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Review of Literature on Studies of Market Integration

Dimitrios Andrikopoulos[a], Chrysostomos Stoforos[b]

[a]PHD Candidate, Department of Economic and Regional Development,
Panteion University of Social and Political Sciences, Greece.
Email: andrikopoulosdimitris0@gmail.com
[b]Associate Professor, Department of Economic and Regional Development,
Panteion University of Social and Political Sciences, Greece.
Email: stoforos@panteion.gr

Abstract

The objective of this paper is to provide extensive literature on market integration that may be useful for academicians, practitioners, and future researchers when studying the current research work. This paper includes studies that have been carried out from 1986 to 2021 and in this period market integration has been studied through various econometric methods. The results of these studies show that the majority of research has focused more on whether markets are integrated and their degree of integration.

JEL Classification: C32, D40, Q11
Keywords: market integration, price transmission, law of one price, Johansen cointegration test, error correction model, nonlinear autoregressive distributed lag model (NARDL), GARCH, Momentum threshold autoregressive model (M-TAR), wavelet analysis.

1. Introduction

Market integration has been studied for several years by researchers. Numerous studies on market integration and price transmission have used different econometric techniques. Most of the studies employ time series econometric analysis techniques, which test for the co-movement of prices. These techniques, such as cointegration and error correction models, have become the standard tools for analyzing spatial market relationships, replacing earlier empirical tools, such as the bivariate correlation coefficient and regressions. The problem identified in the subject of market integration is related to the application of the appropriate methodology for testing market integration and price transmission. The time series analysis has been criticized as unreliable (Blauch, 1997; Barrett and Li, 2002), with recent research focusing on switching regime models that incorporate data on prices, volumes traded, and transactions costs. The discussion on the application methodology for testing for market integration and price transmission has a relatively long history starting with Harriss (1979). Blauch (1997) provides a review of the discussion and investigates the statistical performance of econometric tests for market integration. In essence, linear tests for market integration and

price transmission are considered crude and inappropriate (Blauch, 1997; Fackler and Goodwin, 2002 and Barrett and Li, 2002). Nonlinearities in market relationships that derive from arbitrage conditions, unsynchronized price cycles, discontinuous trade, and non-stationary transfer costs are considered rendering linear representations and models not useful and not accurate. To fill this gap, this paper presents studies that use new methods that address these problems in the subject of market integration.

Another problem on this subject revolves around the concept of market integration. In two areas of economics (international economics and macroeconomics), a common conception of market integration pays attention to tradability, the idea that good is traded between two economies or those market intermediaries are indifferent between exporting from one nation to another and not doing so. Tradability indicates the transfer of excess demand from one market to another, as captured in potential or actual physical flows. Positive trade flows are enough to show spatial market integration under the tradability standard. But prices are not necessary to be equilibrated beyond markets. Spatial market integration conceptualized as tradability is therefore compatible with Pareto inefficient distributions. Thus, the main approach one finds in the spatial market integration literature concentrates instead on the notion of competitive equilibrium and Pareto efficiency manifest in zero marginal profits to arbitrage. At the center of most analyses of market integration lies the Enke-Samuelson-Takayama-Judge (ESTJ) spatial equilibrium model (Enke, 1951; Samuelson, 1952; Takayama and Judge, 1971), in which the dispersion of prices in two locations for an otherwise homogenous good is bounded from above by the cost of arbitrage between the markets when trade volumes are unrestricted and bounded from below when trade volumes reach some ceiling value. Fackler and Goodwin (2001) also give a definition of market integration. They define market integration as the degree to which supply and demand crises arising at one market location are transmitted to another market. Thus, price transmission is at the center of the integration analysis (Goodwin and Schroeder, 1991; Goletti et al., 1995; Kabbiri et al., 2016). Hence, the two terms are used correspondingly. Price transmission appears when a change in the price of a good in one market causes a change in the price of a similar good in another market.

This paper contributes to the subject of market integration by providing extensive literature on this subject that may be useful for academicians, practitioners, and future researchers when studying the current research work.

The rest of the paper is structured as follows: Section 2 analyzes the literature review and methods used for market integration, such as Augmented Dickey-Fuller (ADF) test, Johansen cointegration test, vector error correction model, Markov-Switching error correction model, threshold error correction models, nonlinear autoregressive distributed lag model (NARDL), GARCH, Momentum threshold autoregressive model (M-TAR), and wavelet analysis. Section 3 presents the critical evaluation of the literature that dealt with the subject of market integration and Section 4 concludes the study.

2. Literature Review

2.1 Introduction to market integration

There are numerous studies in the literature that have dealt with the topic of market integration. There are three types of market integration identified in the literature: spatial, cross-commodity, and vertical. Spatial market integration is concerned with the integration of geographically separated markets trading in an identical commodity. Cross commodity integration relates to integration between two commodities. Vertical integration is concerned

with the pass-through of a commodity price across stages of its marketing chain (producer-wholesale-retail-consumer) or product form. The following table presents the studies concerning market integration. The countries examined, the time periods studied, the data used, the indicators used, the estimation techniques employed, and the brief findings from each study are included in the table 1 of appendix.

2.2 Econometric methods

Many studies on market integration have used various econometric techniques. Most of these studies use commodity prices data. These studies apply these econometric techniques to find whether there are long-run and short-run price relationships. The differences that exist in the results of each study are due to the application of different econometric techniques. These econometric techniques, which are used to test market integration, are based on different assumptions.

2.2.1 Ravallion's approach

A significant study on this subject is that of Ravallion (1986). Ravallion (1986) develops a model of spatial price differentials. The differentiation between long-run market integration, short-run market integration, and market segmentation is allowed by this method. This method has been applied to monthly rice price data for Bangladesh. The results indicate that the application of this approach suggests some quite significant departures from the conditions for both short-and long-run market integration. Palaskas and Harriss-White (1993) use weekly spot prices data, cointegration analysis, and error correction models to examine the dynamic relationship of market commodity prices in three locations in West Bengal. They attempt to provide a new method using recent developments in the theory of time series and co-integration to test the hypothesis of market integration because Ravallion's approach has problems in terms of modeling and results in inefficient estimators which are used to perform and test the alternative hypotheses of market integration and segmentation. The empirical results of the study prove the integration of the markets. However, they find a low level of integration between paddy and rice. In addition, the results provide evidence that the hypothesis of market integration at full level was not accepted.

2.2.2 Cointegration methods

Furthermore, there are studies that have used the cointegration approach to test market integration. On the one hand, there are studies that have used the bivariate two-step cointegration testing techniques developed by Engle and Granger (Ardeni, 1989; Rufino, 2011; Hatzenbuehler et al., 2017). The study of Ardeni (1989) uses the Dickey and Fuller test for the examination of nonstationarity and the Engle and Granger test for the examination of the cointegration between the variables. A group of commodities such as wheat, wool, beef, sugar, tea, tin, and zinc is used to conduct the empirical part of this study. The countries that are included in this study are Australia, the UK, the USA, and Canada. The results show the failure of the Law of One Price as a long-run relationship after testing for the nonstationarity and cointegration of a group of these commodities. Rufino and Cesar (2011) analyze whether there is spatial market integration in the prices of rice in the regions of the Philippines. They employ the Engle-Granger and Johansen cointegration test in their study. They find that there are long-run relationships between the prices of the regional markets. The main result is the existence of spatial market integration in the regional market of rice in the Philippines. Hatzenbuehler et al. (2017) examine the price transmission in Nigerian Food Security Crop Markets. They use data for prices of maize, millet, sorghum, rice, cassava, yams, and cowpeas. This study has three main results. Firstly, tradability matters for price transmission, but tradability varies across crops and regions. The strongest international linkages are with

neighboring countries. Rice price transmission is high across all markets, while coarse grain price correspondence is low with world prices but high with neighboring country market prices. Secondly, their results suggest that local conditions are important for price transmission, and are relatively more significant than trade for some crops, such as yams, cassava, than others (imported rice, maize). Thirdly, larger than expected long-run price transmission parameters in world and neighboring countries for rice and coarse grains suggest that, in these select markets, there are either large transaction costs or quality premiums that vary systematically with border prices and/or mark-ups captured by traders with market power.

On the other hand, there are studies that have used multivariate cointegration tests, which are developed by Johansen (1989), and Johansen and Joselius (1990). Goodwin (1992) investigates whether the Law of one price holds for five international wheat markets. The findings of the study indicate that the Law of One Price as a long-run equilibrium holds if the transportation costs are taken into consideration in the analysis. Also, if the prices of wheat are adjusted for freight rates, the Law of One price will hold in this study. Asche et al. (1999) investigate the extent to which the salmon markets are integrated. It is proved that the Law of One Price holds for an international market with five salmon species. Sanjual and Gil (1999) investigate the integration of the European pork markets. They use pig carcasses prices data for the period 1973-1993. The results provide evidence about a high degree of integration between these selected markets. However, the detection of only one cointegrating vector does not provide enough evidence about a unique pork market in Europe. Asche et al. (2001) investigate the degree of market integration in French gas imports. In addition, they analyze the extent of integration between French, German, and Belgian markets and the time series of Russia, Dutch, and Norwegian export prices, which cover the period from 1990 to 1997. The results reveal that the different border prices for gas to France from Russia, Norway, and the Netherlands move proportionally over time so that the law of one price holds. The results also indicate the presence of a close relationship between French, German, and Belgian markets. Makama and Amruthat (2016) use a cointegration approach to investigate the spatial market integration for rice between Nigeria and India. The results show the existence of a relationship between export and domestic prices of rice in the long run, and the domestic price of rice in Nigeria affects the export price of Indian rice in the long run. Moreover, the amount of the coefficient of the speed of adjustment between India and Nigeria, which is -0.903, indicates that the adjustment process is fast, with around 90 percent of divergence from the long-run equilibrium being corrected in each one to six months. Also, the findings provide evidence about the non-existence of short-run causality running from Nigeria rice market to that of India, and the result of the Granger causality test shows that Nigeria market Granger cause India, and India market Granger cause Nigeria. This causation is bidirectional. Furthermore, the estimated period of outgoing price transmission is about five months. The bad road conditions are also an impediment to more complete market integration. In twelve of the seventeen long-run, related market pairs, positive and negative price changes are transmitted symmetrically. The existence of asymmetry in five market pairs is maybe a result of localized market power. Generally, integration responds negatively to spatial separation and quality of communication and positively to improved roads, and with the improvement of transportation and market infrastructure, markets may be better integrated. Moreover, Lanfranco et al. (2019) use a fractional cointegration approach to examine the integration of Mercosur region beef cattle markets with the international market for six spatially distinct cattle markets. The results prove the acceptance of the null hypothesis of segregated markets. Argentina and Uruguay are segregated markets, as well as Brazil and Paraguay. Furthermore, their reactions to particular price shocks were not the same, and the adjustment of the prices to equilibrium was always slow.

2.2.3 Vector Error Correction Models (VECM)

Market integration has also been studied by many studies that have applied the Vector error correction model (Fousekis and Klonaris, 2002; Ikudayisi et al., 2014; Zakari et al., 2014; Hassanzoy et al., 2015; Adekunle and Momoh, 2016; Jena, 2016; Kumar et al., 2016; Arnade et al., 2017; Baiyegunhi et al., 2018; Larre, 2019; Sabhaya et al., 2021). These studies employ the Vector error correction model in addition to cointegration tests to find short-run price relationships. The results show the presence of short-run price relationships. This model is based on the assumption that price adjustment is symmetric. Fousekis and Klonaris (2002) investigate whether there are long-run and short-run relationships between the prices of the Mediterranean olive oil market. They find long-run relationships between the prices of Spain, Italy, and Greece according to the cointegration analysis. They also find that Spain is the price leader and Italy and Greece are the followers. Ikudayisi et al. (2014) examine the existence of spatial market integration among geographically segregated markets of maize in Nigeria using monthly retail price data of maize grain. According to cointegration analysis, the states are cointegrated. Moreover, the rate at which VECM repaired deviation from equilibrium is medium. The study indicates that spatial price linkages exist within the maize market as products moved efficiently across the market, which is associated with the efficiency of price information flow. The study recommends that farmers should be given more price information in order to benefit from spatial price differences. The study of Zakari et al. (2014) investigates price transmission from internal and regional markets to Niger's domestic grain markets using monthly wholesale prices. The results show that grain markets in Niger responded to negative and positive shocks in regional and internal markets differently. Maize and rice markets had a high speed of adjustment to world prices compared to millet and sorghum markets. Hassanzoy et al. (2015) analyze cointegration and the difference in the extent of price transmission, and speed of adjustment between domestic and global prices of high and low-quality rice. The empirical results reveal that the dynamics of price transmission may not be the same for high and low-quality rice markets. Specifically, the extent of price transmission appears to be larger for the global prices of low-quality rice. Moreover, the speed of adjustment to the long-run equilibrium may be faster for domestic prices of high-quality rice. Furthermore, a shock in the global prices of low-quality rice may have a long-lasting effect on domestic prices of low-quality rice as compared to their high-quality counterparts affecting domestic prices of high-quality rice. Adekunle and Momoh (2016) study the analysis of cointegration of spatial price formation of cowpea markets in Southwestern Nigeria. They employ data for retail rural and urban market prices of cowpea. The Augmented Dickey-Fuller test indicates that the price series are stationary at first difference. Moreover, Johansen's co-integration results show that even though there is one co-integrating equation between linear combinations of cowpea price series, there are some stable long-run equilibrium relationships among the price series, which could be given some error correction representations. Results based on pairwise granger causality show that Rural Price of Maize in Oyo State has strong exogeneity over other rural and urban markets. In comparison to a perfect adjustment of 100% threshold, the speed of adjustment of 51%, 87%, and 60% from the short-run to the long-run equilibrium is relatively high. This proves that there is a strong integration among the cowpea markets in Southwest Nigeria. Jena (2016) studies market integration and price transmission in India. The results reveal that there is a short-run and long-run relationship between the indexes of prices between domestic and international commodities, respectively. The results also show that the index of international commodity prices affects the index of domestic commodity prices. Kumar and Mishra (2016) examine the spatial integration of potato markets in Uttarakhand using monthly wholesale prices for ten years. The findings of the study indicate that five potato markets reacted on the long-run cointegrating equations, while the speed of price adjustment in the short-run was

almost absent. Additionally, it is found that there is an inverse relationship between the distance from one market to another and the integration. The efficiency of potato markets in Uttarakhand depends on how the market information system works. Arnade et al. (2017) examine the transmission of the international prices of agricultural commodities to the domestic Chinese market using an error correction model. The results indicate important differences in transmission beyond commodities, with Chinese soybeans and soymeal and chicken price being the most integrated with world prices and rice being the least integrated. They also find that long-run price transmissions are higher than short-run price transmissions, suggesting that stabilization policies may slow down the transmission of price shocks for many commodities. Baiyegunhi et al. (2018) examine the market price integration of tomatoes in Durban and Johannesburg in South Africa using monthly price data for the period 2008–2012. The results indicate the integration of these markets. The results also disclose that one month is a necessary time for the economic agents to adjust back to equilibrium when a shock to the markets appears and causes deviations from the equilibrium. In the Johannesburg market, the reaction to the shock is slower than in the Durban market. The South African fresh produce market is competitive thanks to the high level of degree of market integration and provides little justification for government intervention designed to enhance the level of competitiveness or to improve the efficiency of the market. Larre (2019) tests the market integration in the world market of soybeans between General modified soybeans and non- General modified soybeans using the Johansen cointegration test, vector error correction model, and Granger causality test. The results show the existence of market integration between the United States of America, Argentina, and Brazil, which are the three exporters. Moreover, the causality test reveals that the United States had the leadership at prices. Also, the study proves that the Law of One Price is valid. Sabhaya et al. (2021) investigate the price dynamics of domestic and international wheat markets. They discover that the prices become stationary merely upon first differencing. The presence of integration is confirmed among markets involving that there is price conduction.

2.2.4 GARCH Models

Moreover, Lee and Valera (2016) applied MGARCH and panel GARCH models to investigate world rice price transmission and volatility spillovers across six major Asian rice markets. The results of this study propose that adjustments in the world price of rice have an impact not only on the price levels of domestic rice markets but also on their conditional variances. Furthermore, interdependence over rice markets gave rise to a strong spillover of a price shock from one country to another within the region.

2.2.5 Markov-switching Vector Error Correction Models (MSVECM)

The studies of Bakucs et al. (2012) and Kuck and Schweikert (2017) have used the Markov-switching Vector Error Correction Model. The use of this model is about accounting for potential time-varying adjustment. Bakucs et al. (2012) analyze the price transmission between German and Hungarian wheat producer prices using weekly prices. They discover that Markov Switching Vector Error Correction Model (MS-VECM) with three regimes seems to appropriately capture the dynamics in the price relationship. They also find that among the regimes, one seems to capture highly unusual price drops in the Hungarian market, while another regime seems to relate to normal trade, corresponding to high trade volumes. This regime is the most frequent one. Kuck and Schweikert (2017) examine crude oil market integration over major crude oil prices such as WTI, Brent, Bonny Light, Dubai, and Tapis using a Markov-switching vector error correction model. They find that the crude oil market is characterized by globalization. Dubai is the reference price due to its low level in

comparison to the other prices in all regimes. In addition, an interesting finding is that the degree of market integration appears to be linked to worldwide economic uncertainty.

2.2.6 Threshold Error Correction Models

Wondemu (2015) and Ganneval (2016) have used threshold error correction models in their studies. Wondemu (2015) tested asymmetric price adjustment of Ethiopian grain markets using the point-space model and found that teff crops' prices adjusted quickly to market shocks caused by an increase in prices as compared to when prices were reduced. These findings were further affirmed by Ganneval (2016) who used Threshold Vector Error Correction Model to analyze price transmission among spatial rapeseed, feed barley, corn, and protein pea in French markets. Ganneval (2016) found that market pairs responded faster to high deviations from long-run equilibrium but slower to price equilibration after experiencing shocks. The findings by Wondemu (2015) and Ganneval (2016) underlined the spatial integration of agricultural commodity markets which then explain the degree of price transmission in agricultural commodity markets. Furthermore, the results are indicative of market inefficiencies that may, to some extent, explain how market prices respond to shocks in the agricultural markets across geographical space.

The study of Abunyuwah (2020) has employed the momentum threshold autoregressive (M-TAR) model of Enders and Siklo (2001) to assess price transmission and market efficiencies of Ghanaian yam markets. Abunyuwah (2020) uses monthly wholesale price data between January 2006 and June 2018. The empirical results show the existence of cointegration and price transmission asymmetries. Thus, price increases in the Techiman reference market are more rapidly transmitted to the other regional markets than price reductions.

2.2.7 Nonlinear Autoregressive Distributed Lag Model (NARDL)

Fousekis and Trachanas (2016), Rezitis (2018), and Bronnmann and Bittmann (2019) have used in their studies the nonlinear autoregressive distributed lag model (NARDL) proposed by Shin et al. (2014). The results of their studies indicate the presence of short-run and long run price asymmetries. Fousekis and Trachanas (2016) examine the spatial price transmission in international skim milk powder markets using monthly price data from Europe, the United States of America, and Oceania. It is found that the prices in the three regions are linked with stable long-run relationships. Moreover, they find in their study that there are asymmetries between the prices in the short run. Rezitis (2018) analyzes vertical price transmission between farm and retail markets for a variety of dairy products in Finland. The results indicate the existence of long-run and short-run asymmetry for dairy products. In addition, the findings of the study show the presence of a positive degree of long-run price asymmetry for these products. Bronnmann and Bittmann (2019) investigate vertical price transmission between import and retail markets for cod and herring in Germany. The results show that there is long-run price transmission asymmetry in fishmonger, supermarkets, and discounters in the German cod market. Furthermore, the results provide evidence about asymmetries in short-run cost pass-through for discounters. For the herring market, they find asymmetries in long-run cost pass-through for mongers. In the short run, they find asymmetric cost pass-through for the average retailer and discounter.

2.2.8 Wavelet analysis

In contrast to the above studies, Nigatu and Adjemian (2020) have used wavelet analysis to examine the integration between U.S. and international prices for corn, soybeans, and cotton. They do not find a large number of evidence that short-term variations between domestic and international prices are steady, while specific structural breaks were detected for a large

number of price pairs in the long-run relationships. They also find that prices of commodities in China and the United States had little or no relationship.

3. Critical Evaluation of the Literature

3.1 Introduction

Market integration has been studied for several years, and the literature reviewed is from 1986 to 2021. Most of these studies have focused on whether markets are integrated and their degree of integration.

Researchers over the years have used econometric models to study market integration. Choosing the appropriate methodology is one of the problems this topic has. Many econometric methods have been applied to address this problem. Researchers using many econometric models over the years try to draw valuable conclusions and thus contribute to the literature. Many studies with econometric methods were presented to fill the gaps in the literature.

3.2 Critical Evaluation

The application of each econometric method provided useful results to the researchers dealing with the subject of market integration in their studies. The econometric models used have their advantages and disadvantages. The researchers used these econometric models to make their results more reliable, thus filling the gaps that may exist in the literature.

Ravallion (1986) develops a model of spatial price differentials. The differentiation between long-run market integration, short-run market integration, and market segmentation is allowed by this method. This method did not give satisfactory results for market integration. Palaskas and Harriss-White (1993) attempt to provide a new method using recent developments in the theory of time series and co-integration to test the hypothesis of market integration because Ravallion's approach has problems in terms of modeling and results in inefficient estimators which are used to perform and test the alternative hypotheses of market integration and segmentation. The results they found using these methods provided findings as to the existence of market integration for the researchers.

There are studies that used the Engle and Granger (1987) cointegration method to study market integration (Ardeni, 1989; Rufino, 2011; Hatzenbuehler et al., 2017). One disadvantage of this method is that it only analyzes relationships between two price series. Another disadvantage of this method is that the results are also sensitive to which price series is used to normalize the other. This method, both with its advantages and disadvantages, gave findings to researchers regarding the subject of market integration in their studies.

Other studies used the Johansen cointegration method (Goodwin, 1992; Asche et al., 1999; Sanjual and Gil, 1999; Asche et al., 2001; Makama and Amruthat, 2016; Lanfranco et.al, 2019), which has more advantages than the Engle and Granger (1987) method, thus filling the gaps in the literature. The Johansen (1988) method treats all the variables as explicitly endogenous and takes care of the endogeneity problem by providing an estimation procedure that does not require an arbitrary choice of a variable for normalization. This method also allows tests for multiple cointegrating vectors. This method, having more advantages than the Engle-Granger method, provides evidence of cointegration relationships between the data used in each study.

Also, the researchers who used Vector Error Correction Model (VECM) to find the short-term relationships between prices assumed that the relationships between prices are linear

(Fousekis and Klonaris, 2002; Ikudayisi et al., 2014; Zakari et al., 2014; Hassanzoy et al., 2015; Adekunle and Momoh, 2016; Jena, 2016; Kumar et al., 2016; Arnade et al., 2017; Baiyegunhi et al., 2018; Larre, 2019; Sabhaya et al., 2021). The results of these studies confirm the existence of the short-term relationship between prices and these models are used in many studies for the subject of market integration.

The Threshold Vector Error Correction Models (TVECM) control for linearity and the existence of asymmetry ,unlike the VECM models, thus finding more results and reaching more and more valuable conclusions for the literature on market integration (Wondemu, 2015; Chen and Saghaian,2016; Ganneval, 2016). The disadvantage of these models is the assumption of the constancy of transportation costs. The existence of asymmetry is confirmed using this method in the results of these studies which could not be seen through previous econometric methods, such as VECM.

Other studies used the Markov-switching Vector Error Correction Models (MSVECM), and the advantage of this model is that it allows time-series analysis with different regimes when the corresponding state variable is unknown (Bakucs et al., 2012; Kuck and Schweikert, 2017). These models have been applied in many studies related to the subject of market integration providing useful results to subject researchers.

MGARCH and GARCH models are also econometric models that have been used to test market integration, price transmission, and volatility spillover. These findings were found in the study of Lee and Valera (2016) through the use of these models, enriching the literature in this way.

There are studies that have used the nonlinear autoregressive distributed lag model (NARDL) proposed by Shin et al. (2014) (Fousekis and Trachanas, 2016; Rezitis, 2018; Bronnmann and Bittmann, 2019). This model shows significant advantages over existing methodological approaches (e.g. the error correction model (ECM), the threshold ECM, the Markov-switching ECM, and the smooth transition ECM) for many reasons. First of all, it allows the joint modeling of asymmetries and cointegration dynamics. It can also be implemented relatively easily. Moreover, it can determine cointegrating relationships in small samples efficiently and it does not require that the regressors should be integrated of the same order, allowing for the inclusion of both I (0) and I (1) (but not I (2)) time series processes in the long-run equilibrium relationship (Pesaran and Shin 1998), in contrast to the ECM approach, which imposes the assumption that all series should be integrated of the same order. This method, with its advantages, provides useful results for the subject of market integration and overcomes the limitations of the other methodological approaches mentioned above. The asymmetry in prices, both long-run and short-run, appears in these studies through the application of this model.

Other study used the Wavelet analysis as a new and alternative technique to study market integration (Nigatu and Adjemian, 2020). Wavelet analysis avoids many of the limitations of cointegration models and is an applicant to study periodic phenomena in time series (Ramsey, 2002; Rösch and Schmidbauer 2017; Vacha and Barunik, 2012). The cointegration-based models have linear restrictions and wavelets avoid them, as a result, they have more flexibility in modeling heterogeneity in financial and economic time series data and studying price comovement (Joseph, Sisodia, and, Tiwari, 2015). This new method used for the subject of market integration provides findings in the studies and can be used by the researchers in their future research as well.

4. Conclusions

This paper aims to analyze the state of the art research on market integration and provide a perspective for future research. Some problems were identified in the study of the subject of market integration. Applying the appropriate econometric model to study market integration is an identified problem. The time series analysis has been criticized as unreliable (Blauch, 1997; Barrett and Li, 2002). Linear tests for market integration and price transmission are considered crude and inappropriate (Blauch, 1997; Fackler and Goodwin, 2002 and Barrett and Li, 2002). Nonlinearities in market relationships that derive from arbitrage conditions, unsynchronized price cycles, discontinuous trade, and non-stationary transfer costs are considered rendering linear representations and models not useful and not accurate. To fill this gap, this paper presents studies that use new methods that address these problems in the subject of market integration. Another problem on this subject revolves around the concept of market integration. In two areas of economics (international economics and macroeconomics), a common conception of market integration pays attention to tradability. The main approach one finds in the spatial market integration literature concentrates instead on the notion of competitive equilibrium and Pareto efficiency manifest in zero marginal profits to arbitrage. At the center of most analyses of market integration lies the Enke-Samuelson-Takayama-Judge (ESTJ) spatial equilibrium model (Enke, 1951; Samuelson, 1952; Takayama and Judge, 1971), in which the dispersion of prices in two locations for an otherwise homogenous good is bounded from above by the cost of arbitrage between the markets when trade volumes are unrestricted and bounded from below when trade volumes reach some ceiling value. Fackler and Goodwin (2001) also give a definition of market integration. They define market integration as the degree to which supply and demand crises arising at one market location are transmitted to another market.

The contribution of research work in market integration during the period under study (1986 - 2021) has been increasing continuously. The contribution of this paper is also the chronological presentation of new methods that have been used in the literature to deal with these problems. That is why this article is made so that the methods presented will help academics, and future researchers when studying the current research work.

Many researchers have used econometric methods, such as Augmented Dickey-Fuller (ADF) test, Johansen cointegration test, vector error correction model, Markov-Switching error correction model, threshold error correction models, nonlinear autoregressive distributed lag model (NARDL), GARCH, Momentum threshold autoregressive model (M-TAR), and wavelet analysis to test the market integration. Each study's results differ because of the application of these econometric techniques.

We propose these methods to be used in future research and to overcome the problems identified in the issue of market integration. Also, future research is needed to discover new methods using more data, which will be useful in the future for this subject.

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APPENDIX

Table 1: Previous Literature review

Authors	Countries examined	Time period	Data	Econometric methods/ indicators/ estimation techniques	Brief findings
1. Martin Ravallion (1986)	Bangladesh	1972-1975	Prices of rice	Dynamic model of spatial price differentials	The results indicate that the application of this approach suggests some quite significant departures from the conditions for both short-and long-run market integration.
2.Ardeni (1989)	Australia,Canada,UK,and USA	Wheat: 1965.1-1986.1 (85obs)-1967.1-1983.4 (68obs) for Canada. Wool: 1966.1-1986.1 (81 obs). Beef: 1964.1-1986.1 (89 obs). Sugar: 1957.1-1986.1 (117 obs)-1966.1-1986.1 (81 obs) for Australia. Tin: 1965.1-1985.4 (84 obs). Tea: 1964.1-1984.4 (84 obs). Zinc: 1964.1-1986.1 (89 obs)-1965.01-1983.04 (76 obs) for Canada.	Prices of wheat, wool, beef, sugar, tea, tin, and zinc	Unit root (Dickey and Fuller) test, Engle-Granger cointegration test	The results show the failure of the Law of One Price as a long-run relationship after testing for the nonstationarity and cointegration of a group of these commodities.
3.Goodwin (1992)	U.S, Canada, Australia, Japan, Rotterdam	1978-1989	Prices of wheat for five international wheat markets	Unit root (Dickey-Fuller) test, Johansen multivariate cointegration test.	The findings of the study indicate that the Law of One Price as a long-run equilibrium holds if the transportation costs are taken into consideration in the analysis. Also, if the prices of wheat are adjusted for freight rates, the Law of One Price will hold in this study.

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4. Palaskas, T.B. and B. Harriss-White, 1993	India	1988-1990	rice, potato and oilseed	Cointegration, Autoregressive Conditional Heteroskedasticity	The empirical results of the study prove the integration of the markets. However, they find a low level of integration between paddy and rice. In addition, the results provide evidence that the hypothesis of market integration at the full level was not accepted.
5.Asche et al. (1999)	USA, Norway	1986-1996	Prices of five salmon species	Johansen cointegration test	It is proved that the Law of One Price holds for an international market with five salmon species.
6. Sanjuan A., GilJ. M. (1999)	Denmark, Spain, Germany, United Kingdom, Italy	1973-1993	Pig carcases (grade II) prices from EUROSTAT are used and five countries are considered: Denmark, Spain, Germany, United Kingdom and Italy	Johansen cointegration test, Forecast Error Variance decomposition.	The results provide evidence of a high degree of integration between these selected markets. However, the detection of only one cointegrating vector does not provide enough evidence about a unique pork market in Europe.
7. Frank Asche Et al (2001)	Belgium, France, Germany, the Netherlands, Norway, Russia	1990-1997	Prices of Natural gas	Unit root (ADF) test, Johansen cointegration test	The results reveal that the different border prices for gas to France from Russia, Norway, and the Netherlands move proportionally over time so that the law of one price holds. The results also indicate the presence of a close relationship between French, German, and Belgian markets.
8. Panos Fousekis, Stathis Klonaris (2002)	Greece, Italy, Spain	1992-1998	Prices of Olive oil	Unit root (ADF) test, Johansen cointegration test and Vector error correction model (VECM).	They find long-run relationships between the prices of Spain, Italy, and Greece according to the cointegration analysis. They also find that Spain is the price leader and Italy and Greece are the followers.

9. Cesar C. Rufino (2011)	Philippines	1989-2001	Regional Monthly wholesale price series of rice	Unit root (ADF and PP) test, Engle and Granger cointegration test, Johansen cointegration test	They find that there are long-run relationships between the prices of the regional markets. The main result is the existence of spatial market integration in the regional market of rice in the Philippines.
10. Bakucs L.Z et al (2012)	Germany, Hungary	2003-2007	Weekly German and Hungarian prices of Wheat	Johansen cointegration test, Markov-Switching Vector error correction model (MS-VECM)	They discover that the Markov Switching Vector Error Correction Model (MS-VECM) with three regimes seems to appropriately capture the dynamics in the price relationship. They also find that among the regimes, one seems to capture highly unusual price drops in the Hungarian market, while another regime seems to relate to normal trade, corresponding to high trade volumes. This regime is the most frequent one.
11. Adebola Ikudayisi and Kabir Kayode Salman (2014)	Nigeria	2001-2010	Monthly prices of maize	Unit root (ADF) test, Johansen cointegration test, Vector error correction model (VECM).	According to cointegration analysis, the states are cointegrated. Moreover, the rate at which VECM repaired deviation from equilibrium is medium. The study indicates that spatial price linkages exist within the maize market as products move efficiently across the market, which is associated with the efficiency of price information flow. The study recommends that farmers should be given more price information in order to benefit from spatial price differences.
12. Zakari, S., Ying, L. and Song, B. (2014)	Niger, Thailand, Pakistan, India, Vietnam and the US.	2006-2012	Monthly wholesale market prices of millet, sorghum, maize and rice.	Unit root (ADF) test, Johansen cointegration test, Vector error correction model (VECM), causality test.	The results show that grain markets in Niger responded to negative and positive shocks in regional and internal markets differently. Maize and rice markets had a high speed of adjustment to world prices compared to millet and sorghum markets.

13. Wondemu, K. (2015)	Ethiopia	2008-2012	Prices of white teff, red teff and maize	Unit root (ADF) test, Lo and Zivot (2001) test of linear against threshold cointegration, Threshold vector error correction model (TVECM)	The results show the presence of asymmetric price adjustment only for teff crops but not for maize. For the case of teff crops, prices adjusted quickly to market shocks caused by an increase in prices as compared to when prices were reduced. Furthermore, according to the analysis of the efficiency of the grain markets, the spatial markets are characterized by a significant level of inefficiency. The finding suggests that deviation from perfectly competitive settings is partly to be blamed for the recent food crops price hikes, although further research is necessary to determine what really causes the observed asymmetric price transmission and market inefficiency. In addition to their undesirable redistributional consequences, asymmetric price transmissions and inefficiency are expected to entail efficiency loss. Moreover, the underlying reasons for the observed asymmetric price transmission and market inefficiency should be explained by future empirical work.
14. Najibullah Hassanzoy, Shoichi Ito, Hiroshi Isoda, Yuichiro Amekawa (2015)	Afghanistan, Pakistan, Thailand	2007-2015	monthly time series data on global and domestic rice prices, consumer price indices (CPIs) and exchange rates coupled with annual data on rice production, consumption and imports	Unit root(ADF and PP) test, maximum likelihood cointegration tests of Johansen (1988, 1996) and Johansen, Mosconi and Nielsen (2000), Vector error correction model (VECM)	The empirical results reveal that the dynamics of price transmission may not be the same for high and low-quality rice markets. Specifically, the extent of price transmission appears to be larger for the global prices of low-quality rice. Moreover, the speed of adjustment to the long-run equilibrium may be faster for domestic prices of high-quality rice. Furthermore, a shock in the global prices of low-quality rice may have a long-lasting effect on

					domestic prices of low-quality rice as compared to their high-quality counterparts affecting domestic prices of high-quality rice.
15. A. Kumar* and R. Mishra (2016)	India	2005-2015	monthly wholesale prices of potato	Unit root (ADF) test, Johansen cointegration test, Vector error correction model (VECM).	The findings of the study indicate that five potato markets reacted on the long-run cointegrating equations, while the speed of price adjustment in the short-run was almost absent. Additionally, it is found that there is an inverse relationship between the distance from one market to another and the integration. The efficiency of potato markets in Uttarakhand depends on how the market information system works.
16. Makama, S.A., Amruthat T. J. (2016)	India, Nigeria	2004-2014	Monthly prices of rice	Unit root (ADF) test, Johansen cointegration test, Vector error correction model (VECM), Granger causality test.	The results show the existence of a relationship between export and domestic prices of rice in the long run, and the domestic price of rice in Nigeria affects the export price of Indian rice in the long run. Moreover, the amount of the coefficient of the speed of adjustment between India and Nigeria, which is -0.903, indicates that the adjustment process is fast, with around 90 percent of divergence from the long-run equilibrium being corrected in each one to six months. Also, the findings provide evidence about the non-existence of short-run causality running from Nigeria rice market to that of India, and the result of the Granger causality test shows that Nigeria market Granger cause India, and India market Granger cause Nigeria. This causation is bidirectional. Furthermore, the estimated period of outgoing price transmission is about

					five months. The bad road conditions are also an impediment to more complete market integration. In twelve of the seventeen long-run, related market pairs, positive and negative price changes are transmitted symmetrically. The existence of asymmetry in five market pairs is maybe a result of localized market power. Generally, integration responds negatively to spatial separation and quality of communication and positively to improved roads, and with the improvement of transportation and market infrastructure, markets may be better integrated.
17. Panos Fousekis ,Emmanouil Trachanas (2016)	E.U, U.S, Oceania (Australia, New Zealand).	2003-2015	Prices of skim milk powder	Ng and Perron (2001) unit root tests, Nonlinear Autoregressive Distributed Lag Model (NARDL).	It is found that the prices in the three regions are linked with stable long-run relationships. Moreover, they find in their study that there are asymmetries between the prices in the short run.
18. Bo Chen and Sayed Saghaian (2016)	Thailand, Vietnam, United States of America	2000-2013	rice prices from Thailand, Vietnam, and United States	Unit root (ADF and KPSS) test, Johansen cointegration test Threshold vector error correction model (TVECM).	They find that the export prices of rice in Thailand, Vietnam, and the United States are cointegrated. They also find that the United States and Vietnam have the leadership at the prices and that the price of Vietnam adjusts faster to long-run equilibrium when it is above its equilibrium level with Thai and United States prices.
19. Pratap Kumar JENA (2016)	India	2001-2012	Prices of cereals, sugar, edible oil, cotton, rubber and plastic products, aluminium, metal products, other non-ferrous metals, coal and mineral oil prices.	Unit root (ADF and PP) test, Johansen cointegration test, Vector error correction model (VECM), causality test.	The results reveal that there is a short-run and long-run relationship between the indexes of prices between domestic and international commodities, respectively. The results also show that the index of international commodity prices affects the index of domestic commodity prices.

20. S. Ganneval (2016)	France	2006-2013	Prices of Rapeseed, corn, feed barley, protein pea	Threshold Vector error correction model (TVECM)	The results show that in a regime that is characterized by high volatility, price divergences from the long-run equilibrium are restored faster, and the price equilibration procedure after a price shock does not take more time. Moreover, when the volatility increases, it seems that the information in the reference (producer) price turns out to be more relevant for commodities with (without) a futures market.
21. Jim Lee & Harold Glenn A. Valera (2016)	Bangladesh, China, India, the Philippines, Thailand, and Vietnam	2005-2013	Monthly world and domestic wholesale prices of rice	GARCH models	The results of this study propose that adjustments in the world price of rice have an impact not only on the price levels of domestic rice markets but also on their conditional variances. Furthermore, interdependence over rice markets gave rise to a strong spillover of a price shock from one country to another within the region.
22. Adekunle C. P., Momoh S., (2016)	Nigeria	2004-2013	retail rural and urban market price of cowpea from 2004 to 2013	Unit root (ADF) test, Johansen cointegration test, Vector error correction model (VECM), Granger causality test.	The Augmented Dickey-Fuller test indicates that the price series are stationary at first difference. Moreover, Johansen's co-integration results show that even though there is one co-integrating equation between linear combinations of cowpea price series, there are some stable long-run equilibrium relationships among the price series, which could be given some error correction representations. Results based on pairwise granger causality show that Rural Price of Maize in Oyo State has strong exogeneity over other rural and urban markets. In comparison to a perfect adjustment of 100% threshold, the speed of adjustment of 51%, 87%, and

					60% from the short-run to the long-run equilibrium is relatively high. This proves that there is a strong integration among the cowpea markets in Southwest Nigeria.
23. Carlos Arnade, Bryce Cooke, Fred Gale (2017)	China	2001-2014	monthly prices of beef, chicken, corn, cotton, pork, soybeans, soybean meal, rice, and wheat	Error Correction models (ECM)	The results indicate important differences in transmission beyond commodities, with Chinese soybeans and soymeal and chicken price being the most integrated with world prices and rice being the least integrated. They also find that long-run price transmissions are higher than short-run price transmissions, suggesting that stabilization policies may slow down the transmission of price shocks for many commodities.
24. Patrick L. Hatzenbuehler, Philip C. Abbott and Tahirou Abdoulaye (2017)	Nigeria	2007-2010	Prices of maize, millet, sorghum, rice, cassava, yams and cowpeas.	Unit root (ADF and PP) test, Engle and Granger cointegration	This study has three main results. Firstly, tradability matters for price transmission, but tradability varies across crops and regions. The strongest international linkages are with neighboring countries. Rice price transmission is high across all markets, while coarse grain price correspondence is low with world prices but high with neighboring country market prices. Secondly, their results suggest that local conditions are important for price transmission, and are relatively more significant than trade for some crops, such as yams, cassava, than others (imported rice, maize). Thirdly, larger than expected long-run price transmission parameters in world and neighboring countries for rice and coarse grains suggest that, in these select markets, there are either large transaction costs or quality

					premiums that vary systematically with border prices and/or mark-ups captured by traders with market power.
25. Konstantin Kuck, Karsten Schweikert (2017)	Dubai, USA	1987-2015	major crude oil prices–WTI, Brent, Bonny Light, Dubai and Tapis	Unit root (ADF and KPSS) test, Johansen cointegration test, Markov-switching vector error correction model (MSVECM).	They find that the crude oil market is characterized by globalization. Dubai is the reference price due to its low level in comparison to the other prices in all regimes. In addition, an interesting finding is that the degree of market integration appears to be linked to worldwide economic uncertainty.
26. Lloyd Baiyegunhi et al (2018)	South Africa	2008-2012	Prices of tomato	Unit root (ADF) test, Engle and Granger cointegration test, Vector error correction model (VECM)	The results indicate the integration of these markets. The results also disclose that one month is a necessary time for the economic agents to adjust back to equilibrium when a shock to the markets appears and causes deviations from the equilibrium. In the Johannesburg market, the reaction to the shock is slower than in the Durban market. The South African fresh produce market is competitive thanks to the high level of degree of market integration and provides little justification for government intervention designed to enhance the level of competitiveness or to improve the efficiency of the market.
27. Bruno A. Lanfranco, Bruno Ferraro, Francisco Rostán (2019)	Uruguay, Brazil, Argentina, Paraguay	2004-2012	Prices of beef for Uruguay, Brazil, Argentina, Paraguay	Fractional cointegration	The results prove the acceptance of the null hypothesis of segregated markets. Argentina and Uruguay are segregated markets, as well as Brazil and Paraguay. Furthermore, their reactions to particular price shocks were not the same, and the adjustment of the prices to equilibrium was always slow.

28. Guillermo Andrés Larre (2019)	Argentina, Brazil, USA	1999-2019	spot prices of Brazil, USA, and Argentina soybeans export prices	Unit root (ADF) test, Johansen cointegration, Vector error correction model (VECM), Granger Causality test	The results show the existence of market integration between the United States of America, Argentina, and Brazil, which are the three exporters. Moreover, the causality test reveals that the United States had the leadership at prices. Also, the study proves that the Law of One Price is valid.
29. Getachew Nigatu and Michael Adjemian (2020)	USA, Brazil, China, Japan	2011-2018	Daily closing U.S. and international future prices for corn, soybeans, and cotton	Unit root (ADF) test, Johansen cointegration test, Wavelet analysis	They do not find a large number of evidence that short-term variations between domestic and international prices are steady, while specific structural breaks were detected for a large number of price pairs in the long-run relationships. They also find that prices of commodities in China and the United States had little or no relationship.
30. Abunyuwah, I. (2020)	Ghana	2006-2018	Yam monthly wholesale price data between January 2006 and June 2018	Unit root (ADF and KPSS) test, threshold cointegration test, Hansen and Seo lagrangian multiplier (LM) test, momentum threshold autoregressive (M-TAR) model	The empirical results show the existence of cointegration and price transmission asymmetries. Thus, price increases in the Techiman reference market are more rapidly transmitted to the other regional markets than price reductions.
31. Sabhaya, A. G., Upadhyay, S. M., Vekariya, P. R., & Swaminathan, B. (2021)	India, United States, Argentina	2004-2019	Monthly price data of wheat	Unit root (ADF) test, Johansen cointegration test, Vector error correction model (VECM).	They discover that the prices become stationary merely upon first differencing. The presence of integration is confirmed among markets involving that there is price conduction.