not co-integrated. Assuming that m_t follows a Threshold Autoregressive process (TAR), with a three regime TAR model, the behaviour of m_t may be represented as

$$\begin{cases} r^{(1)} \; if \quad -\infty < m_{t-d} \leq c_1 \\ r^{(2)} \; if \quad c_1 < m_{t-d} \leq c_2 \\ r^{(3)} \; if \quad c_2 < m_{t-d} + \leq +\infty \end{cases} \qquad [2]$$

Where c_1 and c_2 represent the thresholds which give rise to the different regimes, m_{t-d} is the variable used to capture threshold behaviour, and d is the delay parameter which is assumed, as in other studies, to be equal to 1. The Vector[13] Autoregressive (VAR) representation of the threshold model is given by:

$$P_t = \begin{cases} \sum_{i=1}^{l} B_i^{(1)} P_{t-i} + j^{(1)} S_t + e_t^{(1)} .... if .... -\infty < m_{t-d} \leq c_1 \\ \sum_{i=1}^{l} B_i^{(2)} P_{t-i} + j^{(2)} S_t + e_t^{(2)} .... if .... c_1 < m_{t-d} \leq c_2 \\ \sum_{i=1}^{l} B_i^{(3)} P_{t-i} + j^{(3)} S_t + e_t^{(3)} .... if .... c_3 < m_{t-d} \leq +\infty \end{cases} \qquad [3]$$

Where P_t is the vector of prices being analysed ($P^1{}_t$ and $P^2{}_t$). The procedures used to estimate threshold VAR models for the selected market pairs are summarised in Table 2 below.

February/March and the cropping season follows this pattern as well. The dry season is from April to July/August each year.

[12] In this study, individual maize prices were found to be integrated of order zero i.e. $I(0)$. This is assumed to imply that maize prices in each market pair are cointegrated.

[13] Vector Error Correction representation of TAR is not presented here because unit root tests showed that individual prices are integrated of order zero i.e. $I(0)$. See Table 3 for results on unit root tests.

Table 2: Summary of methods used to estimate Threshold VAR model

Steps	Description	Procedure
1	Test on the statistical property of price variables.	Conventional Augmented Dickey Fuller (ADF)
2	Test on the nonlinearity of error correction terms to test for threshold effects.	Tsay (1989)
3	Grid search to estimate threshold parameters[14]	Seemingly unrelated regression (SUR) & log determinant of covariance matrix of residuals
4	Significance of threshold parameters[15]	Hansen (1997)
5	Market integration	TVARM

4. Results and discussions

4.1 Order of integration

The analysis was based on logarithmic transformed monthly real price data. The statistical property of each variable was determined by applying the conventional Augmented Dickey-Fuller (ADF) tests. The ADF tests were preceded by a plot of each variable to determine whether the price series had deterministic components (constant and trend terms). Next, the sequential procedure explained in Harris (1995), which gives special attention to lags and deterministic components to be included in the model, was applied. According to the results found (Table 3), we reject the null hypothesis that all

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[14] Following Serra and Goodwin (2002), sequential conditional iterative Seemingly Unrelated Regression (SUR) procedures are applied to estimate threshold parameters c_1 and c_2 for each apple market pairs. The parameters are estimated by conducting a two-dimensional grid search and by selecting those values of c_1 and c_2 which minimise the log determinant of the variance covariance matrix of residuals. The search is restricted to a minimum of 20 observations in each regime.

[15] Following Serra and Goodwin (2002), an extension of Hansen's (1997) approach is applied to test for the significance of threshold effects. This procedure applies the sup-LR statistic to test a null hypothesis of linear Vector Autoregressive Model (VARM) against the alternative of a Threshold Vector Autoregressive Model (TVARM). The model under the null hypothesis $P_t = \mathrm{B}' x_{t-1} + e_t$ (VECM) is tested against the alternative hypothesis $P_t = \mathrm{b}^{(1)} \mathrm{y}_{t-1} d_{1t}(c_1, c_2, d) + \mathrm{b}^{(2)} \mathrm{y}_{t-1} d_{2t}(c_1, c_2, d) + \mathrm{b}^{(3)} \mathrm{y}_{t-1} d_{3t}(c_1, c_2, d) + e_t$ (TVARM). The sup-LR statistic is computed using the equation $LR = T\left(\ln\left|\hat{\Sigma}\right| - \ln\left|\sum(\hat{c}_1, \hat{c}_2, 1)\right| \right)$. A hundred simulations for each market pairs (eight in total) were made by replacing the dependent variable by iid N(0,1) draws. The asymptotic p-value of the sup-LR was obtained by counting the number of times the simulated LR statistic exceeds the observed LR.

real price variables are I (1). This suggests that individual price variables are stationary in levels i.e. I (0).

Table 3: Results of unit root test

Series	Model[a]	Lags	T-test[b]	LM(1)[c]
Beira	t_T	13	-4.20	0.622
Chimoio	t_m	1	-4.78	0.48
Maputo	t_m	1	-3.75	2.33
Nampula	t_m	1	-3.86	1.53
Mocuba	t_T	1	-5.06	2.20
Ribáuè	t_T	0	-4.66	0.23

[a] Model t_T indicates that the Dickey-Fuller regression contains a constant and a trend; t_m indicates that only a constant is included.

[b] Critical values at 5% level of significance are t_m =-2.89; t_T =-3.45.

[c] LM(1) is the Breusch-Godfrey Lagrange Multiplier statistic. It is used to test a first order autocorrelation problem. Critical value at 5% level of significance is 3.84.

4.2 Threshold values

Test results on the level of integration of individual maize prices, discussed above, were followed by Tsay's (1989) test to determine whether the dynamics of the relationships among prices are linear or whether they exhibit threshold type non-linearities. The autoregressive order of the deviations from the equilibrium was determined by an evaluation of residuals from Equation 1. Autocorrelation patterns confirmed an autoregressive order of one i.e. *AR* (1). Tsay's test results are presented in column 4 of Table 4. In every case, the test rejects the null hypothesis of no thresholds. This suggests that threshold behaviour characterises spatial price linkages among regional maize markets studied. Therefore, maize markets are better characterised by a threshold vector autoregressive model (TVAR) as opposed to a linear vector Autoregressive model (VAR).

Table 4: Threshold values for major market maize pairs

Market Pairs	Distance in Km	Road Condition	Tsay's Test	Negative Threshold (c_1)	Positive Thresholds (c_2)	Sup-LR Test
Chimoio-Maputo	1135	Good	11.64^{*}	-0.207	0.200	297.70^{*}
Chimoio-Beira	198	Good	2.80^{***}	-0.050	0.052	110.46^{*}
Ribáuè-Nampula	138	Bad	9.70^{**}	-0.223	0.031	51.10^{*}
Mocuba-Nampula	500	Bad	18.78^{*}	-0.179	0.237	300.77^{*}

*, ** and *** indicate statistical significance at 1%, 5% and 10% respectively.

After threshold effects had been confirmed, threshold values were searched. A grid search procedure that minimises the log determinant of the variance-covariance matrix of the residuals of the TVAR model was applied to determine the threshold values (Table 4 columns 5 and 6). After threshold values were determined, the sup-LR statistic was used to test for the significance of threshold values across regimes. The results (Table 4, column 7) indicate that in every case, the test statistics exceeded the implied critical values at the one percent level of significance. Therefore, the results confirm that significant thresholds exist and imply that these thresholds play an important role in characterising price adjustment between the maize markets studied. The thresholds directly correspond to transaction costs and represent the amount that price differences have to exceed in order to cross the threshold and trigger the outside-band regime adjustments.

The threshold values, which are analogous to transaction costs and define the neutral band, are expected to correlate positively with the distance between markets and the availability of good roads connecting the markets. The threshold values identified by this study are consistent with expectations (compare distance and road conditions in Table 4 columns 2, 3, with threshold values in Table 4 columns 5 & 6). Roads between the centre and the south are in a relatively good condition according to local standards. On the other hand, roads in northern Mozambique are in bad state (Table 4). The higher threshold values in the Nampula-Ribáuè and Nampula-Mocuba markets reflect the higher transaction costs faced by traders due to the high transportation costs incurred, mainly by poor roads. The very low threshold value identified for the Beira-Chimoio market linkage could be attributed to the distance separating the two markets. Prices in the Beira-Chimoio market linkage should be at least 5% different to exceed the threshold and trigger adjustment. Threshold values estimated for other market linkages may be interpreted similarly.

4.3 Time of switching between regimes

In this sub-section, the aggregate frequency of observations occurring in the three regimes is determined. This is done to determine the distribution of the deviations from the equilibrium in the three regimes. This is then followed by determining the persistence of price differences occurring in each regime and the time it takes for price differences to switch between regimes. Regime two corresponds to observations falling between two thresholds and thus suggests price differences that are within the neutral band. A long series of observations falling outside of the implied neutral band (i.e. Regimes 1 and 3) suggests price differences that persistently exceed transaction costs. Strongly integrated markets would not be expected to display such persistent deviations from the equilibrium. If price differences persist in the neutral band, it is considered to be a case of strongly integrated markets (Goodwin and Piggott, 2001).

Market integration implies that price differences between trading regions should be less than or equal to transaction costs. Therefore, deviations from the equilibrium frequently falling into the second regime, are consistent with market integration. According to the results in Table 5, the neutral band, i.e. the second regime, registered the highest frequency in terms of the percentage of observations that occur in it for any given threshold in the three market combinations. An exception exists for the Chimoio-Beira market linkage[16]. Of the three market pairs which registered high frequency in their neutral band, Chimoio-Maputo and Mocuba-Nampula market linkages have the largest

[16] According to the information we gathered during our field survey, most retail traders in Beira sourced their maize from Nhamatanda, Buzi and Gorongosa. These areas are located in the Sofala province as Beira. For example, Nhamatanda is only 98 kilometers far from Beira. The importance of these areas as sources of maize supply to Beira increased after the war ended which saw the return of people to these areas to farm.

number of observations in their neutral bands. However, market integration is the strongest in Chimoio-Maputo market combinations.

Table 5: Percentage of observations falling in Regimes I, II and III[a]

Market Pairs	Regime I $-\infty < m_{t-d} \le c_1$	Regime II $c_1 < m_{t-d} \le c_2$	Regime III $c_2 < m_{t-d} \le +\infty$
Chimoio-Maputo	18.75(27)	67.36(97)	18.06(26)
Chimoio-Beira	38.89(56)	18.75(27)	42.36(61)
Ribáuè-Nampula	14.58(21)	43.06(62)	42.36(61)
Mocuba-Nampula	34.72(50)	43.06(62)	22.22(32)

[a] Numbers in brackets indicates a count of observations falling in each regime

Regime switching estimates were then analysed to further investigate market integration by looking at the persistence of deviations from the equilibrium and the timing of the switching of observations among regimes. Persistent occurrence of deviations in the second regime is a condition for strong market integration. The persistent occurrence of deviation outside the neutral band (i.e. the 1st and 3rd regimes) represents price differences that are greater than transaction costs which violates efficient arbitrage conditions. According to the results found (Figure 1a through 1d), deviations from the equilibrium persistently fell into the neutral band in Chimoio-Maputo (Figure 1a) markets. Therefore based on the results from Table 5 and Figure 1, we conclude that Chimoio-Maputo maize markets are strongly integrated.

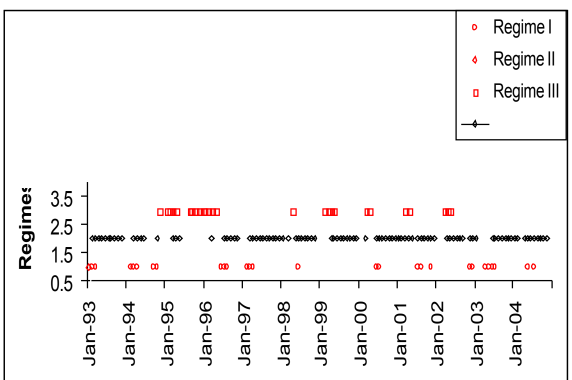

Figure 1a: Regime Switching: Chimoio & Maputo

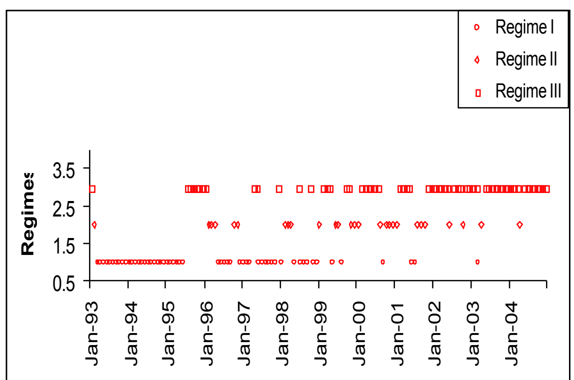

Figure 1b: Regime Switching: Chimoio & Beira

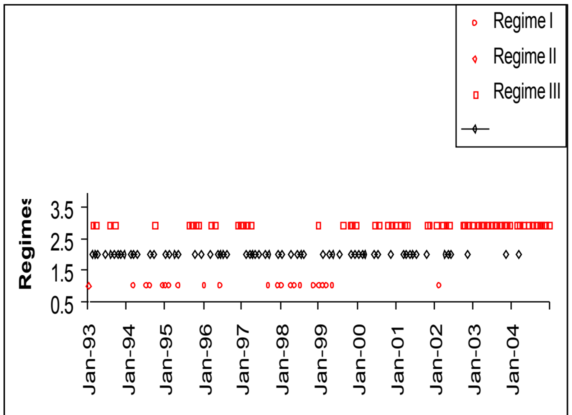

Figure 1c: Regime Switching: Ribaue & Nampula

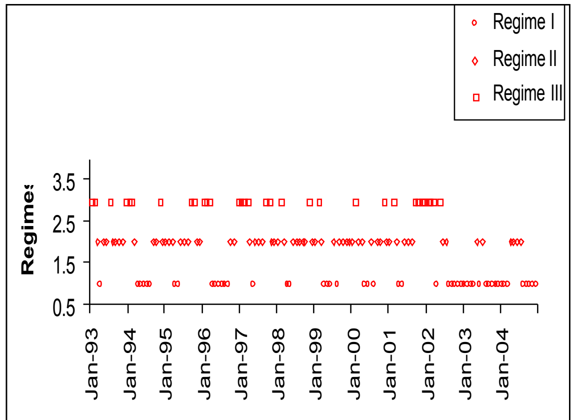

Figure 1d: Regime Switching: mocuba & ampula

4.4 Speed of transmission of negative and positive shocks in the maize markets

The interpretation of the dynamic interrelationships among prices at alterative markets is best pursued through a consideration of impulse response functions (Goodwin and Piggott, 2001). In this section, the results of impulse response function estimation are reported in an attempt to obtain an understanding of dynamic price relationships. This was done by adjusting the last observation of the data (December 2004) to evaluate responses to one-half standard deviation positive and negative shocks. There are many different possible impulse response functions; in this study however, the non-linear impulse response function (NLIRF) approach of Potter (1995) is adopted. The NLIRF is defined as follows:

$$NLIRF_{t+k}(v, Z_t, Z_{t-1},...) = E[Z_{t+k} | Z_t = z_t + v, Z_{t-1} = z_{t-1},...] - E[Z_{t+k} | Z_t = z_t, Z_{t-1} = z_{t-1},...]$$

Where ($z_t, z_{t-1},...$) observed data and v is a shock

Figures 2a through 2d depict the response in surplus markets to shocks in deficit markets; likewise, figures 3a through 3d depict the response in deficit markets to shocks in surplus markets. Dotted lines represent the response to negative shocks, while solid lines with a "+" sign represent the response to positive shocks.

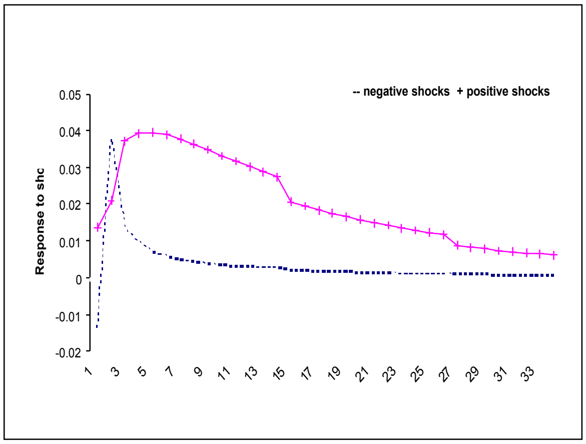

Figure 2a: Response of Chimoio to Maputo Shock

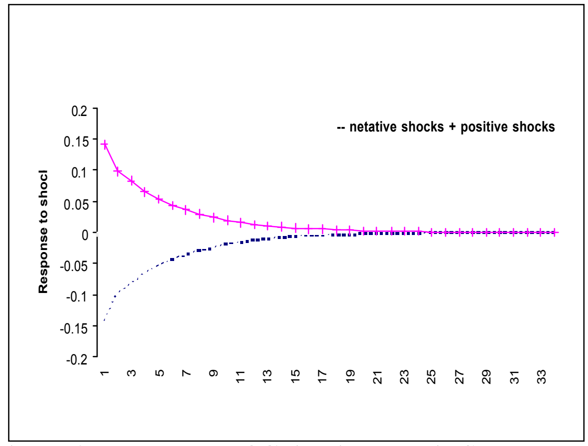

Figure 2b: Response of Chimoio to Beria Shock

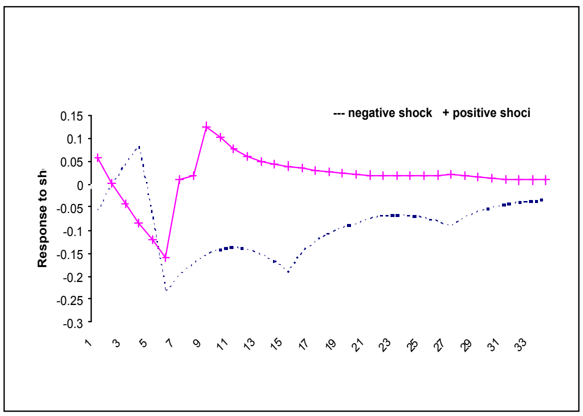

Figure 2c: Response of Ribaue to Nampula

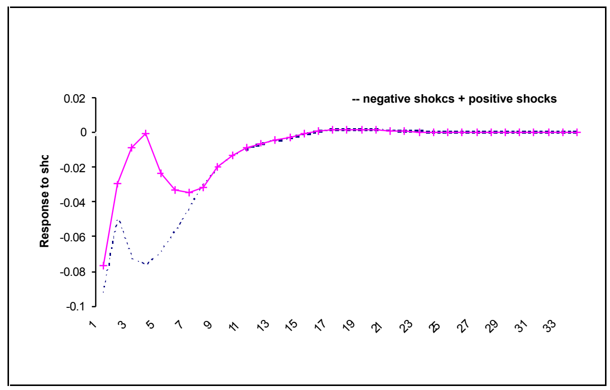

Figure 2d: Response of Mocuba to Na mpula

The time plots (Figure 2 &3) show that both positive and negative shocks introduced either at the deficit or surplus market, lead to a similar pattern of adjustment. The plots further indicate that shocks in surplus markets provoke responses in deficit markets and *vice versa*. However the speeds at which these shocks are normalized differ from one market pair to the other depending on the level at which the market pair concerned is integrated. For example, it takes close to five months for a negative shock in Chimoio market to be completely normalized in Maputo market (Figure 3a) which is relatively faster than the responsiveness of Beira market to a shock in Chimoio market (Figure 3b). Impulse response results from other market combinations lead to similar conclusions. Generally, the responses reflect behaviour consistent with price convergence and hence support long-term market integration. It should, however, be noted that these responses are conditional on the size of shocks, due to asymmetric price relationships among markets.

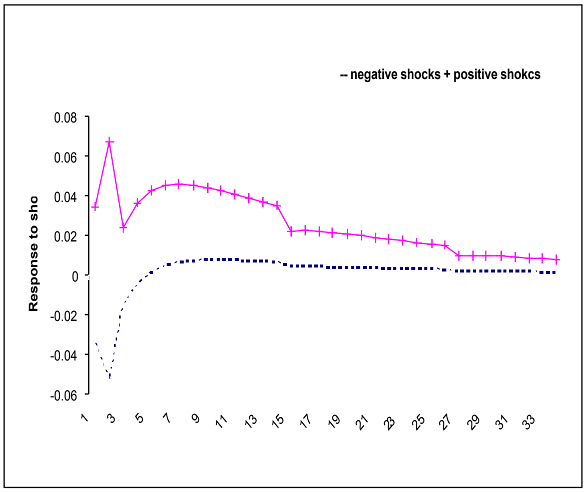

Figure 3a: Response of Maputo to Chimoio

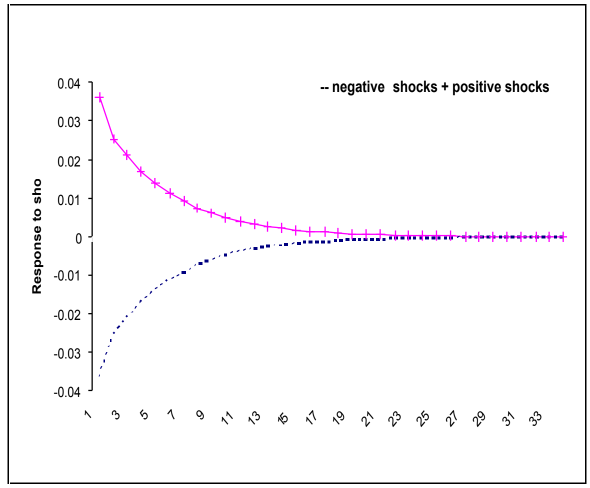

Figure 3b: Response of B eira to Chimoio

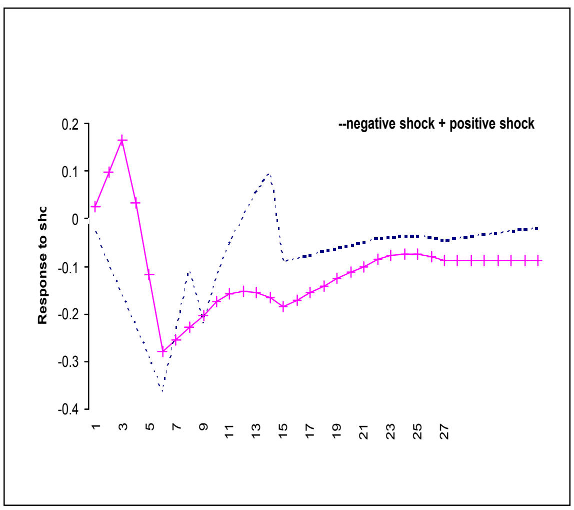

Figure 3c: Response of Na mpula to Ribaue

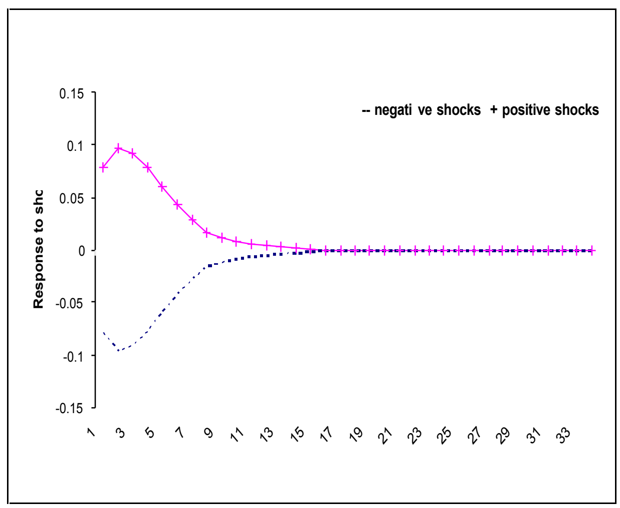

Figure 3d: Response of Nampula to Mocuba

5. Conclusion

In this study, the level of market integration in four major maize market pairs was studied using time series data collected from various maize markets in Mozambique. The following are the major findings of this study:

Threshold values (i.e. the measure of transaction cost in this study) were found to be higher in distant markets and in markets connected by poor roads. Higher threshold values were found for the Mocuba- Nampula, Ribáuè- Nampula, and Chimoio-Maputo market pairs. The first two market pairs are characterised by poor road conditions. However, Maputo-Chimoio market pairs are connected by relatively good roads but close to 1135 kilometres separate them.

The degree of market integration was further investigated by measuring the distribution of deviations from the equilibrium in the three regimes and by the visual inspection of the figures on the degree of persistence of deviations from the equilibrium in the neutral band. According to the results found, the Chimoio-Maputo and Mocuba-Nampula markets are integrated. However, degree of integration was found to be the strongest in the Chimoio-Maputo market pair.

According to the results found from the impulse response functions, one may in general conclude that responses reflect behaviour consistent with the price convergence and long-term market integration. However, we found that it takes relatively shorter periods for shocks introduced in the integrated markets (i.e. Chimoio-Maputo & Mocuba-Nampula) to be eliminated compared with those market combinations which are not integrated (i.e. Chimoio-Beira and Ribáuè -Nampula market linkages).

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