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Spatial Price Transmission And Market Integration Of Timber Products In Selected Markets In Southwest Nigeria

Preisübertragung und Marktintegration von Holzprodukten ausgewählter Märkte im Südwesten von Nigeria

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Schlagwörter: Holzpreise, Märkte, Fehleranalyse, Afirika

Zusammenfassung

Die Studie untersucht lokale Preisgestaltungen und Marktintegrationen von drei ausgewählten Holzmärkten der Regionen Ogun, Ondo, und Oyo für die der Holzarten Iroko, Omo und Mansonia im Südwesten von Nigeria. Als Methoden wurden Co-integrationsmodelle und Fehlerkorrekturmodelle verwendet um die Trends der Holzpreise in der Landeswährung Naira (1 Naira = 0,0045 Euro) zu untersuchen. Die Preise je Kubikmeter schwankten für die Holzarten (i) Omo von ca. 560 Naira bis zu Maximalwerten von 1230-1530 Naira, für (ii) Mansonia von 760 bis 1630 Naira und für (ii) Iroko von 450 bis 930 Naira. Die höheren Preise für Mansonia wurden noch mit anderen Märkten verglichen und sind auf die hohe Qualität, Lebensdauer und Nachfrage zurückzuführen. Die Holzpreise wurden außerdem auf

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ihre Stabilität getestet. Ergebnis der Studie ist, dass Marktverflechtungen bestehen und der Markt für in der Region Ogun als führender unter den untersuchten Märkten anzusehen ist. Die Studie empfiehlt, dass sich die Regierung führende Märkte zum Ziel von geplanten Interventionen oder Marktreformen auswählt, weil damit auf Grund der Marktverflechtungen eine sehr großen Wirkung erzielt wird.

Abstract

Spatial price transmission and market integration study is important in explaining market performance and the degree of integration. This study therefore examined spatial price transmission and market integration in selected timber markets in Southwest of Nigeria for the period between January 2003 and December 2012 using co-integration and error correction modeling approach. Monthly price series (time series) of selected timber species from selected timber markets in three states of Southwest Nigeria were used. The selected timber species were Milicia excelsa (Iroko), Cordia milleni (Omo) and Mansonia altissima (Mansonia) while the selected states were Ogun, Ondo and Oyo States. The study examined the trend in timber prices in Ogun, Ondo and Oyo States. The respective maximum and minimum prices of timber species in each state were found to be N1,530/unit and N760/unit for Cordia milleni; N1,630/unit and N760/unit for Mansonia altissima as well as N930/unit and N450/unit for Milicia excelsa in Ogun State; N1,230/unit and N550/unit for Cordia milleni, N1,630/unit and N740/unit for Mansonia altissima as well as N1,530/unit and N550/unit for Milicia excelsa in Ondo State while in Oyo State, maximum and minimum prices were N1,530/unit and N770/unit for Cordia milleni, N1,530/unit and N950/unit for Mansonia altissima and N1,350/unit and N740/unit for Milicia excelsa in Oyo State. The higher maximum and minimum prices of Mansonia altissima when compared to other selected species across selected states could be attributed to the high quality, durability and demand for Mansonia species. Also timber species prices were subjected to stationarity test and were found to be stationary after first differencing, which implies that timber prices were integrated of order one, I(1). Co-integration analysis showed that timber markets in Ogun and Oyo States were co-integrated as well as timber markets in Ogun and Ondo States. The error correction analysis showed that about 15-35% disequilibrium resulting from the transfer of price shock or price change between co-integrated markets can be corrected within a month. Nine of the market links rejected their respective null hypothesis of no granger causality ($p>0.05$), six of which exhibited bidirectional granger causality or simultaneous feedback relationship while the remaining three market links exhibited unidirectional granger causality at 5% level of significance. Ogun timber market was discovered to be the

leading market among the timber markets in the three states investigated. The study therefore recommends that the leading markets should be the target of the government for any planned intervention or reform.

1. Introduction

In the field of agricultural economics and other related disciplines, price transmission and market integration analysis has received considerable attention in the past 50 years. This is because; price transmission studies have both practical and theoretical usefulness. On the theoretical ground, price transmission plays a key role in neo-classical economics by postulating that prices drive resource allocation and output mix decisions by economic actors (Ghafoor and Aslam,2012; Villafuete,2011), and price transmission integrates markets spatially or vertically. Thus, the absence of price transmission between markets trading with each other may imply gaps in economic theory (Peltzman, 2000 in Meyer and von Cramon-Taubadel, 2004) and may result in less than Pareto efficiency in resource allocation in economic welfare theory.

Price transmission studies are clearly an empirical exercise testing the predictions of economic theory and providing important insights as to how changes in one market are transmitted to another, thus reflecting the extent of market integration, as well as the extent to which markets function efficiently (Dittoh, 1994; Villafuete, 2011). According to Ghafoor and Aslam (2012), price transmission is important because of two major reasons. Firstly, the price transmission conveys unbiased information on prices to agricultural producers; it is a precondition for a good allocation of resources. Secondly, because many policy reforms are implemented via price channel, lack of integration along the marketing chain hinders the reforms from reaching the rest stakeholders of the chain, particularly in agricultural production, while the incomplete price transmission creates biased incentives for producers. This in turn leads to reduced agricultural productivity. A key premise of several arguments in economics is that markets allow for price signals to be transmitted both spatially and vertically (Lohano and Mari, 2006; Choi et al, 2008). An obvious example is the assessment of the relative merits of alternative trade and/or policy environments: potential losses and benefits of a country or a group of economic agents crucially depend, among other things, upon markets receiving price signals, which, in turn, depends upon a number of markets' features, including their very existence (Conforti, 2004; Balcombe and Morrison, 2002). The extent to which a price shock at one point affects a price at another point can broadly indicate whether efficient arbitrage exists in the space that includes the two points. It is also dependent on the magnitude of the price difference between these locations (Goodwin and Piggott 2001; Stephens et al, 2011) At two extremes, one may assume that a full transmission of price shocks can indicate the presence of a frictionless and well functioning market (Mushtaq et al, 2006), while at the other extreme a total absence of transmission may make the very existence of a market questionable.

Therefore, the degree of price transmission can provide at least a broad assessment of the extent to which markets are functioning in a predictable way, and price signals are passing-through consistently between different markets (Mushtaq, 2007; Hussain, 2010). If two spatially separated price series are co-integrated, there is a tendency for them to co-move in the long run according to a linear relationship (Zahid et al, 2007). In the short-run, the prices may drift apart, as shocks in one market may not be instantaneously transmitted to other markets or due to delays in transport. Depending on market characteristics or the distortions to which markets are subjected to, two price series may behave in a plethora of ways, having quite complex relationships with prices adjusting less than completely, or slowly rather than instantaneously and according to various dynamic structures or being related in a non-linear manner.

Given the wide range of ways prices may be related, the concept of price transmission can be thought of as being based on three notions, or components, according to Prakash (1998) and Balcombe and Morisson(2002). These are: co-movement and completeness of adjustment which implies that changes in prices in one market are fully transmitted to the other at all points of time; dynamics and speed of adjustment which implies the process by, and rate at which, changes in prices in one market are filtered to the other market or levels; and, asymmetry of response which implies that upward and downward movements in the price in one market are symmetrically or asymmetrically transmitted to the other. Both the extent of completeness and the speed of the adjustment can be asymmetric.

Within this context, complete price transmission between two spatially separated markets is defined as a situation where changes in one price are completely and instantaneously transmitted to the other price. In this case, spatially separated markets are integrated (Mehmood, 2010). In addition, this definition implies that if price changes are not passed-through instantaneously, but after some time, price transmission is incomplete in the short run, but complete in the long run, as implied by the spatial arbitrage condition (Weber and Lee, 2006). The distinction between short run and long run price transmission is important and the speed by which prices adjust to their long run relationship is essential in understanding the extent to which markets are integrated in the short run (Ghafoor et al, 2009). Changes in the price at one market may need some time to be transmitted to other markets for various reasons, such as policies, the number of stages in marketing and the corresponding contractual arrangements between economic agents, storage and inventory holding, delays caused in transportation or processing, or „price-leveling" practices.

Since prices are the most readily available and often the most reliable information in developing countries' marketing systems, market integration studies have almost exclusively referred to event resulting in price changes. The ability of market system to effectively and efficiently perform its function depends on the ease with which price changes and responses are transmitted spatially and temporally. The transmission of price from a reference market towards the peripheral markets is all faster when the markets are perfectly integrated (Worakos et al, 2008, Dutoit et al, 2009). Hence the synchronous movement over time among prices in different markets becomes an important indicator of market efficiency.

Markets are said to be perfectly spatially integrated if price changes in one market are fully reflected in alternative markets (Goodwin and Schroeder 1991). Prices are the signals that direct and coordinate not only the production and consumption decisions but also the marketing decisions over time, form, and space (Kohls and Uhl 2001). In spatially separated markets, when the price difference between different markets exceeds transportation and transactions costs, the arbitrage activities involve the purchase of commodities from lower-price regional markets and the subsequent resale in higher-price regional markets. Competition among arbitragers will ensure that a unique equilibrium is achieved where local prices in regional markets differ by no more than transportation and transaction costs (Goodwin and Schroeder 1991). Prices in spatially integrated markets are determined simultaneously in various locations, and information of any change in price in one market is transmitted to other markets (Gonzalez-Rivera and Helfand 2001). Moreover, the improved information between regional markets contributes significantly to spatial price convergence, so explicit trade between each pair of markets may not be necessary in order for regional price adjustments to take place (Serra et al. 2006). The analysis of spatial market integration, thus, provides indication of competitiveness, the effectiveness of arbitrage, and the efficiency of pricing (Sexton et al 1991).

Markets that are not integrated may convey inaccurate price signal that may result in distortion in producers' marketing decisions and inefficient product movement (Goodwin and Schroeder 1991), and traders may exploit the market and may benefit at the cost of producers and consumers. In more integrated markets, farmers specialize in production activities in which they are comparatively proficient, consumers pay lower prices for purchased goods, and society is better able to reap increasing returns from technological innovations and economies of scale (Vollrath 2003).

Meanwhile, timber (also known as sawn wood) is a major forest product in Nigeria and it serves as a raw material for wood based industries (Langbour and Gerarrad, 2007). Timber trade in southern Nigeria is highly commercial with over 500 sawmills (Okunomo and Achoja, 2010). Timber marketing like every other marketing enterprise involves the exchange between a buyer and a seller at a given price. The price is such that the seller meets the total cost as well as profit margin (Olukosi and Isitor, 1990). It is therefore, the sum total of all business activities involved in the movement of commodities from point of production until the commodities are received by the ultimate consumer. It denotes all the activities that enable forest goods and services to flow from the producer to the ultimate consumer which shape the management processes because it undoubtedly benefits the stakeholders who depend on forest enterprises for survival. The efficiency of the marketing process as a link between the producer and the consumer is a major determinant of economic incentives of forestry subsector. This invariably, has effects on the consumption pattern of the products which is mostly felt in timber marketing.

In a competitive economy, efficient marketing of timber will not only give sellers higher prices but also give consumers lower ones achieved through bargaining power. Owing to the economic importance of timber marketing as source of income, employment generation as well as foreign exchange earnings to Nigeria, there is the need to examine the functioning and performance of timber markets in the study area. Although several studies have been carried out on price transmission and market integration on various agricultural commodities, little or nothing has been done on price transmission in timber markets especially in Southwest Nigeria. In addition, most of previous studies on price transmission and market integration do not fully capture the use of co-integration test with a description of dynamic features and patterns of causality among price series as well as the Error Correction Mechanism (ECM), which according to Granger Interpretation Theorem, forms the basis of the long term relationship between co-integrated variables. This study therefore attempted to address some of these gaps.

The general objective of the study was therefore to examine the price transmission and market integration of timber products in selected states in the Southwest Nigeria, with specific focus on;

- examining the trend in price movements of selected timber species from 2003 to 2012
- comparing the integration of timber markets in the selected states
- estimating the short term and long term effects of one price series on another and
- identifying the leading markets among the selected states.

2. Review of related literature

There is no gainsaying the fact that researches on market integration and application of the Law of One Price (LOP) have been carried out and documented for a number of commodities and most especially agricultural consumables outside Nigeria. For instance, roundwood market integration between the Nordic countries has been earlier studied by Thorsen et al. (1996) who tested co-integration on roundwood markets between Danish and other Nordic countries, Germany and the U.S.A. Findings from their studies indicated co-integration between Denmark, Norway, Sweden and even the USA on the markets for coniferous logs.

Also, in a number of Scandinavia countries, Toppinen and Toivonen, (1998) Stordal and Nyrud, 2003) investigated the integration of regional timber markets using Johansen's (1996) co-integration approach to examine price relationships in the timber market. Also, Kainulainen and Toppinen (2006) applied the same method to analyse the markets of forest industry products. Johansson and Lofgren (1985) applied an empirical model to the Swedish roundwood market consisting of a competitive sawlog market model and a monopsony market model and in a subsequent study carried out by Brannlund (1988, 1989), an equilibrium model of the sawtimber market was tested against a disequilibrium model. The results of the study showed that under-priced pulpwood affected the relative sizes of pulpwood and sawtimber markets with overall minimal welfare losses to the society.

Meanwhile, Ravallion (1986), Ardeni (1989) and Baffes (1991), examined the LOP for wool, beef, sugar, tea, tin, and zinc and Goodwin et al. (1990b) investigated the LOP for some oilseed products, wheat varieties, corn, and sorghum. In their study, Bellego (1992) and Sanjuan and Gil (1999) examined the LOP in the pork sector and Sanjuan and Gil (2001) looked at the LOP in the European pork and lamb markets. Mutanen (2006) examined import demand and substitution between suppliers in the sawnwood trade to Germany and found that the law of one price does not exist in the market.

However, in their study on demand and supply in both sawlog and pulpwood markets using time series data from 1965-1985 in Finland, Kuuluvainen et al. (1988) found that the short-run own-price elasticity in demand was found to be positive and insignificant, while the long-run effect was unitary and negative, as expected. The implication of this is that in integrated markets, regional prices may fluctuate independently from prices in other locations as long as the price variations are less than the transaction costs between two locations.

Using the approach of Johansen (1988), Ripatti (1996) in his estimation of an error-correction model of the Finnish pulpwood and sawlog markets found in contrast to other studies an exogenously determined pulpwood stumpage price with a supply elasticity of 0.4 and a cross-price elasticity of sawlog price of –1.5.

From the foregoing, it is clear that using the LOP as the basis for testing co-integration have some pitfalls which according to Ardeni (1989), Tailor and Webster (1994) include using retail prices, omitting transportation costs, ignoring time and not using identical products. Thus, the last three of these pitfalls are widely recognised as problems for testing the LOP and these are common occurrences in studies involving use of time series data.

3. Methodology

3.1 Study Area, Data Source and Collection Method

This study was conducted in southwest of Nigeria, which is one of the six geo-political zones in the country. This zone is dominated by the Yoruba-speaking tribe and consists six states, namely Ondo, Ekiti, Osun,Oyo, Ogun and Lagos States. The study therefore covered three (3) of the six (6) states that make up the zone. The selected states are Oyo, Ogun and Ondo States of Nigeria. Oyo State is made up of thirty-three(33) Local Government Areas (LGAs) with Ibadan as its capital, Ogun has 21 LGAs with Abeokuta as its capital, while Ondo State has 18 LGAs with Akure as its capital. The choice of timber and the Southwest for this study was based upon the economic importance of timber and the high level logging (lumbering) and timber marketing in the Southwest Nigeria. The time frame of the study covered 2003 to 2012. Secondary data of retail prices of selected timber species in selected timber markets in the study area were collected from Forestry Research Institute of Nigeria (FRIN), Ibadan, Associations of Timber Marketers from the chosen States and supplemented with comparable information drawn from International Tropical Timber Organization (ITTO) and National Bureau of Statistics (NBS). The data was sourced on monthly basis and covered a period of ten (10) years (2003-2012).

Data on three of the most commonly traded timber species were sourced for this study. The species were Mansonia altissima (Mansonia), Cordia mil-leni (Omo), and Milicia excels (Iroko). For each species, price data on one timber dimension was sourced from each timber market in each of the chosen States. The timber dimension used was 2.5cmx30cmx360cm, popularly called '1x12' (slab) .Three price series were therefore sourced from each state and in all; there were nine (9) price series for the study.

3.2 Analytical Tools and Framework

Traditional time series econometric techniques were based on the assumption of stationarity. However, a recent advancement in time series econometric techniques indicates that the most time series are non-stationary. If the time series is non-stationary, then the application of the usual statistical tools to analyze data is inappropriate. Most economic time series are trended over time and regression among trended series may produce significant results with high R2 but may be meaningless or spurious (Granger and Newbold, 1974). Many economists have ignored the possibility of spurious regression (the analysis of non-stationary time series) and used standard statistical techniques which are developed for stationary processes. The initial solution to analyze the integrated series are derived from the work of Box and Jenkins (1970 and 1976), who formulated the regression in which the variables were expressed in first differences. But the process of differencing results in the loss of valuable long run information among the series. In general, the Box-Jenkins approach assumes that non-stationary data can be continually differenced until stationarity is achieved. Granger and Newbold (1974) recommended that for regression with high R2 and low DW-statistics, regression should be used on the first differences of the variables. To overcome the problem of spurious regression, the concept of co-integration was introduced (Granger, 1988; and Engle and Granger, 1987). Econometric techniques based on co-integration take into account long run information so that results can wander extensively, but when paired with another series or a set of series then the pairs tend to move together over time and the difference between them are constant (i.e. stationary).

Stationarity and non-Stationarity

A series is said to be stationary if its mean and variance remain constant over the time and the value of the covariance between the two time periods depends only on the distance or lag between the two time periods and not the actual time at which the covariance is computed or in other words remain constant over time (Gujarati and Porter 2009). On the other hand a series is said to be non-stationary if it fails to satisfy any part of above definition i.e., its mean, variance or covariance change over time. A stationary series has a tendency continuously to return to its mean value and to fluctuate around it in a more or less constant range, while a non-stationary series has a changing mean at different points in time and its variance varies with the sampling size.

To demonstrate the conditions for stationarity, consider the following first order autoregressive model.

$$X_t = \varphi X_{t-1} + \mu t \quad (1)$$

Where: t =1…... T

Here μt is assumed to be strictly white noise i.e. IID (0, σ2). If $\varphi < 1$, the series X_t is stationary and if $\varphi = 1$, the series is non-stationary and is known as random walk. X_t can be made stationary after differencing once but it is not necessary that it become stationary after first difference. The number of times series needs to be differenced in order to achieve stationarity depends upon the number of unit roots it contains. If a series becomes stationary after differencing 'd' times, then it contains 'd' unit roots and it is said to be integrated of order 'd', denoted by I(d) in (1) where $\varphi = 1$, Xt has a unit root and thus Xt ≈ I(1) .

Testing for Unit root

The first step in dealing with time series data is to test for the presence of a unit root in the individual time series of each model. There are a number of methods to test the unit root hypothesis but the early and pioneering work on testing for a unit root in time series was done by Dickey and Fuller (Dickey and Fuller 1979; Fuller 1976). The number of lags in the Dickey–Fuller (ADF) equation are chosen to ensure that serial correlation is absent, using the Breusch-Godfrey statistics (Greene, 2000). The DF-test requires us to estimate the following by OLS:

$$\Delta X_t = \alpha + \beta_3 t(\Phi_3 - 1)X_{t-1} + \mu_t \quad (2)$$

Equation (2) indicates that the series X_t now has both stochastic and deterministic trends and can be used as a DF-equation for testing the unit root hypothesis i.e., Ho: $(\Phi_3-1) = 0$. The test statistics used to test the unit root hypothesis is the ττ- statistics and the critical values are as follows.

If the absolute calculated ττ-value (t-value of the coefficient Φ_3-1) is greater than the ττ-value, then X_t is stationary.

From equation (2) we can also test the joint hypothesis of unit root and no trend i.e. Ho: $(\Phi_3\text{-}1) = \beta = 0$ against the alternative hypothesis of trend stationary i.e. H1: $(\Phi_3\text{-}1) = \beta \neq 0$ by using the Φ3-statistics with the critical values as in the above table. If the calculated Φ3-Value is less than the critical values, the null hypothesis is accepted and X_t is non-stationery with insignificant trends, conversely, if the null hypothesis is rejected, X_t is stationary with a significant trend and is a trend stationary series.

The DF- statistic is based on the assumption that μt is white-noise, but the error term is not white-noise, there is autocorrelation in the residual of the OLS regression in (2). This will invalidate the use of the DF-statistic for testing for a unit root. Two approaches have been put forward to overcome this problem. First, we can generalize the testing equation of (2) and secondly we can adjust the DF-statistic. It is common to follow the Augmented Dickey-Fuller (ADF) test. So it make μ_t white-noise, lagged value for the dependent variable are include on the right hand side of the DF- equation of (2) which become:

$$\Delta Xt = \alpha 3 + \beta 3t\ (\Phi 3\text{-}1)\ Xt\text{-}1 + \Sigma_{t=1}^{k} \Phi i \Delta Xt{-}i + \mu \qquad (3)$$

We do not know that how many lagged values of the dependent variable to include on the right hand side of the (3). This can be determined by certain information criteria such as Schwartz Information Criterion (SIC) and Akaike Information Criterion (AIC). The ADF-statistic has the same asymptotic distribution as the DF-statistic, so the same critical values can be used as previously (Dickey-Fuller, 1981).

Granger Causality and Error Correction Mechanism

Error Correction Mechanism explains dynamics of short run adjustment towards long run equilibrium. When variables are co-integrated, there is general and systematic tendency for the series to return to their equilibrium value. It means that short run discrepancies may be constantly occurring but cannot grow indefinitely which shows that adjustment dynamics is intrinsically embodied in the co-integration theory. The theorem of Granger representation states that if a set of variables is co-integrated, it implies that residuals of co-integrating regression is of order I(0), thus there exists an ECM describing that relationship. This theorem explains that co-integration and ECM can be used as a unified theoretical and empirical framework analyzing both short run and long run behaviour. The ECM specification is based on idea that adjustments are made to get closer to long run equilibrium relationship. Hence, link between co-integrated series and ECMs is intuitive;

an error correction behaviour induces co-integrated stationary relationship and vice versa (McKay *et al.*, 1998). When two price series are stationary of the same order and co-integrated, causality test can be carried out on the series. This is due to the fact that at least one granger –causal relationship must exist in a group of co-integrated series, according to Chirwa (2000). Let's assume that Pit and Pjt variables are co-integrated, and relationship between these two series can be expressed as ECM.

$$\Delta P_{it} = \beta_o + \beta_1 P_{i(t-i)} + \beta_2 P_{j(t-i)} + \sum \delta_k \Delta P_{i(t-k)} + \sum \alpha_h \Delta P_{j(t-h)} + e_t \quad (4)$$

From equation (4), acceptance of the null (no causality) implies that past values of the series on the right hand side are not adding information on the actual values of the series on the left hand side, in addition to what is provided by its own past values. Rejection of this implies that prices in market i Granger cause those in j. However, if prices in both markets influence each other, then prices are determined by a Simultaneous Feedback mechanism, hence a phenomenon of bi-directional Granger-causality. If the causality runs one way, it is called unidirectional Granger causality and the market which Granger-causes the other is tagged the exogenous market. This test is significant in the sense that it can be used as a confirmation of the test for the long run equilibrium between two price series as well as to understand which of the two prices acts as a source of information for the other. In addition, it enables us gain qualitative elements to understand the results, in terms of the causality direction.

Definition of Variables

- OGMAN (1x12) = Ogun State market price for *Mansonia altissima* (Mansonia) 1x 12 dimension
- OGCOR (1x12) = Ogun State market price for *Cordia milleni* (Omo) 1x12 dimension
- OGMIL (1x12) = Ogun State market price for *Milicia excelsa* (Iroko) 1x12 dimension
- ONMAN (1x12) = Ondo State market price for *Mansonia altissima* (Mansonia) 1x12 dimension
- ONCOR (1x12) = Ondo State market price for *Cordia milleni* (Omo) 1x12 dimension
- ONMIL (1x12) = Ondo State market price for *Milicia excelsa* (Iroko) 1x12 dimension
- OYMAN (1x12) = Oyo State market price for *Mansonia altissima* (Mansonia) 1x12 dimension
- OYCOR (1x12) = Oyo State market price for *Cordia milleni* (Omo) 1x12 dimension

- OYMIL (1x12) = Oyo State market price for *Milicia excelsa* (Iroko) 1x12 dimension

4. Results and Discussion

4.1 Price Trend Analysis

Figure 1 shows the trend in prices of selected timber species (*Cordia milleni*) often known as Omo, *Mansonia altissima* commonly called Mansonia and *Milicia excelsa* known as Iroko) in Ogun State, Southwest Nigeria. The maximum price for *Cordia milleni* was found to be ₦1, 530/unit which was obtained in August and September 2012, while the minimum price was obtained in January and February 2003 at ₦760/unit. For *Mansonia altissima*, maximum price was ₦1, 630/unit and was obtained from June to September, 2012 while the minimum was ₦760/unit which was obtained in January and February 2003. The maximum price for *Milicia excelsa* (Iroko) was ₦930/unit in September 2012 and the minimum was ₦450/unit in January and February 2003. The observed differences in prices of timber species could be due to variation in quality, durability and demand.

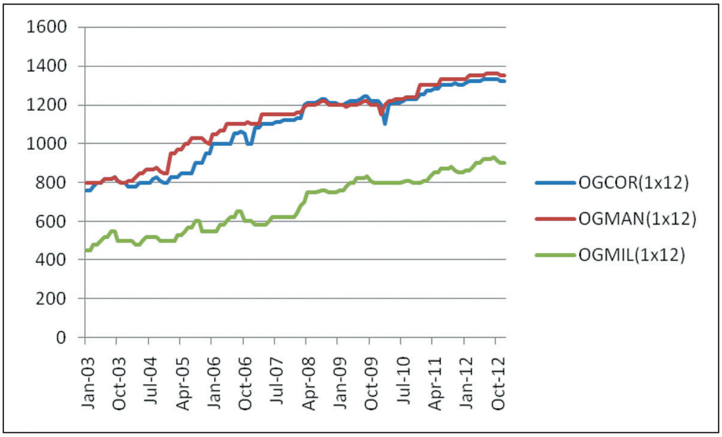

Figure 1: Average monthly price of timber in Ogun State

Similarly in Figure2, the maximum price of *Cordia Milleni* in Oyo State was found to be ₦1, 530/unit obtained from June to September 2012 while the minimum of ₦770/unit was obtained from January to March 2003. Mansonia maximum price was obtained from June to September 2012 while the minimum price was obtained in January and February 2003 and these were ₦1, 530/unit and ₦950/unit respectively. One thousand three hundred and fifty naira (N1, 350) was the maximum price per unit of *Milicia excelsa* from July to November 2012, with the minimum price obtained at ₦740/unit in January and February 2003. Likewise, the observed differences in prices of timber species could be due to variation in quality, durability and demand.

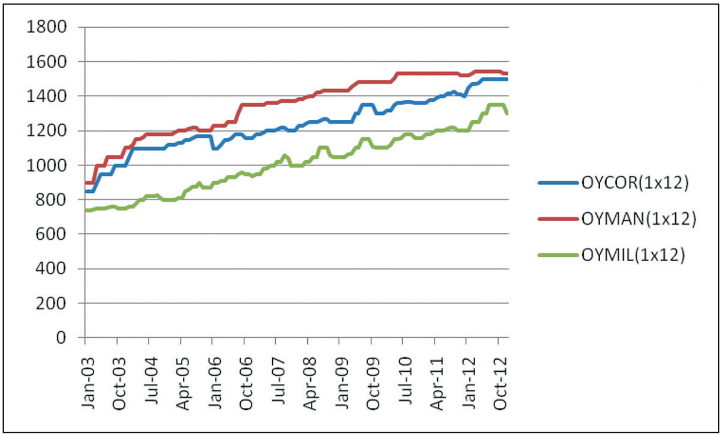

Figure 2: Average monthly price of timber in Oyo State

Likewise, Figure 3 shows the price trend of selected timber species in Ondo State. The highest price for which *Cordia milleni* (1x12 dimension) was sold within the period of study (2003-2012) was ₦1, 230/unit and this was obtained in October 2012 while N550 was the lowest price a unit of the species was sold and this was obtained in January and February 2003. For Mansonia, the maximum price was ₦1, 630/unit in September 2012 and the minimum was ₦740/unit in January 2003; while *Milicia excelsa* sold at ₦1, 530/unit as the highest price from July to September 2012 and ₦550/unit in January 2003 as the least price. The observed trend here could also be adduced to variation in quality, durability and demand.

It was observed from the study that prices of timber species were relatively stable from January through March and at times April. But they began to rise from May and were at their peak around September before they began to decline around October. This could be attributed to the fact that the periods within which prices began to rise and reached their highest points fall within the raining season when logging activities become more tedious and difficult to accomplish. This is because bushes are overgrown during this period, making the accessibility of the forests more difficult for the lumbers or loggers, thereby attracting additional cost to employ labour to clear the bushes for easy access to the forests. In addition, the forests are waterlogged during this period, making it an onerous task for loggers to convey logs of wood from the forest to sawmill where they are processed into marketable timber or planks. All these contribute to the relatively higher prices of timber species being noticed during this period.

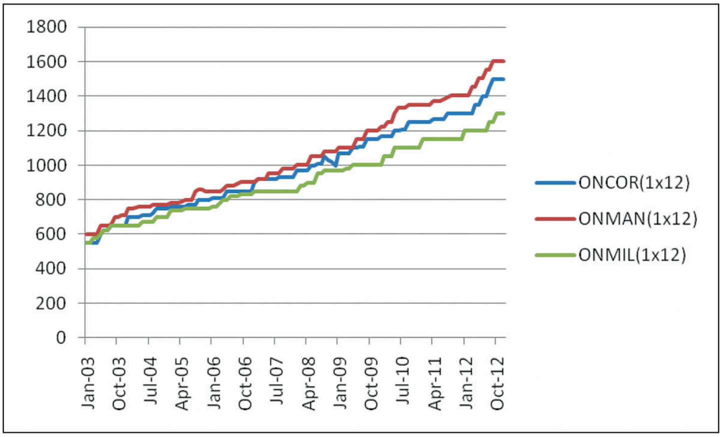

Figure 3: Average monthly price of timber in Ondo State

Stationarity test of timber price series

Augmented Dickey Fuller (ADF) unit root test was used to determine whether each time series is stationary or not. The null hypothesis is that the variable observed has a unit root, against the alternative that it does not. Table 1 depicts the results of test of the series (in logarithms) for unit roots using ADF Test (Dickey and Fuller 1979, Fuller 1976).The results of all the tests, except that of *Cordia milleni* (Omo) in Ondo State, indicate that all price series are non-stationary at their level form but stationary at their first difference. Here, the order of integration is one and the variables are said to be integrated of the first order. That is I (1). This therefore corroborates earlier studies by Okoh (1999), Mafimisebi (2002), Adeoti and Owoyemi (2006) and Ghafoor et al (2009) that commodity prices are integrated of order one and are usually stationary after first differencin (Hussain,2010;

Mehmood, 2010).The results therefore allow to proceed for co-integration tests for examining long-run equilibrium relationship.

Table1: Stationarity test of timber price series.

Price Series	Augmented Dickey-Fuller Test (Level Form)	Remark (Level Form)	Augmented Dickey-Fuller Statistics (At First Difference)	Remark At First Difference
OGCOR	-0.713354	Non Stationary	-11.10951	Stationary
OGMAN	-0.481162	Non stationary	-10.34174	Stationary
OGMIL	-0.863280	Non Stationary	-10.37691	Stationary
OYCOR	-1.153025	Non Stationary	-11.47682	Stationary
OYMAN	-2.278160	Non Stationary	-12.33797	Stationary
OYMIL	-0.413309	Non Stationary	-7.210039	Stationary
ONCOR	-2.776242	Non Stationary	-10.55095	Stationary
ONMAN	0.025577	Non Stationary	-10.48425	Stationary
ONMIL	0.43778	Non Stationary	-11.27838	Stationary
Critical values are -3.486064 and -3.486551 at 1% level of significance for price at their level and first difference series respectively				

Co-integration Analysis

Co-integration analysis is concerned with the existence of a stable relation among prices in different localities. It refers to co-movements of prices, and, more generally, to the smooth transmission of price signals and information across spatially separated markets. Prices move from time to time, and their margins are subject to various shocks. When a long-run linear relation exists among different series, these series are said to be co-integrated (Engle and Granger (1987). Hence, the Engle and Granger test of co-integration was applied to analyze long-run market integration among timber markets in the Southwest Nigeria. The test result is presented in Table 2. The result indicates that only six (6) of the nine (9) market pairs considered were found to be co-integrated. The co-integrated market pairs were OGCOR-ONCOR, OGCOR-OYCOR, OGMAN-ONMAN, OGMAN-OYMAN, OGMIL-ONMIL and OGMIL-OYMIL. This shows that Ogun and Oyo timber markets are co-integrated as well as Ogun and Ondo timber markets. This implies that the number of co-integrated variables gives the number of stationary linear combinations of the price series. It is therefore consistent with Jezghani et al (2013) identification of one linear combination of prices (as it is a bivariate case) that exhibits stability over the time. The market pairs that do not have long term equilibrium relationship between them are ONCOR-OYCOR, ONMAN-OYMAN and ONMIL-OYMIL, which imply that there is no co-integration and price transmission between Ondo and Oyo timber markets. This could be described as a case of market segmentation and could possibly be due to high transportation cost involved in conveying timber species from Ondo State (which seems more of a producing State) to Oyo State. This corroborates the study by Goletti et al (1995) where they stated that when markets are very far away from each other, the lack of co-integration between them may be due to transportation costs. It could also possibly be due to the fact that Oyo and Ondo States are not regular trading partners in terms of timber marketing, as Oyo State buys timber from Ondo State mainly when there is insufficient supply from its main and regular trading partner, Ogun State. This therefore explains the absence of long-term equilibrium relationship and consequently, price transmission between them. This however has important implications for economic welfare because according to Meyer and von Cramon-Taubadel (2004), the absence of price transmission between markets trading with each other could imply gaps in economic theory and result in less than Pareto efficiency in resource allocation in economic welfare theory.

Table 2: Engle-Granger Co-integration Test Result.

Market Pair	Augmented Dickey-Fuller Coefficient of regression residual	t-value
ONCOR-OGCOR	-0.1569	-3.1540*
OYCOR-OGCOR	-0.5465	-5.811*
ONMAN-OGMAN	-0.3940	-3.0905*
OYMAN-OGMAN	-0.4612	-3.5601*
ONMIL-OGMIL	-0.1969	-3.2540*
OYMIL-OGMIL	-0.5786	-3.8088*
OYCOR-ONCOR	-0.0461	-1.5601
OYMAN-ONMAN	-0.0160	-1.8371
OYMIL-ONMIL	-0.0726	-1.834

*Indicates that the coefficients are significant at 5% level of significance. The critical value at 5% is -2.8863. Therefore the null hypothesis of no co-integration is rejected.

Long run Equilibrium Relationship

The estimated long-run equilibrium relationships between co-integrated variables are as given in equations 5 to 10 below. The figures in parentheses are t-values. It can be observed from the equations that the long-run equilibrium relationship between Ogun State and Oyo State timber markets is about perfect. This is evident from equations 6, 8 and 10 where the coefficients of the co-integrating equations range from about 0.81 to 1.1. This implies that about 83% of the price change in Ogun timber market for *Milicia excelsa* (Iroko) is transmitted to Oyo timber market for Iroko in the long-run. However, an approximately equivalent of the price changes in Ogun timber markets for *Cordia milleni* (Omo) and *Mansonia altissima* (Mansonia) are transmitted to Oyo timber markets for these timber species. This is an indication that Ogun and Oyo timber markets are strongly co-integrated and could be described as a case of complete price transmission.

On the other hand, timber markets in Ogun and Ondo States are weakly co-integrated as the coefficients of the co-integrating equations of the selected timber species markets range from about 0.26 to 0.47 as seen from equations 5, 7 and 9. This shows that about 26% of price change in Ogun market for mansonia is transmitted to Ondo market for mansonia in the long-run while about 47% of the change in price in Ogun market for *Milicia excelsa* (Iroko) is passed to Ondo market for Iroko in the long run. This is a situation of incomplete or imperfect price transmission. Several factors, according to Gharfoor and Aslam (2012), could be responsible for this incomplete transmission some of which are trade and other policies, transaction costs such as poor transport and communication infrastructure which results in a reduction in the price information available to economic agents and consequently may lead to decisions that contribute to inefficient outcomes (Conforti,2004).

$$ONCOR = 1.2954 + 0.3633OGCOR \quad (5)$$

(3.443)

$$OYCOR = 3.3241 + 1.0434OGCOR \quad (6)$$

(4.731)

$$ONMAN = 2.5114 + 0.2635OGMAN \quad (7)$$

(3.534)

OYMAN = 3.6453 + 1.015OGMAN 8

(5.813)

ONMIL = 1.3605 + 0.4744OGMIL 9

(3.557)

OYMIL = 1.5414 + 0.8331OGMIL 10

(3.954)

Error Correction Model

Since co-integration only considers the long-run property of a model and does not deal with the short-run dynamics explicitly, a Vector Error Correction Model (ECM) was specified for this purpose. This ECM is perhaps the most useful tool as it provides a stylized picture of the relationship between two prices. The closeness of the error correction coefficient to -1 can be used to assess the extent to which policies, transaction costs, delay in transportation and other distortions delay full adjustment to the long run equilibrium.

When we therefore express market integration through co-integration there could be disequilibrium in the short-run. That is price adjustment across markets may not happen instantaneously. This is because it often takes traders to notice the change and respond to it. Therefore it may take some time for spatial price adjustments to happen. The error correction model takes into account the adjustment of short-run and long-run disequilibrium in markets and time to remove disequilibrium in each period. Table 3 shows that about15-35 % disequilibrium resulting from the transfer of price shock or price change between co-integrated markets in the study can be corrected within a month period. This implies that about 15 percent disequilibrium arising from the transfer of price shock between Ondo and Ogun States markets for Cordial milleni (Omo) timber species can be corrected within a month period, while 31 percent disequilibrium arising from transfer of price shock between Oyo and Ogun States markets for this same timber species can be corrected after one month. Twenty eight (28) percent disequilibrium resulting from transmission of price change between Ondo and Ogun States markets for Mansonia altissima (Mansonia) species can also be corrected after a period of one month. Between Oyo and Ogun

States markets for Mansonia, 35 percent disequilibrium is corrected after one month. In Ondo and Ogun markets for Milicia excelsa (Iroko) timber species 19 percent disequilibrium is corrected after one month period; while in Oyo and Ogun markets for Iroko, 21 percent disequilibrium is corrected after a period of one month. This therefore implies that disequilibrium arising from the transfer of price shocks between co-integrated timber markets in the selected states

Table 3: Result for Error Correction Models (ECMs) and Price Transmission for Selected Timber Markets.

D(ON-COR)	Coef-ficient	D(OY-COR)	Coef-ficient	D(ON-MAN)	Coef-ficient	D(OY-MAN)	Coef-ficient	D(ON-MIL)	Coef-ficient	D(OY-MIL)	Coef-ficient
ECM	-0.15*	ECM	-0.31*	ECM	-0.28*	ECM	-0.35*	ECM	-0.19*	ECM	-0.21*
	(-3.45)		(-4.12)		(-3.61)		(-3.23)		(-2.98)		(-3.11)
C	1.27	C	0.07	C	1.10	C	0.27	C	1.02	C	2.12
	(0.21)		(0.11)		(0.70)		(0.31)		(0.02)		(0.01)
D(ON-COR(-1)	0.19*	D(OY-COR(-1)	0.25*	D(ON-MAN(-1)	0.09	D(OY-MAN(-1)	-0.12*	D(ON-MIL(-1)	0.08	D(OY-MIL(-1)	-0.47*
	(2.71)		(3.35)		(1.34)		(-3.27)		(0.43)		(-3.01)
D(ON-COR(-2)	0.14	D(OY-COR(-2)	0.20*	D(ON-MAN(-2)	-0.17*	D(OY-MAN(-2)	-0.10	D(ON-MIL(-2)	0.16	D(OY-MIL(-2)	-0.34*
	(1.71)		(2.63)		(-2.37)		(-0.93)		(0.87)		(-2.97)
D(OG-COR(-1)	-0.07	D(OG-COR(-1)	-0.18*	D(OG-MAN(-1)	-0.10*	D(OG-MAN(-1)	-0.18*	D(OG-MIL(-1)	-0.46*	D(OG-MIL(-1)	0.19*
	(-0.82)		(-2.73)		(-2.44)		(-3.14)		(-2.43)		(3.22)
D(OG-COR(-2)	-0.10*	D(OG-COR(-2)	-0.06	D(OG-MAN(-2)	-0.02	D(OG-MAN(-2)	-0.12*	D(OG-MIL(-2)	-0.36*	D(OG-MIL(-2)	-0.03
	(-2.56)		(-0.69)		(-0.36)		(-2.97)		(-2.43)		(-0.50)
Goodness of fit of model											
Adj. R2	0.28		0.16		0.08		0.32		0.18		0.27
F-Stat.	4.43		5.41		4.27		4.60		1.90		0.19
AIC	1.78		2.92		3.38		2.42		2.82		3.21
SIC	1.79		2.83		3.28		2.31		2.70		3.10

Note: 'D' denotes first difference, 'C' denotes intercept, (-1) is the first order lag and numbers in parentheses are t-values. Variables are in log level.

Granger-Causality Test

From Table 4, six market links showed bi-directional Granger-causality or simultaneous feed-back relationship while the remaining six market links showed unidirectional Granger-causality. Oyo and Ogun market prices for Cordia milleni(Omo), Ondo and Ogun market prices for Mansonia altissima(Mansonia), Oyo and Ogun market prices for Mansonia exhibit bi-directional Granger-causality. This implies that they demonstrate equal strength since they Granger-caused each other at 5% level of significance.

Six of the market prices exhibit unidirectional Granger-causality at 5% level of significance. Among these markets, Ogun State market for Mansonia Granger-caused Ogun State market for Cordia milleni. This implies that when there is an increase in the price of Mansonia in the State, this will also cause the price of Cordia milleni(Omo) in the State. Similarly, Ogun State market price for Cordia milleni Granger-caused Ondo state market price for Cordia(Omo), Ogun market price for Milicia excelsa(Iroko) Granger-caused Oyo State market price for Milicia(Iroko). Likewise, Oyo State market price for Mansonia altissima(Mansonia) Granger-caused the market price for Oyo Cordia milleni(Omo). This indicates that changes in market price of Oyo mansonia determines the price change in Oyo Cordia milleni(Omo). It was also observed that market prices of Ogun State timber species are completely exogenous to the system.

Table 4: Granger Causality Test.

Hypothesis(H0): No causality	F-Statistics	Probability
OYCOR OGCOR	3.5029	0.0164*
OGCOR OYCOR	0.0070	0.0280*
ONMAN OGMAN	3.7527	0.0069*
OGMAN ONMAN	3.5047	0.0152*
OYMAN OGMAN	4.1474	0.0211*
OGMAN OYMAN	3.8269	0.0400*
OGMAN OGCOR	3.5439	0.0331*
OGCOR ONCOR	4.4725	0.0135*
OGMIL ONMIL	3.4929	0.0121*
OGMIL OYMIL	2.0999	0.0400*
OYMAN OYCOR	4.4499	0.0138*
OYCOR OYMIL	4.2572	0.0165*
Note: Variables are in log level. The Granger causality is tested using up to second lag.*significant at 5% level		

5. Conclusion and Recommendations

The study concludes that there is low price transmission and by extension market integration between Ondo and Ogun States timber markets resulting in an inefficient market. However, timber markets in Oyo and Ogun States are more integrated and efficient than those between Ondo and Ogun States. It has also been found that there is no market integration between Oyo and Ondo States timber markets, implying a situation of market segmentation. It was found that delay in price transmission could be attributed to high transaction costs, policy, the number of stages involved in marketing the commodity and the corresponding contractual arrangement between economic agents, storage and inventory holding as well as delay caused by transportation or processing. These together reduce both spatial market efficiency and integration. More so, it was discovered that the transmission of price from one market (reference market) to another market (peripheral market) is faster when the markets are perfectly integrated and slower in weakly integrated markets. Therefore the contemporaneous movement over time of prices in different markets becomes an important indicator of market efficiency or market performance. The study therefore concludes that market price linkages and the interrelationship among spatial markets are important in economic analysis. The study therefore recommends that the leading markets should be the target of the government for any planned intervention or reform.

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