

A Global Perspective of Food Market Integration: A Review

AGREKON

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Abstract

This paper analyses the state of the art research on food market integration, classifies it and provides a comprehensive bibliography for researchers with interest in market integration. A thorough review of literature published between 1990 and 2014 on food market integration generated 65 articles for in-depth analysis. Findings show that the majority of research has concentrated relatively more on identifying the degree of linkages among the markets but not on its implications. The paper also identifies the following factors as very important in increasing/decreasing the degree of market integration: physical infrastructure, market institutions, information, competition, market power, trade, social capital, public/government intervention and export restrictions/ban. The paper further identifies several areas for future research.

Keywords Price co-movement, Co-integration, Price transmission, Commodity markets, Market inter-relationships

1.0 Introduction

Food market integration is a process of market inter-relationships, evidenced by tradability and the resultant co-movements of market prices (Abunyuwah, 2007, Penzhorn and Arndt, 2002). There are mainly two forms of market integration, vertical market integration and spatial market integration (Meyer, 2004). While vertical market integration refers to transmission of price signals from one marketing channel to another, spatial market integration means transmission of price signals between markets in different locations (Minot, 2010). Price transmission, the core of market integration, occurs when a change in one price causes another price to change. Price transmission can either be spatial, vertical or cross-commodity.

Closely related to price transmission is price volatility, which describes how quickly or widely prices can change (Minot, 2010). Price fluctuation is a common feature of well-functioning agricultural markets. Nevertheless, when it becomes large and unexpected, i.e. volatile, price fluctuation can have a negative impact on food security of consumers, farmers and the entire population.

The degree of market integration, which is assessed through price transmission and volatility, determines the strength and effectiveness of price mechanism in resource allocation. If food markets are not integrated, price signals will not be transmitted from supply deficit regions to surplus markets. In case prices are volatile, agricultural and food producers will not specialise according to long-run comparative advantage and gains from trade will not be realised (Baulch, 1997a). It is therefore important to understand price transmission and market integration mechanisms in market economies. Further, research on the degree of interdependence and co-integration between food markets around the world helps in improving the decision making techniques and international investor strategies.

While reviewing literature on food market integration, we noticed that earlier studies examined integration among food markets in a linear framework using simple correlation and regression tests as tools for analysis (Li, 2000). However, recent studies have applied econometric techniques like co-integration, error correction models, parity bounds model, Johansen co-integration, autoregression, Granger-causality, and Ravallion/Timmer models to test the integration hypothesis (Faminow and Benson, 1990, Badiane and Shively, 1998, Kuiper et al., 1999, Minten and Kyle, 2000, Minten et al., 2014).

Regarding the location of the studies reviewed, majority of them were conducted in USA, China, Ethiopia and Ghana. Despite majority of them being located in these few countries, the distribution of research in market integration is worldwide. Many countries have been reached. For the countries which have received little or no attention with regard to market integration research, it could be probably because of scarcity of data.

In regard to the number of years considered as sample data, Li (2000) used the biggest sample of 173 years, followed by Marks (2010), who used 58 years. Ghoshray (2011) followed with a sample of 51 years. The rest of the studies used less than 30 years. Regarding the number of countries considered as sample, the majority of studies used only one country. However, Baquedano and Liefert (2014) had 29 countries.

This paper evaluates and systematically arranges past literature by reviewing it thoroughly so that researchers in the area of food market integration can find it useful. Specifically, the study analyses the state of the art research on food market integration, classifies it and provides a perspective for future research. The literature reviewed covers articles on vertical and spatial market integration, symmetric and asymmetric price transmission and price volatility published in high quality journals between 1990 and 2014.

The rest of the paper is structured as follows: section II presents the rationale of the study, section III discusses methodology, section IV presents and discusses results and section V concludes and also suggests questions for further research.

2.0 Rationale of the study

Markets are important determinants of food availability and accessibility. The extent to which markets make food available, accessible and keep prices stable depends on whether or not they are integrated. If markets are well-integrated, it is assumed that market forces are working properly, i.e. price changes in location A are consistently related to those in locations B and C. For integrated markets, food will flow from surplus to deficit areas; and imports will flow from port and border areas into the hinterland. High prices in deficit areas provide an incentive to traders to bring food from surplus to deficit areas. As a result, food prices should decline in deficit areas, making it accessible to the majority.

Considering the importance of market integration in the food sector, a lot of research has been done to test integration of food markets all over the world. Some studies found weak or strong integration in food markets whereas others did not find any. Some studies rejected the integration hypothesis and concluded that the food markets they studied were integrated (Abdulai, 2000, Gonzalez-Rivera and Helfand, 2001, García-Enríquez et al., 2014). Other studies, on the other hand, failed to reject the integration hypothesis and concluded that the food markets they studied were not integrated (Gardner and Brooks, 1994, Zhou et al., 2000).

Determinants of market integration are those factors or drivers which may either facilitate or hinder integration of markets (Goletti et al., 1995). Examples of these determinants include physical infrastructure, information, institutions, competition, market power, trade, social capital, government intervention and export restrictions/bans. Several studies have been conducted on how determinants facilitate or hinder market integration (Dercon, 1995, Goletti et al., 1995, Ismet et al., 1998, Loy and Weaver, 1998, Lutz et al., 2006a, Park et al., 2002, Zant, 2012, Cudjoe et al., 2010, Ianchovichina et al., 2014). This paper reviews this literature and identifies questions that require more research. The paper also brings together and analyses various methodologies which have been used in various countries for studying food

market integration. Finally, several issues that future research on market integration should address are identified in the paper.

3.0 Methodology

A total of 65 published articles on market integration in the food sector from various countries all over the world were reviewed. All the reviewed papers were published between 1990 and 2014 in A1 journals. Table 1 shows the basis for classification of the literature, i.e. year, country and source of study, data sample used, methodology adopted and findings and conclusions from the reviewed literature.

The search for literature was based on the keyword descriptor “food or commodity market integration/price transmission/price volatility” for selected databases and websites for a period ranging from 1990 to 2014. We selected the databases for keywords in titles, abstracts, keywords list and full text. The search produced thousands of papers. We then reviewed the full text of the papers, subject to relevance, in order to select the ones related to this study. Based on relevance and consideration of the time period for this study, we finally obtained 65 articles on which we based to write this paper.

We classified the entire literature on food market integration using a systematic model in Figure I (Sharma and Seth, 2012), i.e.

- econometric tools/methodology used in data analysis,
- year of publication,
- country-wise distribution,
- number of years taken as sample dataset,
- number of countries considered for study forming sample data and
- sources of the articles.

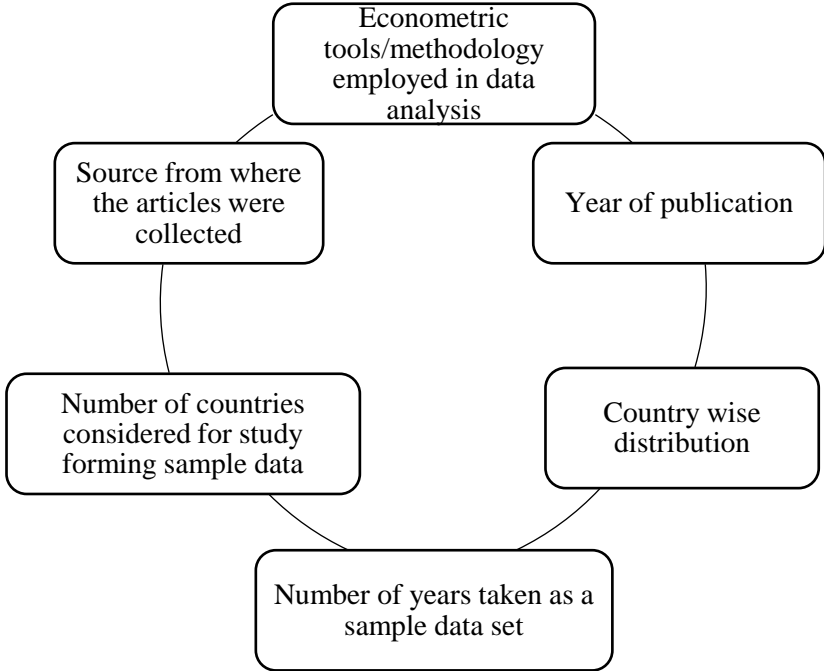


Figure I: Basis for classification of literature on food market integration (modified from Sharma and Seth (2012))

Table 1: Classification of literature on food market integration

S. no	Author(s), year and country of study	Title of study	Journal	Sample data (no. of years)	No. of sample countries	Determinants covered	Methodology used for data analysis	Findings & conclusions
1	Faminow and Benson (1990), Canada	Integration of spatial markets	American Journal of Agricultural Economics	11	1	None	Ravallion	Results suggest non-competitive pricing system disintegrated during the 1970 – 75 period, a time when substantial changes in the Canadian hog market occurred, and was replaced by FOB pricing system. The markets then became integrated.
2	Dahlgran and Blank (1992), USA	Evaluating the integration of contiguous discontinuous markets	American Journal of Agricultural Economics	3	1	None	Vector auto-regression (VAR)	Results indicate that continuous markets were less integrated when discontinuous markets were operating than when they were not operating. California-Arizona alfalfa hay markets were competitive, price being an important factor in the allocation process.
3	Alderman (1993), Ghana	Inter-commodity price transmittal: analysis of food markets in Ghana	Oxford Bulletin of Economics and Statistics	14	1	None	Ravallion, co-integration, Granger causality	Results show that prices of grains in Ghana were co-integrated. The dynamic model of price integration indicates functional, if not perfect, efficiency of Ghanaian coarse grain markets.
4	Palaskas and Harriss-white (1993), India	Testing market integration: new approaches with case material from the west Bengal food economy	Journal of Development Studies	2	1	None	Co-integration, Autoregressive Conditional Heteroskedasticity (Gluschenko and Karchevskaya)	Results suggest that markets were integrated, but a lower degree of integration for paddy and rice prices were identified. Structural and institutional factors which affect the specifics of performance were also identified.
5	Alexander and Wyeth (1994), Indonesia	Cointegration and market integration: an application to the Indonesian rice market	Journal of Development Studies	12	1	None	Co-integration	Results confirm that supply sources are more important than demand sources in driving prices. The CPI was co-integrated with all the price series but there was no great deal of causality from it to the rice

								prices. It did not therefore appear to be the driving force behind the price changes.
6	Gardner and Brooks (1994), Russia	Food prices and market Integration in Russia: 1992-93	American Journal of Agricultural Economics	1	1	None	Ravallion	There was no observable progress toward market integration during the January 1992 to April 1993 period. Therefore, markets for food stuffs were not integrated during that period in Russia.
7	Goletti and Babu (1994), Malawi	Market liberalization and integration of maize markets in Malawi	Agricultural Economics	8	1	Market liberalisation, transportation, communication, market power	Co-integration	The study shows that liberalization enhanced market integration in Malawi. The private sector has a capacity of responding to new operating environment and improving the extent of price transmission across spatially separated markets. However, the extent of market integration was still very low. Market liberalization by itself cannot achieve a structural change in market integration unless investments in marketing infrastructure (transportation, communication, etc.) are undertaken.
8	Dercon (1995), Ethiopia	On market integration and liberalisation: Method and application to Ethiopia	Journal of Development Studies	6	1	Market liberalisation	Co-integration	Results from this study show that liberalisation had important effects on the long-run and short-run integration of food markets Ethiopia. Several markets became integrated with Addis Ababa during the period of liberalisation.
9	Fafchamps and Gavian (1996), Niger	The spatial integration of livestock markets in Niger	Journal of African Economies	21	1	None	Parity bounds model (PBM)	This article shows that livestock markets in Niger were poorly integrated. Prices were seldom co-integrated, suggesting that large price differentials occasionally persisted between adjacent areas for long periods of time. The results confirmed descriptive studies that had emphasised regional segmentation in West African livestock trade.
10	Palaskas and Crowe (1996), UK	Testing for price transmission with seasonally integrated producer and consumer	European Review of Agricultural Economics	20	7	None	Co-integration	This paper suggests that adequate research into economic issues such as agricultural price transmission, the law of one price, market integration and such like, involving

		price series from agriculture						the use of time-series price data could utilise more sophisticated techniques to test for integration and co-integration, given the often seasonal properties of agricultural producer price time-series.
11	Baulch (1997b), Philippine	Transfer costs, spatial arbitrage, and testing for food market integration	American Journal of Agricultural Economics	14	1	None	PBM	This paper developed another methodology, the parity bounds model (PBM), for testing market integration. It uses information on transfer costs in addition to food prices to assess the efficiency of spatial arbitrage. PBM was applied to Philippine rice markets and it detected efficient arbitrage.
12	Badiane and Shively (1998), Ghana	Spatial integration, transport costs, and the response of local prices to policy changes in Ghana	Journal of Development Economics	1	1	Transport costs	Timmer, ARCH	Results show that reductions in local prices and local price variance following the introduction of economic reforms in 1983 could be traced to both local and central market forces, but that differences in the degree of market integration had important implications for long-run changes in transport costs and the evolution of prices in outlying markets.
13	von Cramon-Taubadel (1998), Germany	Estimating asymmetric price transmission with the error correction representation: An application to the German pork market	European Review of Agricultural Economics	4	1	None	Error correction representation	The article demonstrates that transmission between producer and wholesale pork prices in northern Germany was asymmetric. In accordance with common belief, the margin was corrected more rapidly when it is squeezed relative to its long-run level, than when it was stretched.
14	Ismet et al. (1998), Indonesia	Government intervention and market integration in Indonesian rice markets	Agricultural Economics	12	1	Government intervention	Multivariate co-integration	Results show that government intervention in terms of rice procurement significantly influenced market integration. This indicates that the aspect of government intervention had positive influence on integration, in contrast to distribution efforts, which were not found to be statistically significant. Regional per capita income was also found to be positively related to higher levels of market

								integration.
15	Loy and Weaver (1998), Russia	Inflation and relative price volatility in Russian food markets	European Review of Agricultural Economics	3	1	Inflation	Multivariate Generalised Autoregressive Conditional Heteroskedasticity (MGARCH)	Results indicate that distortions in relative prices were induced by the anticipated inflation rate, rather than by unanticipated inflation or a measure of inflation uncertainty. No support was found for the Lucas hypothesis that a positive relationship exists between the relative price structure and the unanticipated rate of inflation.
16	Lutz and Bassolet (1999), Burkina Faso	Information service and integration of cereal markets in Burkina Faso	Journal of African Economies	3	1	Information service	Co-integration	This article shows that impact of diffusion of prices on market integration was moderate. In general, market information service did not have a significant influence on the integration of cereal markets in Burkina Faso.
17	Kuiper et al. (1999), Benin	Testing for the law of one price and identifying price-leading markets: an application to corn markets in Benin	Journal of Regional Science	2	1	None	Johansen co-integration	Although the spatial arbitrage system did not function for the Benin corn market, it had a significant time lag for several marketplaces. This suggests that in 1988 – 1989, the sample period, there was scope for improving the speed of market adjustment to spatial price differentials.
18	Minten and Kyle (1999), Democratic Republic of Congo	The effect of distance and road quality on food collection, marketing margins, and traders' wages: evidence from the former Zaire	Journal of Development Economics	1	1	Distance, road quality	Seemingly unrelated regression estimation (Goletti and Babu)	This analysis shows that food price dispersion was significant both across products and across regions in former Zaire. Transportation costs explained most of the differences in food prices between producer regions. Road quality was also an important factor in transportation costs. However, food prices decreased relatively faster than transportation costs increased and traders' wages were higher on bad roads.
19	Zanias (1999), Italy	Seasonality and spatial integration in agricultural (product) markets	Agricultural Economics	17	5	Seasonal roots	Co-integration	Results show that France and Italy soft wheat market seemed to be integrated. The same applied to Belgium, Germany and UK. There was no indication of market

								integration between the two groups of countries. The study also found out that the presence of seasonal unit roots did affect co-integration.
20	Abdulai (2000), Ghana	Spatial price transmission and asymmetry in the Ghanaian maize market	Journal of Development Economics	17	1	Market power	Threshold co-integration	The findings indicate that major maize markets in Ghana were well integrated. Both measures of co-integration revealed that wholesale maize prices in local markets responded more swiftly to increases than to decreases in central market prices.
21	Li (2000), China	Integration and disintegration in north china's grain markets, 1738-1911	Journal of Economic History	173	1	Trade policies, physical infrastructure, market infrastructure	Correlation, coefficients of variation	The paper demonstrates that while Zhili (Hebei) province's local grain markets gradually fragmented, the provincial market as a whole simultaneously grew more closely integrated with external markets, first with Fengtian (Manchuria) and later with the Lower Yangzi region. The Qing state's food policies, the deterioration of transport routes, and the condition of rural markets provide a context for understanding these seemingly paradoxical trends.
22	Minten and Kyle (2000), Democratic Republic of Congo	Retail margins, price transmission and price asymmetry in urban food markets: the case of Kinshasa (Zaire)	Journal of African Economies	3	1	Transaction costs	SURE	Search, supervision and other difficult-to-measure transactions costs were more important in the margin of food products than measurable marketing costs. Price transmission between wholesale and retail happened in the same week. Price asymmetry was also present for most products. Products characterised by relatively more standardisation and homogeneity were shown to have lower retail margins and to behave symmetrically.

23	Tiffin and Dawson (2000), UK	Structural breaks, co-integration and the farm-retail price spread for lamb	Applied Economics	15	1	None	Co-integration	Results show that a long-run relationship existed, and that the direction of Granger-causality was from retail to producer prices. Lamb prices were therefore set in the retail market. Results also show that there was a structural break in the relationship in January 1990 when the price increased; this coincided exactly with a change in policy.
24	Zhou et al. (2000), China	Integration of rice markets: the case of Southern China	Contemporary Economic Policy	4	1	Transport facilities, government intervention, market liberalisation	Co-integration	There was lack of integration between the indica rice markets in China. Poor transport facilities, government interventions, and limited amount of grain available for arbitrage were identified as major impediments to market integration. In general, the more liberalized a marketing system is, the more integrated the markets are.
25	Gonzalez-Rivera and Helfand (2001), Brazil	The extent, pattern, and degree of market integration: a multivariate approach for the Brazilian rice market	American Journal of Agricultural Economics	28	1	Trade volumes, distance, product quality	Vector Error Correction (VEC)	Findings show that large volumes of trade were not sufficient to generate a high degree of integration. Among other factors, it appears that physical distance and distance in product space (quality) can both lead to a low degree of integration.
26	Goodwin and Piggott (2001), USA	Spatial market integration in the presence of threshold effects	American Journal of Agricultural Economics	7	1	None	Threshold Autoregression (TAR), co-integration	Results confirmed the presence of thresholds and indicated strong support for market integration though adjustments following shocks may take many days to complete. Threshold models suggested much faster adjustments in response to deviations from equilibrium than was the case when threshold behaviour was ignored.
27	Lloyd et al. (2001), UK	The impact of food scares on price adjustment in the UK beef market	Agricultural Economics	9	1	Market power	Co-integration	Results demonstrated that market power exacerbates price changes in the upstream sectors for a given change in the retail demand function. The implication of those varying price changes was that food safety concerns also cause marketing margins

								between the stages to widen.
28	Barrett and Li (2002), USA	Distinguishing between equilibrium and integration in spatial price analysis	American Journal of Agricultural Economics	7	4	None	Extended PBM	The study found competitive equilibrium and tradability to prevail in Pacific soybean meal markets even though trade flows were intermittent at monthly frequency on most international routes. After distinguishing between competitive spatial equilibrium and integration, it was apparent that Pacific soybean meal markets were functioning well.
29	Park et al. (2002), China	Market emergence and transition: arbitrage, transaction costs, and autarky in China's grain markets	American Journal of Agricultural Economics	8	1	Trade restrictions, trade policies, physical infrastructure	PBM	According to this paper, trade restrictions could not explain the pattern of uneven market development over time. Infrastructure bottlenecks, managerial incentive reforms, and production specialisation policies, all were likely important factors affecting market performance.
30	Thompson et al. (2002), Germany	Spatial market efficiency and policy regime change: seemingly unrelated error correction model estimation	American Journal of Agricultural Economics	24	3	Market liberalization	Seemingly unrelated regression-augmented Dickey-Fuller (SURADF), Error Correction Model (ECM)	The paper argues that SURADF is more efficient than ordinary co-integration and error correction models. Empirically a strong evidence of efficient spatial markets and conformity to the law of one price was found. Market liberalization reforms in the EU increased the co-movement of domestic and world wheat prices.
31	Rashid (2004), Uganda	Spatial integration of maize markets in post-liberalized Uganda	Journal of African Economies	3	1	Market liberalization	Co-integration, VAR	Results show that there was an overall improvement in spatial price responsiveness in maize markets in Uganda although the northern districts continued to lack integration with major consumption markets in the central region. Compared to the 1993-1994-time period, representing the early years of liberalization, interdependence among markets increased.

32	Araujo (2005), Burkina Faso	Devaluation and cattle markets integration in Burkina Faso	Journal of African Economies	7	1	None	Switching regime regression	The theoretical model and econometric results in this study highlight a positive impact of the CFA franc devaluation. It favoured local cattle market integration through an increase in the marginal trade profit. Indeed, the devaluation induced a more significant rise in cattle prices than in transaction costs which mainly consist of non-tradable goods and services such as labour. This effect simply results from the real exchange rate depreciation that follows the nominal devaluation and from the predominance of labour-intensive transaction costs within the country.
33	Bojnec and Peter (2005), Slovenia	Vertical market integration and competition: the meat sector in Slovenia	Agricultural and food science	11	1	None	Co-integration	Results from this paper confirmed the existence of long run market integration in the meat chain and the speed of adjustment of price changes. Farm-gate meat prices were identified as weakly exogenous, indicating the crucial role of supply side processing and marketing factors in the retail meat price determination. The increased competitive market pressures are very likely to increase efficiency in the beef markets. Efficiency improvements in the Slovenian food markets are needed in the increased competitive market pressures of the enlarged EU markets.
34	Getnet et al. (2005), Ethiopia	Modelling spatial price transmission in the grain markets of Ethiopia with an application of ARDL approach to white teff	Agricultural Economics	1	5	Government intervention	Autoregressiv e distributed lag (ARDL), co-integration	The results reveal that the wholesale price of white teff in the central consumer market was a major short- and long-run determinant of the producer price in the local supply markets. Therefore, the institutional role of government with the aim of improving producers' marketing margin and the overall performance of the grain markets in the post-liberalization period could be influenced through targeted interventions at the central

								wholesale market.
35	Lutz et al. (2006b), Vietnam	Rice market integration in the Mekong River Delta	Economics of Transition	4	1	None	Vector Error Correction (VECM)	The results show that price patterns correlated strongly in the Mekong River Delta. Even prices in other regions were integrated with price patterns in the South. Private traders in the Mekong Delta were only indirectly responsible for the latter result. In the framework of the national food security policy, the state-owned food companies 'subsidized' transactions between the South and the North. Moreover, the state-owned food companies still dominated export transactions.
36	Lutz et al. (2006a), Benin	Maize market liberalisation in Benin: a case of hysteresis	Journal of African Economies	15	1	Market liberalisation	Co-integration	According to this article, the liberalisation policies in Benin did not significantly affect maize market integration. Therefore, more effective policy instruments were required in order to strengthen the competitive forces in the market.
37	Asche et al. (2007), Norway	Price transmission and market integration: vertical and horizontal price linkages for salmon	Applied Economics	7	3	None	Co-integration, VAR, ECM	The study found a high degree of price transmission and market integration in both supply chains for salmon produced in Norway and UK and then sold at retail level in France as smoked salmon. While Norwegian and UK salmon obviously do not compete at the producer level, the high degree of price transmission gives the close link through the competition at the export level. This implies that measures at any point in the supply chain are to a large extent transmitted to the producer prices and that all measures that restrict Norwegian production or market access will be highly beneficial for UK producers.
38	Awokuse (2007), China	Market reforms, spatial price dynamics, and China's rice market integration: a causal	Journal of Agricultural and Resource Economics	1	10	Market reforms	Co-integration, directed acyclic graphs	While empirical results confirm existence of strong market linkages subsequent to the reforms of the early 1990s, the linkages became less as the Chinese government

		analysis with directed acyclic graphs						reversed several reform policies in the mid-1990s. Overall, the empirical evidence from this study indicates that China's agricultural market policy reforms have been relatively effective.
39	Negassa and Myers (2007), Ethiopia	Estimating policy effects on spatial market efficiency: an extension to the parity bounds model	American Journal of Agricultural Economics	7	1	Market reforms	Extended PBM	The study found evidence of a dynamic adjustment path and grain marketing reforms to have improved spatial efficiency in a few markets, worsened it in a few others, but generally to have had little effect on the spatial efficiency of Ethiopian grain markets. Estimated adjustment periods for the full effects of the policy change to be felt ranged from instantaneous adjustment to 21 months, with most adjustment periods lasting between zero and six months. These results highlight the importance of allowing for adjustment to policy changes.
40	Van Campenhout (2007), Tanzania	Modelling trends in food market integration: method and an application to Tanzanian maize markets	Food Policy	12	1	Transaction costs	PBM, TAR	For all six market pairs considered in this study, transaction costs decreased over time. More specifically for Tanzania, this study has the potential to help government officials in their efforts to increase market performance in order to maintain food security.
41	Baulch et al. (2008), Vietnam	The spatial integration of paddy markets in Vietnam	Journal of Agricultural Economics	14	1	Market policies	Ravallion	There was evidence of both threshold effects and stronger market integration within the Red and Mekong River deltas. These results suggest that national level policies cannot be relied upon to stabilise or support paddy prices in Vietnam.
42	Cirera and Arndt (2008), Mozambique	Measuring the impact of road rehabilitation on spatial market efficiency in maize markets in Mozambique	Agricultural Economics	1	6	Fuel prices, transaction costs, road rehabilitation	PBM	While results point broadly toward a positive impact of road rehabilitation on spatial efficiency, they were not as robust as one would have liked. Large increases in fuel prices likely offset the positive impacts of road rehabilitation on transaction costs, contributing to the

								increase in the probability of being in an autarky regime.
43	Brummer et al. (2009), Ukraine	The impact of market and policy instability on price transmission between wheat and flour in Ukraine	European Review of Agricultural Economics	5	1	Market reforms	Markov-switching VECM	The analysis reveals four regimes whose timing coincided with political and economic events in Ukraine. Strong coincidence between a ‘high uncertainty’ regime and discretionary policy interventions suggests that policy responses to fluctuations in Ukrainian harvests may have amplified instability.
44	Coleman (2009), USA	Storage, slow transport, and the law of one price: theory with evidence from nineteenth-century U.S. corn markets	Review of Economics and Statistics	14	1	Inventory management, transaction costs, transport costs	Threshold regression	This paper argues that localised price spikes should be a regular feature of competitive commodity markets. It develops a rational expectations model of physical arbitrage in which trade takes time and shows that inventory management plays a crucial role in the way regional prices are determined.
45	Moser et al. (2009), Madagascar	Spatial integration at multiple scales: rice markets in Madagascar	Agricultural Economics	1	1	Market institutions, physical infrastructure	PBM	This study shows that Malagasy rice markets are fairly well integrated spatially at the sub regional level. Even without significant public provision of supporting institutional or physical infrastructure, local-level trade appears to operate in an efficient, competitive manner in the vast majority of places and periods. By contrast, markets at national and regional (provincial) levels are far less commonly in competitive tradable equilibrium.
46	Cudjoe et al. (2010), Ghana	Local impacts of a global crisis: food price transmission, consumer welfare and poverty in Ghana	Food Policy	2	1	Distance	Threshold co-integration	This paper shows that prices for domestic grain products were highly correlated with world market prices. Price transmission was high between regional producer markets and markets located in the country’s largest cities. The distance between producer and consumer markets and the size of consumer markets explained the price transmission. It was further noted that the poorest of the poor

								were hardest hit by high food prices. The negative effect of the food crisis was particularly strong in northern Ghana.
47	Ge et al. (2010), China	Cotton market integration and the impact of China's new exchange rate regime	Agricultural Economics	5	2	Exchange rate, market liberalisation	ARCH	The study found a long-run co-integration relationship that exists between Intercontinental Exchange in the U.S. and the Zhengzhou Commodity Exchange in China. The two markets share price transmissions. This paper argues that China's recent exchange rate reform and its gradual liberalisation in bilateral cotton trade since it joined World Trade Organization have had important impacts on the futures market.
48	Marks (2010), Indonesia	Unity or diversity? On the integration and efficiency of rice markets in Indonesia, c. 1920–2006	Explorations in Economic History	58	1	None	Coefficient of variation (CV), co-integration	The paper shows that during Indonesia's colonial period, rice markets were relatively well integrated and functioned efficiently. However, the Second World War and the subsequent struggle for independence resulted in disintegrated and inefficient markets. It was in the late 1970s that markets in Indonesia returned to a situation which could be spoken of as a national integrated economy with well-functioning markets.
49	Sanogo and Maliki Amadou (2010), Nepal	Rice market integration and food security in Nepal: the role of cross-border trade with India	Food Policy	6	1	None	TAR	Results show that price response behaviour of traders was consistent with an asymmetric price adjustment mechanism, indicating coarse rice prices in Nepal responded to shocks originating in India. Adjustments to negative price deviations from long-run stable equilibrium were also faster than adjustments to the positive ones given a null threshold.
50	Iregui and Otero (2010), Colombia	Testing the law of one price in food markets: evidence for Colombia using disaggregated data	Empirical Economics	9	1	None	Kwiatkowski–Phillips–Schmidt–Shin tests (KPSS), Hadri tests,	This study suggests that market integration is favoured by similarities in terms of both population and economic sizes. The study also found out that the rate of convergence of price differentials to exogenous shocks

							VAR	or innovations, in a context in which trade barriers and exchange rate volatility are absent, is much faster the more perishable a food product is.
51	Serra et al. (2010), Brazil	Price volatility in ethanol markets	European Review of Agricultural Economics	8	1	None	Co-integration, MGARCH	Results show that ethanol producers consider crude oil as a substitute and, consequently, transmit the inflation originating in the crude oil market to the Brazilian renewable fuels market. Increases in sugar prices were also found to increase ethanol price levels and volatility. Given that ethanol markets have strengthened the link between food and energy markets, both sugar and oil prices were found to respond to changes in the other prices in the model.
52	Baquedano et al. (2011), Mali and Nicaragua	World market integration for export and food crops in developing countries: a case study for Mali and Nicaragua	Agricultural Economics	10	2	None	Generalized ECM	Results show that for both its main export and import commodity, Nicaragua is more integrated into world markets and has higher price transmission than Mali. The results for Nicaragua also show much higher integration and price transmission for its main agricultural export (coffee) than its major import (rice).
53	Ghoshray and Ghosh (2011), India	How integrated is the Indian wheat market?	Journal of Development Studies	19	1	Transaction costs, information services	Multivariate-TAR	Results indicate that wheat price signals within states were transmitted over time in an asymmetric manner. This type of price adjusting behaviour was consistent as to how price differentials may respond to poor dissemination of knowledge regarding market conditions and high transactions costs.
54	Serra et al. (2011), USA	Nonlinearities in the U.S. corn-ethanol-oil-gasoline price system	Agricultural Economics	19	1	None	Smooth Transition Vector Error Correction Model	Results indicate the existence of long-run relationships among the prices studied. There were also strong links identified between energy and food prices.

55	Alam et al. (2012), Bangladesh	The dynamic relationships between world and domestic prices of rice under the regime of agricultural trade liberalization in Bangladesh	Journal of the Asia Pacific Economy	10	1	None	Johansen multivariate co-integration, VECM	This paper highlights the dependence of Bangladeshi rice market on the world rice market and underline the need for adequate policies which specifically address the issue of food security when world prices are very high.
56	Asche et al. (2012), Tanzania	Testing the central market hypothesis: a multivariate analysis of Tanzanian sorghum markets	Agricultural Economics	10	1	None	Multivariate co-integration, Johansen co-integration	This article shows that the central market hypothesis can be tested in a Johansen co-integration test provided that prices are non-stationary. The results indicate that Tanzanian sorghum market can be grouped into two market regions, with prices being determined in a central market in each region.
57	Sekhar (2012), India	Agricultural market integration in India: an analysis of select commodities	Food Policy	21	1	Trade policies	Gonzalo–Granger model	According to this paper, commodity markets that do not face inter-state or inter-regional movement restrictions, like gram and edible oils, appear well-integrated. On the contrary, rice market, subject to the maximum inter-state movement restrictions, does not show integration at the national level. The broad implication of the study is that markets can play a more effective role if supplemented with more open policy initiatives.
58	Zant (2012), Malawi	How is the liberalization of food markets progressing? Market integration and transaction costs in subsistence economies	World Bank Economic Review	10	1	Market liberalisation, transaction costs	PBM	The study found out that probabilities of market regimes, computed on the basis of predicted transaction costs, fluctuate significantly and do not support fixed regime probabilities over time. The probability of market integration with trade decreases consistently during food shortages, increasing either the probability of no trade or loss-making trade or the probability of profitable but unexploited trade opportunities. This paper proposed a modification to Baulch's PBM.

59	Götz et al. (2013), Russia and Ukraine	Wheat export restrictions and domestic market effects in Russia and Ukraine during the food crisis	Food Policy	4	4	Export restrictions	Markov-switching VECM	Results show that export restrictions temporarily reduced the degree of integration of Russian and Ukrainian domestic markets in world wheat markets, which pushed the growers' prices below their long-run equilibrium level. Domestic markets were also disconnected from their equilibrium and market instability increased.
60	Weldesensbet (2013), Slovakia	Asymmetric price transmission in the Slovak liquid milk market	Agricultural Economics	18	1	None	Granger causality, Johansen co-integration, ECM	Results reveal that wholesale and producer prices as well as the retail and producer prices were co-integrated, but there was no evidence of co-integration between the wholesale and retail prices. Price transmission in the Slovakian liquid milk market was found to be asymmetric both in the short- and long-run.
61	Baquedano and Liefert (2014), USA	Market integration and price transmission in consumer markets of developing countries	Food Policy	5	29	None	Single Equation Error Correction Model (SEECM), co-integration	Results show that developing countries' consumer markets were co-integrated with world markets. Transmission of changes in both world market prices and real exchange rates to domestic consumer prices was not high. Movement of domestic consumer prices to new equilibrium with world market prices after a shock to the latter was relatively slow.
62	Bor et al. (2014), Turkey	Asymmetry in farm-retail price transmission in the Turkish fluid milk market	New medit: Mediterranean journal of economics, agriculture & environment	10	1	Market power	Co-integration, ECM	Results suggest a positive price asymmetry in the farm-retail price transmission in the Turkish milk market. Co-integration results imply a significant market power in the Turkish fluid milk market. These results support the view that retailers can exercise significant market power.
63	García-Enríquez et al. (2014), Spain	Spatial integration in the Spanish mackerel market	Journal of Agricultural Economics	12	1	None	Co-integration	Results indicate that the Spanish mackerel market was not integrated. There were no links, at least in the long term, between any of Spain's five regional markets. The results have significant implications in policy terms, as local, regional and

								European authorities must take into account the need to apply distinct local policies.
64	Ianchovichina et al. (2014), Saudi Arabia	How vulnerable are Arab countries to global food price shocks?	Journal of Development Studies	12	18	None	Co-integration, VAR	Findings from this study suggest that international food price shocks are transmitted to various degrees into domestic markets. The magnitude of the estimates appears to be in line with empirical evidence for other countries, even though caution is required when interpreting the coefficients' magnitudes given differences in the composition of national and world food baskets.
65	Minten et al. (2014), Ethiopia	Structural transformation of cereal markets in Ethiopia	Journal of Development Studies	11	1	None	TAR	Results show that cereal markets in Ethiopia, over the last decade, have undergone important local changes such as strong economic growth, urbanisation, improved road and communication infrastructure, and higher adoption of modern inputs in agriculture. These changes are associated with better spatial price integration as well as with significant declines in real price differences between supplying and receiving markets and in cereal milling and retail margins. In short, important improvements have occurred in Ethiopia's cereal marketing system.

4.0 Results and discussion

A comprehensive bibliography of the literature on food market integration is presented in Table 1, classified on the basis of the variables mentioned in Figure 1. Each of the variable and the results obtained from the review is discussed in this section.

4.1 Econometric tools/methodology used in data analysis

The frequency of various econometric tools adopted for data analysis in the papers reviewed is presented in Table 2. The majority of the studies used co-integration analysis, followed by parity bounds model, threshold autoregression, vector autoregression, Ravallion, and error correction model in testing food market integration. Others used autoregressive conditional heteroskedastic regression, threshold co-integration, and Johansen co-integration and vector error correction models. Less popular econometric tools are also shown in Table 2; they include coefficient of variation, multivariate generalized autoregressive conditional heteroscedasticity, multivariate co-integration, Granger-causality, Markov-switching vector error- correction model, seemingly unrelated regression error and many others.

Table 2: Summary of results on literature review of food market integration studies

Variable	No. of studies
Econometric tools/methodology used in data analysis (multiple response)	
Model	
Co-integration	23
Parity bounds model (PBM)	7
Threshold Auto-regression (TAR)	4
Vector auto- regression (VAR)	4
Ravallion	4
Error correction model (ECM)	4
Autoregressive conditional heteroskedastic regression (Gluschenko and Karchevskaya)	3
Threshold co-integration	3
Johansen co-integration	3
Vector Error correction model (VECM)	3
Coefficient of variation	2
Multivariate generalized autoregressive conditional heteroskedasticity (MGARCH)	2
Multivariate co-integration	2
Granger-causality	2
Markov-switching vector error- correction model	2
Extended Parity Bounds Model	2
Seemingly unrelated regression Error (Goletti and Babu)	2
Other econometric tools*	14
Total	86
Other econometric tools include: Threshold regression, Switching regime regression, momentum threshold auto-regressive models, autoregressive distributed lag model, correlation, Johansen multivariate co-integration, Timmer, generalized error correction, single equation error correction model, smooth transition vector error correction model, Kwiatkowski–Phillips–Schmidt–Shin, seemingly unrelated regression-augmented Dickey-Fuller, Gonzalo–Granger model, and error correction representation.	
Year wise classification of studies	
Year	
1990-1994	7
1995-1999	15
2000-2004	11
2005-2009	14

2010-2014	18
Total	65
Country wise distribution of studies	
Country	
USA	6
China	5
Ethiopia	4
Ghana	4
India	3
Indonesia	3
Russia	3
UK	3
Brazil	2
Burkina Faso	2
Malawi	2
Tanzania	2
Vietnam	2
DRC (Zaire)	2
Benin	2
Germany	2
Other countries*	18
Total	65
Other countries include: Bangladesh, Canada, Colombia, Italy, Madagascar, Mali, Mozambique, Norway, Philippines, Slovak, Slovenia, Spain, Turkey, Uganda, Ukraine, Nepal, Niger and Saudi Arabia	
Number of years taken as a sample data set	
Number of sample years	
1-5	22
6-10	17
11-15	14
16-20	6
21-25	3
26-30	1
More than 51	2
Total	65
Number of countries considered for study	
Number of sample countries	
1-10	60
11-20	4
21-30	1
Total	65
Sources from where literature was collected	
Journal name	
Agricultural Economics	12
American Journal of Agricultural Economics	10
Food Policy	6
Journal of African Economies	6
Journal of Development Studies	6
European Review of Agricultural Economics	5
Journal of Development Economics	3
Applied Economics	2
Journal of Agricultural Economics	2
Other journals*	13
Total	65
Other journals include: World Bank Economic Review, Journal of Economic History, Oxford	

4.2 Year and country wise distribution of studies

Although the trend in food market integration has been fluctuating, with least researches recorded in early 1990s, there has been a general increase in research in this field since mid-2000s. It can be observed from Table 2 that the majority of the studies were conducted in the period between 2010 and 2014. More than 50 percent of the reviewed work was done in the last 10 years of the study period, i.e. from 2005 to 2014.

Country wise distribution of the studies is also shown in Table 2. Out of the 65 papers, 6 were from USA, 5 from China, Ethiopia and Ghana had 4 papers each, India, Indonesia, Russia and UK each had 3 papers. Countries that had two studies each are Brazil, Burkina Faso, Malawi, Tanzania, Vietnam, Democratic Republic of Congo (DRC), Benin and Germany. The rest of the countries under the category of “others” each had only one study.

4.3 Number of years taken as sample

Table 2 further describes the number of years considered as sample for each study. Most studies had a sample size of less than five years. Out of the 65 studies, 53 had datasets with time frame between one and 15 years and six had datasets falling between 16 to 20 years. Three studies had datasets falling between 21 to 25 years. Only one study had a dataset of 26 to 30 years. The remaining two studies had datasets with more than 51 years each.

4.4 Number of countries considered for study forming sample data

The number of countries considered for each study is shown in Table 2. These results reveal that all the papers sampled covered less than 30 countries. Out of the 65 papers, 60 used less than ten countries in their analysis. Four studies sampled 11 to 20 countries and only one study covered a sample of between 21 and 30 countries. The majority of the studies sampled less than ten countries possibly because of scarcity of data on food markets in some countries.

4.5 Sources of data collection

The papers reviewed were collected from different A1 journals as summarized in Table 2. Results show that most of them (12 out of 65) were collected from Agricultural economics journal, followed by American Journal of Agricultural Economics, Food Policy, Journal of African Economies, Journal of Development Studies, European Review of Agricultural Economics, Journal of Development Economics, Applied Economics and Journal of Agricultural Economics. The remaining 13 papers were collected from other journals as shown in Table 2.

4.6 Determinants of market integration

Several factors can increase the degree of integration of food markets, these include: physical infrastructure, information, institutions, competition, market power, trade, social capital and policies, which facilitate market exchanges (Table 3). The transaction costs associated with these factors are the key determinants of market integration. These factors or determinants of market integration operate by lowering transaction costs that affect the flow of goods and information between markets. In this section, we present an analysis of the determinants of market integration, as per the extensive literature review. We further present some questions related to food market integration that can be addressed by future research.

Table 3: Determinants of market integration

Variable	No. of studies	Percentage
Studies that addressed determinants of market integration		
Yes	26	40
No	39	60
Total	65	100
Determinants of market integration identified in the studies (multiple response)		
Determinant		
Roads (distance, quality, rehabilitation, transport facilities, fuel prices)	8	17.4
Trade (policies, volumes, restrictions, quality, seasonality)	8	17.4
Transaction costs	8	17.4
Market liberalisation	7	15.2
Infrastructure (physical, market and communication)	6	13
Government intervention	2	4.3
Information services	2	4.3
Inflation	1	2.2
Inventory management	1	2.2
Market institutions	1	2.2
Means of communication	1	2.2
Urbanisation	1	2.2
Total	46	100

4.6.1 Physical infrastructure

A market is a complex institution and its performance depends on numerous factors. One of the most important factors is the quality of roads or physical infrastructure. Poor roads lead to an increase in transportation costs in the following ways: higher fuel consumption, higher maintenance costs, faster depreciation of vehicles, tyre replacement costs, and loss of time due to lower speeds (Taravaninthorn and Raballand, 2009). Some studies have quantified the effect of road quality on transportation costs and market integration. One of the studies conducted in Rwanda showed that a road improvement project reduced the price differences between two markets and increased the correlation of their prices over time (Loveridge, 1991). Another study by Minten and Kyle (1999) found that transportation cost was twice as high on poor roads as on paved roads in Zaire (now Democratic Republic of Congo). The higher cost of transportation on poor roads resulted in lower prices received by farmers on selling their crops. Generally, most studies have been on how the quality and distance of physical infrastructure affects the degree of market integration.

4.6.2 Market institutions and information

Institutions and information are very important determinants of transaction costs and market integration (Rashid and Minot, 2010, Muto and Yamano, 2009, De Bruyn et al., 2001, Worako et al., 2008). In the absence or incomplete or missing institutions, personalised market transactions are very common. But if market institutions are functional, then personalised transactions are rare (Aker, 2009, Goyal, 2010, Geertz, 1996). Market information is essential for location of buyers and sellers. Sometime back, in rural areas of developing countries, information flow was by word of mouth and through informal channels. Currently, however, the importance of radios, televisions, newspapers and telephones is increasing. Because of high illiteracy levels, a radio is the most important mechanism for farming communities to obtain information on agricultural markets. There is also a rapid expansion in the use of mobile phones among farming communities and traders (Jensen, 2007, Jensen, 2010, Bayes, 2001, Abraham, 2006, Donner, 2008, Muto and Yamano, 2009). With

the popularity of mobile phones in agriculture, there is no doubt that information on prices is exchanged faster than it used to be sometime back. There are studies which have been conducted on mobile phone usage in food markets (Abraham, 2006, Muto and Yamano, 2009). However, more research is still needed on how mobile phone popularity has affected the degree of integration of food markets. From our review, we did not get clear answers to this research question.

4.6.3 Competition and market power

Whereas some studies suggest existence of market power in food markets, others suggest otherwise. A study by Abdulai (2000) found asymmetry in price transmission in Ghana, suggesting some market power. Bor et al. (2014) also found asymmetry in farm-retail price transmission in Turkish milk markets, implying significant market power. Osborne (2005) found evidence of imperfect competition among wholesalers in smaller markets which were isolated from the main cities in Ethiopia. The impact of imperfect competition, however, was modest, reducing producer prices by 3 percent. On the other hand, Goletti and Babu (1994) did not find any asymmetry in maize markets in Malawi. From this review, it is not obvious what the effect of a lack of competition and presence of market power should be on the degree of integration. A marketing structure that is more concentrated is likely to achieve certain economies of scale in trade and information, which can lower costs. On the contrary, markets that are less competitive could restrict flows in order to raise prices and profits (Goodwin and Schroeder, 1991). More empirical research is required to clarify these issues.

4.6.4 Trade

A larger volume of inter-regional trade should lead to a higher degree of integration since it contributes to reducing transaction costs (González-Rivera and Helfand, 2001). Some studies demonstrate that per unit transportation costs are an inverse function of volume (Jensen, 2010, Gabre-Madhin, 2001). There are quantity discounts due to factors such as use of larger trucks, lower per unit costs of loading and unloading larger quantities and reduced logistical costs. There are also studies which show that large volumes of trade do not necessarily generate high degree of integration (Klaes, 2000, Somda et al., 2005). Trade, as a determinant of market integration, still needs to be studied further. There is need to study how factors like demand and supply, which are related to trade, can affect the degree of integration (Gonzalez-Rivera and Helfand, 2001, Key et al., 2000). Also, more research into the combined effect of all the three, i.e. demand, supply and trade, on market integration is needed.

4.6.5 Social capital

Social capital relates to trust and networks that allow people to cooperate (González-Rivera and Helfand, 2001). It is a factor that can lower transaction costs of information flow, monitoring and enforcement. Social capital in form of networks can increase information flow and productivity. Also, social capital in form of trust can lower transaction costs and facilitate trade flows. Social capital, therefore, is very relevant to the study of market integration. More empirical research on how social capital influences price transmission and market integration needs to be done. To date, very little research has been done on how this determinant affects market integration.

4.6.6 Public policies

Policies by governments directly or indirectly affect food markets. Examples of public policies include public/government intervention in food markets and export restrictions/bans. Below we discuss the relationship between these policies and market integration.

Public/government intervention

Governments in many countries, especially in Africa, continue to intervene heavily in food markets. These interventions are done by state enterprises. Countries with high level of state interventions in food markets include Ethiopia, Kenya, Malawi, Zambia, China and Indonesia (Rashid and Minot, 2010). Other countries with some level of state intervention include Tanzania, Mozambique and Uganda. Typically, intervention by governments is aimed at maintaining grain stocks for emergency use. It is also an attempt to stabilise grain prices and provide grain to remote deficit areas. Depending on the motive, government intervention may either improve or hinder the integration of food markets. For the case of China, this intervention has been a major hindrance to market integration (Zhou et al., 2000, Park et al., 2002). On the other hand, Indonesian government's intervention in terms of rice procurement has improved the integration of rice markets in the country (Alexander and Wyeth, 1994, Ismet et al., 1998). Government intervention has both positive and negative effects on market integration. The relationship between government intervention and price transmission still needs further research.

Export restrictions/bans

In the presence of export bans/restrictions, food markets do not operate freely between countries. Even market information does not move freely, which affects market integration. There are countries, like Tanzania, which have followed a practice of banning food exports following poor harvest to ensure that local supplies go to deficit areas within the country (Rashid and Minot, 2010). Kenya maintains high import duties on maize from outside the East African Community, and has imposed temporary restrictions on maize imports from East African Community countries to protect its farmers (Rashid and Minot, 2010). Generally, export bans/restrictions are not good for food markets. They reduce the degree of market integration. This needs to be proved further by research. More issues that need research include effect of export restrictions on price volatility and price transmission in food markets.

From our analysis, we appreciate the work that has so far been done on determinants of market integration. However, we have also found out that there is still a lot that needs to be done in order to address the issues that have been raised.

5.0 Conclusions and future research

The objectives of this review were to: analyse the state of the art research on food market integration; classify it; and provide a perspective for future research. The contribution of research work in food market integration during the period under study, i.e. 1990 to 2014, has been increasing continuously. This is especially evident from 2009 to 2014. Much of the work has concentrated on countries like USA, Ethiopia, China, Ghana, India, Russia and Malawi. However, there are many countries which have not caught the attention of researchers in this field. Future research should therefore include countries which have not been covered. Sample data and sample countries considered for future research should be altered to notice any variation in research results.

We have also noted the growth in research in food market integration. However, little has been done regarding application of this research. The majority of the research has concentrated relatively more on identifying the degree of linkages among markets.

We also appreciate the work that has been done on determinants of market integration and, hence, identified the following factors as very important: physical infrastructure, market institutions, information, competition, market power, trade, social capital, public/government

intervention and export restrictions/bans. Notwithstanding the work that has been done on market integration, there is still much that needs to be done. Future research on food market integration should address the following questions. How does the quality of physical infrastructure/roads affect the speed of adjustment of markets in case of a shock? How has the popularity of mobile phone use among the farming communities affected the degree of food market integration? How does trust and networking among farmers and traders influence price transmission and market integration? What is the effect of export restrictions on price volatility and price transmission in food markets?

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