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Essays on Agri-food markets in West and Central Africa

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Dedication

This work is dedicated to my BELOVED daddy, whom I love beyond any words FOREVER, who has been my EVERYTHING and BEYOND, more than the best thing EVER in the world. Words and description could NEVER qualify nor quantify, even beyond the end of time.

To my lovely siblings.

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Kiel, 2021

Akem Nina Fabinin

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List of Abbreviations

ADF	Augmented Dickey Fuller Test
AfCFTA	African Continental Free Trade Area
AUC	African Union Commission
BEAC	Bank of Central African States
ECM	Error Correction Model
FAO	Food and Agriculture Organization
FAOSTAT	Food and Agriculture Organization Corporate Statistical Database
FCFA	Franc of the French Community of Africa
FE	Fixed Effect
FFB	Fresh Fruit Bunches
GDP	Gross Domestic Product
IFPRI	International Food Policy Research Institute
IMF	International Monetary Fund
ISS	Institute for Security Studies
LDC	Least Developed Countries
LOP	Law of One Price
MAEP	Ministry of Agriculture, Livestock and Fisheries (Benin)
MTN	Mobile Telephone Network
OECD	Organization for Economic Co-operation and Development
PADA	Agriculture Productivity and Diversification Project (World Bank)
RE	Random Effect
SSA	Sub-Saharan Africa
USD	United States dollar
USDA	United States Department of Agriculture
VECM	Vector Error Correction Model
WFP	World Food Program
WHO	World Health Organization
XOF	West African Cfa Franc

Abstract in English

The cumulative dissertation presents eight contributions that attempt to shed light on the issues regarding price transmission and cost pass-through on agri-food supply chains and value chains in West and Central Africa.

Given recent attempts on trade expansion in Sub-Sahara Africa, price signals are of crucial importance for the success and better performance of markets as they still account for a small percentage of global trade. To this end, chapters 2, 3 and 4 investigate domestic and regional markets across food categories (pulse, root and tubers, cereals, fruit, vegetables, meat and fish, staples) using time series and panel models. Findings lend support to the underlying necessity to explore market opportunities that can facilitate more symmetric price responses and boost market performance for broader outcomes. With rapid globalisation and the adoption of new information and technologies whereby payments are increasingly becoming cashless, chapter 5 and 6 investigate the impact of price transmission on the vertical food chain. Using a panel error correction model, findings from chapter 5 show that the use of cashless payments is associated with faster speeds of disequilibrium adjustments back to the long-run equilibrium. To account for non-linearities, chapter 6 further investigates the impact of mobile money on asymmetric price transmission. It is empirically revealed that the adjustment speeds become more symmetric when more transactions are done cashless. Price adjustment paths favour the wholesaler for more cash transactions. This shifts to the retailers when more transactions are cashless. Given the pressures on oilseed crops and their oil markets downstream for alternate uses beyond food, Chapters 7, 8 and 9 examine the value chains vertically, as well as spatial price linkages in these markets. To the extent of these food chains' significant convergence of producer prices and price flow trends, empirical insights largely point to the correlations between the upstream and downstream markets.

Abstract in German

Diese kumulative Dissertation umfasst acht Beiträge, die versuchen, Fragen der Preisübertragung und Kostenweitergabe innerhalb von Agrar-, Lebensmittelversorgungs- und Wertschöpfungsketten in West- und Zentralafrika zu beleuchten.

Angesichts der jüngsten Versuche zur Handelsexpansion in Subsahara-Afrika sind Preissignale von entscheidender Bedeutung für den Erfolg und die bessere Performance der Märkte, da diese immer noch nur einen kleinen Prozentsatz des Welthandels ausmachen. Daher untersuchen die Kapitel 2, 3 und 4 die inländischen und regionalen Märkte über Lebensmittelkategorien hinweg (Hülsenfrüchte, Wurzeln und Knollen, Getreide, Obst, Gemüse, Fleisch und Fisch, Grundnahrungsmittel) anhand von Zeitreihen und Panelmodellen. Die Ergebnisse unterstützen die zugrunde liegende Notwendigkeit, Marktchancen zu erforschen, so dass symmetrischere Preisreaktionen ermöglicht werden und die Marktleistung zur Erzielung besserer Ergebnisse gesteigert werden kann. Angesichts der rasanten Globalisierung sowie der Einführung neuer Informationsmöglichkeiten und Technologien, bei denen Zahlungen zunehmend bargeldlos werden, untersuchen die Kapitel 5 und 6 die Auswirkungen der Preisübertragung auf die vertikale Nahrungskette. Mit Hilfe eines Panelfehlerkorrekturmodells kann in Kapitel 5 gezeigt werden, dass die Verwendung bargeldloser Zahlungen mit einer schnelleren Geschwindigkeit von Ungleichgewichtsadjustierungen zurück zum langfristigen Gleichgewicht verbunden ist. Um Nichtlinearitäten zu berücksichtigen, untersucht dann Kapitel 6 die Auswirkungen von mobilem Geld auf die asymmetrische Preisübertragung. Es wird empirisch gezeigt, dass die Anpassungsgeschwindigkeiten symmetrischer werden, wenn mehr Transaktionen bargeldlos erfolgen. Preisanpassungspfade begünstigen den Großhändler im Falle von Bargeldtransaktionen. Dies verlagert sich auf die Einzelhändler, wenn mehr Transaktionen bargeldlos durchgeführt werden. Angesichts des Drucks auf Ölsaaten und Öl, deren Ölmärkte

für alternative Verwendungen über Lebensmittel hinaus nachgelagert sind, untersuchen die Kapitel 7, 8 und 9 die vertikalen Wertschöpfungsketten sowie die räumlichen Preisverknüpfungen in diesen Märkten. Das Ausmaß der signifikanten Konvergenz der Erzeugerpreise und der Preisflussentwicklung in diesen Lebensmittelketten lässt gemäß empirischer Erkenntnisse weitgehend auf die Korrelationen zwischen den vor- und nachgelagerten Märkten schließen.

Chapter 1

Introduction and Summary

As agriculture is a mainstay activity for countries in Sub-Saharan Africa (SSA), market reforms continue to be of major importance as can be seen even more recently with the effort to expand the integration of markets and trade activities through free trade agreements (AfCFTA). Regional continental trade is important for Africa's integration into global value chains (Zeufack et al., 2021). The proper functioning of these agri-food markets is vital for economic development (FAO et al., 2011) as these markets may be underperforming and exhibiting unstable price patterns (Dillon and Barrett, 2017; Varela et al., 2016; Timmer, 2017). An understanding of their functionality is necessary to provide insights for trade policy across supply chains and value chains. Hence the first contribution examines spatial and vertical market linkages in selected West African countries.

In the region of West Africa, disintegrated value chains with minimal coordination vertically and spatially are notable (Hollinger and Staatz, 2015). This has been emphasised as the World Bank and FAO (2021) have underscored the promotion of international food value chains in an attempt for pro-food security agendas, and even better with the use of digital technologies, more so after the impacts of COVID-19 on the functioning of economies. As trade challenges including unaffordable pricing may compromise the broad development and food security

efforts in developing countries, consequently, the second contribution analyses the market for several food categories (root and tuber, cereals, meat and fish, other staples). The expansion of value chains may be able to create access for higher value chain niches across national and international markets, also for smallholder farmers that populate agri-food markets in developing countries (Staatz and Dembélé, 2008).

As agri-food markets have associated links with health (Hawkes and Ruel, 2007), more affordable pricing can increase healthy consumption especially for low-income households in developing countries as poorer countries have been noted to be more sensitive to price changes (Seale and Regmi, 2006). Hence the consumption of fruits and vegetables have been underscored given its plethora of health benefits (FAO, 2020). However, considering that consumption leaves more to be desired, the productivity outcomes and measures can be significantly augmented by the performance of their markets as an important factor, and it is hence essential to consider these economic related analyses for aggregate understanding attempts of these food systems (FAO, 2020). Better performing markets across food supply chains can provide a step towards strategic development policy efforts for food security through availability, accessibility, and affordability, given more choices. As vegetables and fruits are particularly essential for health in combating malnutrition or other health related issues, with an impending need to promote short chain markets (FAO, 2020), and given that the prices for fruits and vegetables have been posited to fall in Benin (World Bank and FAO, 2021), the third contribution examines long-run and short-run dynamics of pricing behaviour in these markets.

With globalisation and the emergence of new technology and information for an upcoming cashless society in Africa, and the possible impact for markets and consequent techno-

development, the fourth and fifth contributions hence subsequently examine the impact of digital technologies on an agri-food market given its importance for the functioning of markets and associated development for the economy. Advances in this new information technologies have the potential for improving techno-economic development and improving market performance (Jack and Suri, 2014; Aker and Fafchamps, 2015).

The evidence for food supply and value chains is notably relatively sparse in the region of SSA (Elbehri et al., 2013). For international markets, Mofya-Mukuka and Abdulai (2013) found evidence for varying price responses in some regional African markets (Zambia and Tanzania), while Dillon and Barrett (2017) even more recently, detail market failures in SSA. In this light, a sixth contribution examines domestic and regional agri-food markets.

According to the World Bank (2020), Africa accounts for only about 3% of global trade. Domestic and international (regional) value chains for oilseed crops are further examined in a seventh, and eighth contribution given market pressures for oilseed crop uses that may draw attention for the proportion available to food uses (USDA, 2018; OECD-FAO, 2019). The contributions consider countries in both West Africa and Central Africa.

Pulse, Export and Staple Convenience Food: Market Analysis in West Africa

As changing price signals and trends are necessary for the performance of markets in developing countries, examining market adjustments to price shocks across agri-food chains is essential for informing trade development policy.

The study evaluates market inter-dependencies between regional and domestic markets using a vector error correction model. Employing time series data sets from the Ministry of

Agriculture, Livestock, and Fisheries in Benin, and the National Federation of Benin Cashew Nut Producers, symmetric and asymmetric analyses are utilised for spatial cowpea (*Vigna unguiculata*), cashew (*Anacardium occidentale*), cassava (*Manihot esculenta*) and value-added commodity markets.

While value addition is found to be associated with price transmission rates, the differentiated commodities on the chain have lower price transmission rates compare to other commodities. Further, price transmission in intra-regional domestic markets is about as high as for regional markets.

Food Markets and Price Responses: Panel Evidence from a developing Economy market

Given the food needs in developing countries and long-standing development efforts in this light, the study examines the market for several food categories with diverse nutrient sources and significant nutritional values across the classes of food nutrients (proteins, carbohydrates, water, vitamins, minerals, fiber and fats).

Using a recent panel data set from the Ministry of Agriculture, Livestock, and Fisheries in Benin, the study utilises panel estimation techniques with a model that augments the error correction for disequilibrium adjustments. Empirical results show heterogenous effects across food categories and differentiated food commodities.

Functional Food Markets: Panel Evidence from Benin

As food prices are pivotal to access to food, particularly healthy food in developing countries, the study examines the market for fruits and vegetables that have enormous health benefits across malnutrition and obesity amongst others.

The study employs a panel data set from the Ministry of Agriculture, Livestock, and Fisheries in Benin using a panel error correction model to examine market dynamics for this food.

Findings show associations for both fruits and vegetable food in markets.

Mobile Money and Price Transmission: Panel Evidence from Cameroon

As payments are increasingly becoming cashless, this might mean new dynamics for the flow of prices and price signals in agri-food markets that need to be analysed. We employ a recent panel data set from Cameroon for the oil palm market.

Using panel estimation techniques, we find empirical evidence of reduced mark-ups and retail prices that are associated with cashless payments.

Mobile Money and Asymmetric Price Transmission: Panel Evidence from Cameroon

As mobile money is a pivotal cashless instrument in the region of SSA, we further examine the market dynamics and price transmission process considering non-linearities. We employ panel estimation techniques using an asymmetric error correction model.

We empirically find that price responses vary for positive and negative equilibrium discrepancies in markets. More precisely, we find that the speed of adjustment is more symmetric when more payments are using mobile money.

Cost pass-through in the oil and oilseed market: Panel Evidence from West Arica

Demand pressures on oilseed crops beyond food uses may have direct effects on the pricing of oilseed upstream and oil commodities downstream. Further, even domestically and regional for spatial and vertical markets. Understanding the market is important to guide informed policy efforts.

The study employs a panel data set across five West African countries using panel estimation techniques and empirically show heterogeneous effects in markets. Spatial infrastructural allocations can affect market participation.

By what difference: Price transmission in the palm oil value chain in Cameroon

Given that changing commodity forms and the nature of commodities can influences pricing, price signals and consequent price flows, the study examines the price transmission on the value chain of an important cash crop in Cameroon.

Employing a panel data set and panel estimation techniques, we empirically find that markets for value-added and commodity transformed products downstream are correlated with the upstream markets.

Spatial Price Flows in Domestic Markets: Panel evidence from the Soybean market in

Benin

The study examines horizontal market relationships comparatively across different regions of the country. For the homogenous product market, we employ panel data utilising an error correction framework. Findings empirically show that the direction of trade flows influences price transmission. Further, the magnitude of trade transactions can directly influence price flows in different directions.

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Chapter 2

Pulse, Export and Staple Convenience Food: Market Analysis in West Africa

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Abstract

Recent expansion of trade measures across countries in Sub-Saharan Africa provide market opportunities for the agri-food sector. However, price signals and changes across domestic and regional continental markets are a factor to boost the success and performance of these markets. Examining commodity market adjustments to price shocks are essential for insights to boost trade performance. Using prominent food categories of the agricultural sector in this region, the study examines market dynamics between pulses, export, and other staple convenience food crops. Spatial analysis evaluates market inter-dependencies between regional and domestic markets using a vector error correction model. Symmetric and asymmetric estimations are done in each market for comparison purposes. Findings suggest heterogenous market effects across commodities horizontally and vertically for value-added product forms on the food chain. Price transmission is slower for differentiated commodities compared to other value-added products, and broadly higher for value added commodities. In domestic intra-regional markets, price transmission is about as high for regional continental markets, while the extend in inter-regional domestic markets is varied by the commodity niche on the value chain. Tailored market development policies can better the overall functioning of agri-food markets and boost the convergence of markets as well as trade integration and expansion.

Keywords: Agricultural markets, Value-addition, Price linkages, West Africa

JEL: C22, Q11, Q13, Q18

2.1 Introduction

The need for continental economic integration and trade expansion has attracted recent interest in Sub-Saharan Africa (SSA) and agri-food markets, such as the African Continental Free Trade Area (AfCFTA). Such trade agreement measures substantiate the need for enabling domestic and cross-border policies that can facilitate the implementation needed. Understanding the trade sector in the region might be necessary for guided development and market policy insights towards the market and trade expansion potentials for streamlining border measures and its trade policy reforms. These insights can facilitate complete reforms for specific and aggregate measures that maximise trade potentials. AfCFTA comes with gains in all sectors (World Bank, 2020). Despite potential to boost productivity and resource allocation across sectors and countries, output in agriculture might however face contractions relatively, with declining output by the mid 2030s despite growing faster in the regions of SSA (World Bank, 2020).

Trade expansion and integration across borders has the potential of lifting about 30 million people from extreme poverty while providing more employment in agriculture (World Bank, 2020). Access to agricultural markets is notably vital in supporting poverty alleviation strategies and the broad development agenda for SSA, which has been the talk for decades (Barrett, 2008; Taylor et al., 2009).

Growth rates in the agricultural sector have not been able to meet poverty reduction goals in West Africa (Hollinger and Staatz, 2015). The integration of markets and expansion of trade can offer opportunities towards better profits and incomes as the poor obtain access to higher value chains. Trans-border trade in this region is yet inefficient (Elbehri et al., 2013).

Relevant output losses have been incurred in recent times with a steep fall in commodity prices (World Bank, 2020). With population pressures and increasing global food demand (Berger, 2017), there is an impending need and opportunity for output and market expansion potentials that are yet unexploited. Recent crisis such as the pandemic contribute to food insecurity as food prices face an upward trend in many areas, with heterogenous impacts across countries (World Bank, 2020). Border closures have disproportionately affected particularly small-scale cross-border traders and those in the agricultural sector, hence showing the shortfall in trade facilitation measures domestically and across the borders (World Bank, 2020). Food price trends, signals, and volatility are vital in the effort towards alleviating rural poverty for farmers (Timmer, 2017).

Africa constitutes less than 3 percent of trade globally (World Bank, 2020). The markets for traditionally consumed export crops, pulses and other food staples can have food security implications in SSA, as well as for income generation, employment, and alleviating poverty incidences (e.g see Elbehri et al., 2013; Snapp et al., 2018); existing challenges with long-standing strategies and efforts towards being curbed.

Notably, market opportunities exist for West African food producers following from amongst others increasing output prices as well as dietary aspirations (Hollinger and Staatz, 2015), but are these food markets integrated? Inadequate market links in food markets offset long-standing pro-poor development strategies (Taylor et al., 2009), as even more recently, several countries in West Africa have been flagged for caution on impending food insecurity (WFP and FAO, 2021), despite existing agricultural engagement levels. Rising food prices in recent times can significantly impact food access, and the vulnerability of households to food insecurity consequently (WFP and FAO, 2021).

Literature has posited that if producers can practice free trade arbitrage, the convergence of markets can be facilitated (Cachia, 2017). We hence employ producer prices in this study to examine market dynamics in these markets.

Pulses and other food staples, as well as export cash crops can together broadly signify an important component of the food chain and agricultural sector of the economy in SSA, with domestic and cross-border trade and market potentials that can boost the sector. While export crops can generate foreign exchange revenue, staple foods produced and consumed domestically support the survival of local trade and farmers. Understanding the market of basic staple and pulse food can provide development policy insights to better the hunger situation through better affordability, availability, and accessibility. Understanding the market for an export has implications towards intraregional and international trade for foreign exchange earnings and growth of the economy especially for developing countries; further enhancing market participation that can provide the potential to boost income per capita and alleviate existing poverty levels. Changing product forms and value addition can affect pricing behaviour in markets (Larsen and Asche, 2011).

Unlike previous literature, the study examines the price transmission at various stages each of the value chain and when value is added by changing commodity form: This is important in analysing the performance of the market given that value addition can require additional cost and strategies that influence market processes and functioning (Swinnen and Vandeplass, 2014). Given prospects and opportunities for regional continental trade in the SSAn region, the current study examines cross-border regional trade among selected West African countries for plausible insights that can guide trade expansion opportunities. Considering Cachia (2017) and

Mofya-Mukuka and Abdulai (2013), who analyse price transmission across borders employing error correction and threshold cointegration models using time series data, the current study differs in accounting for non-linearities employing regional level price data between selected countries in West Africa using a Vector Error Correction Model (VECM). Adopting such multi-dimensional framework could be useful in situating correlations among shocks to prices at the regional level (Cachia, 2017). The current study additionally analyses spatial price linkages for possible policy insights on price stabilisation measures to better market functioning and enhance participation. As food consumption patterns are similar across SSA with similar growth rates reported in West Africa that influences consumption (von Braun and Paulino, 1990), findings could support generalisability across the region (e.g., in the case of pulses) and the possibility for comparisons with other regions. Additionally, the current study examines and compares domestic intra-regional markets, domestic inter-regional markets, and regional continental markets.

Understanding these markets is important as they constitute raw material base on the supply side for other food, industrial and livestock products. The love of variety by consumers and consumer preference have been associated with diversification and alternate product forms (see theories of industrial organisation e.g Hotelling, 1929; Lancaster, 1966). Cashew (*Anacardium occidentale*) production is notably prominent in Africa, with about 80% production in the region of West Africa (Hollinger and Staatz, 2015). Cassava (*Manihot esculenta*) and its value-added products, as well as cowpea (*Vigna unguiculata*) are crucial in diets and largely consumed as basic staple and convenience food and pulse in Benin respectively (Katsumata et al., 2007). The study examines cross-border trade for an export crop (cashew), and domestic trade for pulse food (cowpea) and other basic convenient staples (cassava and its value-added products) nationally.

The study hence attempts to contribute to extant literature by (a) examining market adjustment responses to ascertain the presence of any key players that can influence the growth and pace of regional integration and hence aggregate regional market expansion, (b) establish producer price mechanisms for basic staple foods and the convergence of these markets towards the welfare of market participants, (c) link adjustment responses for diversification and differentiation on the value chain of basic food staple and convenience food of domestic origin, hence the potential for expanding its market and promote local market participation. Processing on the cassava value chain is dominated by the artisanal sector and small-scale operators, providing employment to many (Hollinger and Staatz, 2015), (d) the study compares the price mechanisms for the markets of an export cash crop, pulses, and a traditional staple convenience food crop. Many value chains are disintegrated with negligible spatial and vertical coordination, as well as unstable links across actor niches in this region (Hollinger and Staatz, 2015), (e) the study compares domestic markets intra-regionally (e.g for cowpea), inter-regionally (tapioca, ordinary garri, fine garri), and regional continental markets (cashew).

The remaining part of the study is organised as follows. Section 2.2 and 2.3 present the markets and a review of literature respectively, section 2.4 presents the data and statistics, section 2.5 presents the method, section 2.6 and 2.7 present the findings and discussion respectively, while section 2.8 concludes with policy insights and limitations.

2.2 Markets for Cassava, Cowpea and Cashew in Benin and West Africa

While Africa aggregately accounts for a great share of cashew production globally, about 80 percent of its production is accounted for by West Africa (Hollinger and Staatz, 2015). However, it occupies a small trade share in the global market despite cashew constituting a major commodity player in the global market and an export commodity for foreign exchange in this region (Hollinger and Staatz, 2015). The region's share in the world market is on an upward trend, further with growing international, and domestic demand typically from countries like Benin and Nigeria amongst others (Hollinger and Staatz, 2015). The cashew industry exhibits growth potential and keeps attracting interest (Hollinger and Staatz, 2015).

In export trade, West African cashew and cassava exports grew higher than the rest of the world, and these portend promising prospects for the expansion of regional and global markets and offering market opportunities in the coming years (Hollinger and Staatz, 2015). This can offer a strategic path toward trade integration. The share of cassava production for non-food uses has also been on the rise in recent decades, but however, for major cassava producing countries in the region such as Benin, growth rate has been at a relatively slower rate, yet literature on the cassava staple value chain is relatively sparse in the region generally (Elbehri et al., 2013). Demand prospects are notably prominent in the cashew market while the cassava value chain has insights for the opportunities and challenges of West African agriculture (Hollinger and Staatz, 2015).

Pulses as part of staple crops are prominent in West Africa with cowpea as the most important of pulses in the dry parts of the Tropical Africa (Snapp et al., 2018). Cassava and cowpea as basic staple food are vital in food diets and nationally consumed across Benin (Katsumata et al., 2007).

Growth in the consumption of cassava and its value-added products, as well as pulses especially cowpea, exhibit growth per capita despite projected decreases in yield in the case of cowpea. These can constitute market implications for the welfare of market actors (Hollinger and Staatz, 2015). Considering a growing and diversifying market in West Africa, the integration of its markets domestically and internationally has development prominence and trade and market opportunities especially given that eleven of the countries in this region are on the LDCs list (Lauzon and Bossard, 2006).

2.3 Literature Review

The literature on global agri-food value chains and price transmission is burgeoning and an important area of research interest is on the transformation of products especially in Sub-Saharan Africa where this niche remains insufficiently exploited despite market and livelihood potentials particularly for the small-scale farm producers. As pricing is a critical factor for food markets in SSA, an understanding of the performance of these markets is important for the strengthening of price policies that can support welfare on the production and consumption sides through food availability, affordability, and accessibility, and an overall attempt for pro-poor hunger alleviating measures. This can be further buttressed by the presence of food commodity alternatives that diversify food production lines creating more income streams whilst the possibility of managing post-harvest losses in the case of perishable commodities especially, as well as increasing consumption choices for consumers.

Recent literature has taken interest in the value-added chain of agri-food commodities, examining the transmission of prices on the vertical chain (e.g., Gizaw et al., 2021). Important questions that could be asked include (a) what happens to the transmission of prices in the long run when a product is transformed in form? In another case, (b) what will be the adjustment

responses to shocks for value added transformed commodities? Additionally, given the possibility for non-linearities in markets (c) what is the nature of linear adjustments compared to non-linear adjustment responses given the direction, speed, and magnitude of the adjustments (see Meyer and von Cramon-Taubadel, 2004). Examining the asymmetric price transmission process is hence important to further detail the price mechanism for rising and falling prices. Gizaw et al. (2021) have examined the fresh and smoked salmon value chain. Findings empirically show some level of asymmetric adjustments for the unprocessed fresh salmon value chain.

If we talk of cross-border trade, the integration of markets is also key to its performance, as the prices tend to converge if producers freely practice arbitrage (Cachia, 2017). Understanding the pricing and the transmission of prices is essential for policy (von Cramon-Taubadel, 2017). Compared to Asia and Latin America, Conforti (2004) empirically found that African markets can exhibit lower transmission of prices. Given the vertical transmission of local prices domestically, Rahman (2015) examines the price transmission for pulses in India and findings show the existence of asymmetry.

Extant literature has documented spatial and vertical price flows in developing countries (Abdulai, 2000; Mai et al., 2018). Baquedano and Liefert (2014) examine the integration of markets in developing countries and empirically reveal slow adjustment of domestic prices back to equilibrium. Inconclusive findings have however been found for the integration of export crop markets (Conforti, 2004). Other studies have shown evidence of slow price transmission rates between international and agri-markets in Africa, as well as limited to no growth in the price volatility of the staple food market in Africa (Minot, 2011; Minot, 2014).

Ceballos et al., (2017) have further found that income per capita is a significant factor that accounts for differentials in the food price pass-through across countries.

In terms of methodology, recent studies that examine agri-food value chains and the differentiation of commodities have employed different methods for insights. Bittmann et al., (2020) employ a distance measure within an error-correction model in the German fish market. They show that the differentiation of commodities influences the equilibrium market dynamics. Landazuri-Tveteraas et al. (2018) examined the price transmission in the salmon supply chain. In their study, the authors employ a Johansen bivariate time-series approach. Findings showed that more processing is associated with reduced price transmission to the retail prices. Loy and Weiss (2019) employed a panel-error-correction model to examine product differentiation and cost pass-through in the German yoghurt market. Findings showed that more differentiated products are associated with more sluggish adjustments to common cost shocks. Acosta et al. (2019) also suggested the simultaneous use of econometric and market structure methods in modelling price transmission.

In summary, despite different empirical methods used in analysing value chains in agri-food markets, evidence has pointed towards an important role of value addition and product differentiation on the performance of markets and its effect for market actors and participants. The current study employs symmetric and asymmetric analysis at the different levels of the value-added chain to further provide robust findings for the price transmission process when value is added at each individual stage and changing commodity forms (Jaffry, 2004). Hence, empirical policy insights for a developing economy market can direct development policy measures for broad development goals. Regional trade across national borders as well as domestic trade within a country are further assessed. The study also compares the market

dynamics across a regional export commodity, a staple convenience food, and a pulse commodity for insights.

2.4 Data

Data for cassava and its value-added products including tapioca (cassava root starch) and garri (coarse-grained cassava/cassava granules) are obtained from the Ministry of Agriculture, Livestock and Fisheries in Benin and inclusive of Benin, while cashew price data was obtained from the National Federation of Benin Cashew Nut Producers, inclusive of two other West African countries (Guinea and Nigeria) considered in the study. The Southern and Central parts of Benin are notably the major cassava growing areas (Agre et al., 2016). Hence these regions constitute the sample areas for cassava. Based on available data, Dantokpa market is sampled in the Southern region of Benin and Glazoué in the Central region for tapioca, ordinary garri, fine garri, over the period from February 2010 to September 2016 for the producer prices. For cassava, the producer price data covers the period from September 2013 to October 2016 in Dantokpa (Southern) and Comé (Southern/Southwest Benin) based on available data. Table 2.1 presents a summary of sampled communes within Benin used for analysis of the cassava value-chain. Data for cowpea is monthly from January to December 2016. Monthly price data for corresponding markets in the various communes are used in analysis across represented food categories.

Table 2.1: Data sample description

Commodity	Region	Department	Commune	Period
Cassava	Southern	Mono	Comé	September 2013 to October 2016
	Southern	Littoral	Cotonou (Dantokpa)	
Tapioca (cassava root starch)	Central	Collines	Glazoué	February 2010 to September 2016
	Southern	Littoral	Cotonou (Dantokpa)	
Ordinary garri	Central	Collines	Glazoué	February 2010 to September 2016
	Southern	Littoral	Cotonou (Dantokpa)	
Fine garri	Central	Collines	Glazoué	February 2010 to September 2016
	Southern	Littoral	Cotonou (Dantokpa)	
Cowpea	Northern	Alibori	Banikoara	January to December 2016
		Alibori	Gogounou	

For cashew, data includes weekly producer prices within two annual cashew marketing seasons in 2019 and 2020 for two countries in West Africa (Guinea and Nigeria), over eight weeks.

Descriptive statistics of the data are presented in table 2.2.

Table 2.2: Descriptive statistics of Commodities by market

Commodity	Market	Mean	Std. Dev.
Cashew	Guinea	272.5	59.926
	Nigeria	316.875	64.859
Cassava	Comé	73.421	26.178
	Dantokpa	214.737	108.022
Tapioca	Glazoué	618	94.097
	Dantokpa	694.313	100.643
Ordinary garri	Glazoué	192.813	37.677
	Dantokpa	330.263	78.152
Fine garri	Glazoué	229.563	49.824
	Dantokpa	404.313	95.592
Cowpea	Gogounou	400	36.927
	Banikoara	450	47.673

Source: Own computation

Note: Prices are given in CFA Franc. The CFA Franc is the official currency of West Africa, 1 XOF is equivalent to about 0.00181 USD

As seen on table two, average prices of cashew are more affordable in Guinea based on the sample data. The products on the cassava value chain are averagely more affordable in the Central part of Benin (Savalou) compared to the Southern part (Dantokpa). There is evidence of the existence of spatial price differentials based on the sample. As expected, the prices for cassava which serve as an input resource to the other commodities on the value chain are the least. When value is added, the value-added commodity price appreciates. There is a more considerable distinction in the sample average price for value-added tapioca commodity. Variance may be a factor of the nature of processing needs, further in terms of quality and grading.

Diagnostic checks on variable parameters are presented as shown on table four and five for commodity markets under consideration. The findings of the Dickey-Fuller test for unit root are presented in table 2.3.

Table 2.3: Test of unit root

Market	Z(t)			
	I(0)		I(1)	
	Test statistic	p-value	Test statistic	p-value
Cashew-Guinea	-0.409	0.9086	-3.520	0.0075
Cashew-Nigeria	0.184	0.9714	-3.119	0.0252
Cassava- Comé	-1.118	0.7080	-4.014	0.0013
Cassava- Dantokpa	-1.078	0.7237	-7.556	0.0000
Tapioca- Glazoué	-1.894	0.3348	-9.866	0.0000
Tapioca- Dantokpa	-1.525	0.5212	-10.046	0.0000
Ordinary garri- Glazoué	-1.465	0.5507	-8.357	0.0000
Ordinary garri- Dantokpa	-1.814	0.3737	-9.707	0.0000
Fine garri- Glazoué	-0.542	0.8836	-7.674	0.0000
Fine garri- Dantokpa	-1.919	0.3230	-10.829	0.0000
Cowpea- Gogounou	-1.732	0.4147	-3.406	0.0108
Cowpea- Banikoara	-1.874	0.3445	-3.450	0.0094

Source: Own computation. P-values are the MacKinnon approximate p-value for Z(t)

Findings of cointegration from the Engle and Granger (1987) procedure are presented under the null hypothesis of no cointegration. Findings of the test of cointegration are presented in table 2.4.

Table 2.4: Cointegration test

Market	Z(t)						
	Cashew (Guinea- Nigeria)	Cassava	Tapioca	Ordinary garri	Fine garri	Cowpea	
Test Statistic	-4.140	-1.705	-2.540	-3.313	-1.809	-4.909	
cv	1% 5% 10%	-5.921 -4.348 -3.706	-4.209 -3.506 -3.161	-4.039 -3.415 -3.099	-4.039 -3.415 -3.099	-4.039 -3.415 -3.099	-5.078 -3.948 -3.452

cv=test critical value(s) from STATA.

Critical values from MacKinnon (1990, 2010)

Source: Own computation

The Breusch-Godfrey test is used to check for serial correlation under the null hypothesis of no serial correlation. Findings are shown in table 2.5.

Table 2.5: Test of Serial correlation

Market	chi2	Prob > chi2
Cashew (Guinea-Nigeria)	0.741	0.3895
Cassava	2.687	0.1012
Tapioca	0.219	0.6395
Ordinary garri	0.794	0.3730
Fine garri	0.001	0.9755
Cowpea	1.056	0.3042

Source: Own computation

2.5 Methodology

Employing a non-linear cointegration approach and to capture non-linearities in addition to symmetric error correction estimates, the study employs an asymmetric vector error correction model (see von Cramon-Taubadel, 1998). The long-run and short-run relationships can be specified as follows;

$$P_t^b = \alpha_1 + \alpha_2 P_t^a + \epsilon_t \quad (1)$$

$$dP_t^b = \gamma_1 + \gamma_2 (\epsilon_{t-1})^+ + \gamma_3 (\epsilon_{t-1})^- + \gamma_4 dP_{t-1}^a + \dots + \mu_t \quad (2)$$

Where P_t^b is the price in market b at time t, P_t^a is the price of market a at time t, and ϵ_t is the disturbance term. d represents the first-difference operator, γ_1 is the intercept, γ_2 and γ_3 are the speed of adjustment coefficients back to long-run cointegrating relationship for positive and negative discrepancies respectively following the cointegrating equation and the

disturbance term from (1). α_1 and α_2 are long-run coefficients to be estimated. Assuming symmetry in the adjustment process of (1), the second stage estimation following Engle and Granger (1987) is thus:

$$dP_t^b = \gamma_1 + \gamma_2 \epsilon_{t-1} + \dots + \epsilon_t \quad (3)$$

Where ϵ_t is the random error. The estimations following cointegration for (2) and (3) can be summarised in table 2.6.

Table 2.6: Error correction adjustment process

Symmetric adjustment process	Asymmetric adjustment process	
	Above the equilibrium (1)	Below the equilibrium (1)
$d \epsilon_t = \rho \epsilon_{t-1} + \mu_t$ Where $\rho \neq 0$	$\epsilon_{t-1} \geq 0$ (positive process)	$\epsilon_{t-1} < 0$ (negative process)

2.6 Findings

Table 2.7 presents long-run estimates for markets under consideration. Short-run estimates are presented for both symmetric and asymmetric adjustments.

Table 2.7: Long-run and Short-run Estimates

		Dependent variable			
		P_t^b	dP_t^b	$dP_t^b (+)$	$dP_t^b (-)$
Cashew	(Guinea-Nigeria)	0.862*** (.007)			
	Guinea		-1.814* (.750)	0.361 (7.630)	-2.197 (1.706)
	Nigeria		-0.627 (.710)	-0.088 (7.245)	-0.721 (1.497)
Cassava	(Comé-Dantokpa)	0.286*** (.028)			
	Comé		-0.132*** (.033)	-0.120** (.057)	-0.151*** (.040)
	Dantokpa		0.251 (.494)	0.073 (.070)	0.676 (1.489)
Tapioca	(Glazoué-Dantokpa)	0.882*** (.014)			
	Glazoué		-0.100** (.041)	-0.113* (.067)	-0.084 (.066)
	Dantokpa		0.076 (.048)	0.046 (.010)	0.092 (.102)
Ordinary garri	(Glazoué-Dantokpa)	0.573*** (.009)			
	Glazoué		-0.105* (.062)	-0.185** (.087)	-0.046 (.104)
	Dantokpa		0.308 (.198)	0.122 (.273)	0.444 (.395)
Fine garri	(Glazoué-Dantokpa)	0.558*** (.012)			
	Glazoué		0.059 (.037)	-0.003 (.104)	0.098 (.069)
	Dantokpa		0.461** (.226)	0.198 (.374)	0.629 (.409)
Cowpea	(Banikoara-Gogounou)	0.887*** (.012)			
	Gogounou		-0.846* (.443)	-1.441*** (.414)	-0.045 (.538)
	Banikoara		0.300 (.581)	-0.552 (.565)	1.447* (.719)

Source: Own computation

Robust standard errors are in parenthesis. ***p<0.01, **p<0.05, *p<0.1

Broadly, long-run price transmission is relatively slower for cassava and its value chain compared to cashew and cowpea. Findings may suggest spatial dependencies of commodity

markets, for instance in the tapioca market, the central market appears to respond to changes more than the Southern market, hence the Southern market may exhibit lesser dependence toward market conditions in the Central region. This may be in line with the sampled Southern market as a prominent market (national and international) in the region of West Africa and Benin.

2.7 Discussion

Findings show differences in the magnitude of long run price transmission between countries in the same region. Cachia (2017) documented differences in the extend and speed of price transmission across regions. While regional asymmetric responses are insignificant in this region, Mofya-Mukuka and Abdulai (2013) in their study show that in the East African region, the elimination of positive and negative discrepancies differed between Zambia and Tanzania pre-reform and post-reform periods.

The price transmission is faster for ordinary garri compared to fine garri. Earlier findings showed that price transmission could be faster for less processed commodities compared to more processed commodities (Landazuri-Tveteraas et al., 2018). Price transmission is affected by changing product forms (also see Asche et al., 2014) as can be seen with the cassava, and its value-added product form markets.

The spatial transmission of prices in the long run is faster for value-added processed cassava forms compared to its raw input cassava, for all the value-added commodities under consideration. Value-addition may hence enhance performance of markets through faster price transmission rates. The long run price transmission parameters are all significantly different from zero at one percent level. Price transmission for differentiated commodity attributes

(ordinary garri and fine garri) is slower compared to other value-added tapioca product. Loy and Weiss (2019) have found that product differentiation is associated with slower price transmission rates. Significant convergence to long-run equilibrium is however only noticeable in some markets. When non-linearities are considered for rising and falling prices, over correction is also noticeable in some markets. Slow adjustments back from disequilibrium may support the need for trade integration that may propel competition and the potential for faster adjustments and stability of markets. This provides a caveat for future research.

Some levels of asymmetric adjustments exist on the cassava value chain. Gizaw et al. (2021) empirically showed some level of asymmetric adjustments on the unprocessed fresh salmon value chain. Based on the sample data, price transmission in domestic intra-regional markets is about as high as for regional continental markets. In the case of inter-regional domestic markets, value addition on the commodity and the level of the commodity on the value chain is a factor for the extend of price transmission.

2.8 Conclusion

Continental and regional trade has recently attracted interest in SSA. This presents potentials for trade expansion and integration of markets for better economic output in these developing regions. Prominent food categories are examined in this study for market dynamics and possible development policy insights. Spatial markets for pulse, export and other staple convenience food are evaluated as well as symmetric and asymmetric convergences for disequilibria. Using a vector error correction model, time series techniques are employed. Spatial market dependencies may exist among markets and affect the formation of complete markets. Price transmission is broadly similar for export and pulses food commodities and more variant for staple convenience food depending on the value chain niche. Tailored policy

towards convenient staple food crops, export crops and pulses can enhance the state of the agricultural market and output towards broad development strategies especially for the poorest farmers through trade. The findings may hence provide development policy insights to strengthen needed agricultural policies for intra-regional and inter-regional markets. Augmenting available institutional and technological support facilities can boost the expansion of markets in developing countries especially in value-added processing, for domestic and regional trade integration. Findings should be generalised with caution given the sample sizes of communes representing markets as well as the period of data coverage.

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Chapter 3

Food markets and price responses: Panel analysis for a developing economy market

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Abstract

Agricultural markets are crucial in boosting trade development efforts for emerging markets. Food chains in these markets play a key role for the stabilisation of prices and welfare of market actors. Using panel data for thirteen commodities relevant to food markets in developing Sub-Saharan Africa, market dynamics for agricultural commodities are examined for the short-run and long-run equilibrium process. The study employs panel estimation techniques and utilises a model that augments the error correction for adjustments in price disequilibria. Findings suggest that differentiated commodities display heterogenous effects in the transmission of prices across food market categories. Differential effects can be seen across cross-commodity price movements and value-added food chains. Findings further provide insights between spatial domestic prices and prices for an import food. Market trade policy on commodity diversification and spatial market infrastructural allocations towards augmenting food market linkages can boost the performance of these markets.

Keywords: Food market, agricultural price, value addition, differentiated food, Benin

3.1 Introduction

Agricultural Markets are vital for the long-standing efforts to curb food security and poverty related issues in Sub-Saharan Africa (SSA), where despite a significant proportion of smallholder agrarian activities and especially in food production, even these farmers remain vulnerable to food insecurity (Barrett, 2008; Taylor et al., 2009; Sibhaitu and Qaim, 2017). Properly functioning agricultural markets support pro-rural and pro-poor development agendas in emerging markets (World Bank, 2008). However, these markets may not be well performing (Dillon and Barrett, 2017) and may exhibit unstable price trends that can affect the broad development agenda for SSA towards food security and poverty alleviation (World Bank, 2008; Varela et al., 2016; Timmer, 2017). Several literatures have linked the role of well-functioning agricultural markets to broad development strategies (FAO et al., 2011; FAO et al., 2018). Stable agricultural markets are essential for survival in developing economies (Taylor et al., 2009). Declining maize prices for instance have been evidenced to increase poverty rates (Dyer et al., 2006). Despite the presence in food uses and trade of continentally consumed staples such as maize, rice, and root and tubers, proportions are still almost at the point of starvation (Katsumata et al., 2007). This may further imply the need for better performing markets that can enhance actors and participants' welfare in these markets.

This study examines the agricultural market and prices across food categories in SSA with diverse nutrient sources and significant nutritional values to food, ranging across the classes of food nutrients; proteins, carbohydrates, water, vitamins, minerals, fiber, and fats.

Thirteen food commodities including value added forms and/or differentiated alternatives are examined in the study. The study analyses the agricultural market for relevant food and staple crops spanning from cereal grains and their value-added form, protein food, root and tubers, as

well as processed value-added alternatives. Farmer access to higher value chains is necessary in the advancement and proper functioning of agricultural markets (Taylor et al., 2009). These crops are nationally consumed across Benin hence exhibiting relevance in the agricultural market and potential for alleviating hunger levels and raising incomes through better markets for survival (see Katsumata et al., 2007). Commodities include rice (*Oryza sativa*), maize (*Zea mays*), wheat flour, white and red cereals (millet/sorghum), snail (*Gastropoda*), fresh and sea water fish, ordinary yam (*Dioscorea allata*), dried yam flour, taro (*Colocasia esculenta*), and potato (*Solanum tuberosum*). Understanding these food markets and their functioning may be a step towards deeper policy insights and consequent measures for improving the livelihoods of farmers, especially small-scale farmers that constitute a relevant proportion of agrarian activities in developing economies and living in rural areas. According to Herrero et al. (2017), these farmers however account for the greater proportion of food production in SSA. The convergence of markets can be facilitated when producers practice free arbitrage (Cachia, 2017). The study employs a recent panel data set for producer food prices to examine dynamics in agri-food markets.

Understanding these agri-food markets is fundamental to inform development policy especially in emerging markets with broad development agendas to better the livelihood of people, a significant proportion of whom are employed in agrarian food activities and markets and depending on it for survival in both subsistence and commercial ends. This is further important in meeting hunger needs and in line with the Sustainable Development Goal 2 if trade policy in these agri-food markets can be better and regularly informed in a bid to boost food affordability, accessibility and availability attempts for the population in developing countries. According to the World Bank and FAO (2021), there has reportedly been an increase in the

number of undernourished people in West Africa. Deficiencies in micronutrients have also been reported in the region (World Bank and FAO, 2021).

The study attempts to contribute to extant literature in the following ways; (1) using a recent panel data set to examine the price trends and commodity market dynamics across several categories of food and staples in a developing economy, (2) establish commodity price and market relationships for value-added processed commodity forms and the raw input in downstream and upstream markets respectively, (3) examine the linkage between various food category substitute markets (root and tuber commodities, cereals, meat and fish, and other relevant staples as maize and rice), (4) evaluate the price responses and market mechanism for differentiated food (white cereal and red cereal: fresh water fish and sea water fish), (5) establish spatial relations in cross-border price markets (local rice and imported rice) as well as domestic spatial markets, (6) examine domestic market relationships. Combined, the supply chain and value chain for the commodities are broadly examined. The study employs a recent panel data set using a recent estimation technique that augments error correction models in the reduce-form price transmission models (see Nagel, 2017).

The rest of the paper is organised as follows. Section 3.2 presents the conceptualisation and literature, section 3.3 describes the data and statistics, section 3.4 presents the methodology, section 3.5 presents the results and discussion, and section 3.6 concludes the study with policy insights from the findings.

3.2 Literature and Conceptualisation

Alerts have recently been put forward for the possibility of potential food crisis in some countries of SSA and the West African region (WFP and FAO, 2021) with proportions of the

population in West Africa still undernourished and deficient in micronutrients (World Bank and FAO, 2021). Given the key role of food systems in food availability, affordability, and accessibility, strengthening the role of actors on the food system is essential, and critical to this are competitive trades and markets (IFPRI, 2021). However, literature on staple food value chains is relatively sparse in this region and maybe tailored for particular or individual food markets (Elbehri et al., 2013). Staple food markets and agrarian activities leave more to be desired in this region (Elbehri et al., 2013).

Recent interest has been directed towards enhancing competitiveness of staple foods and promoting the access to higher value chains for producers (Elbehri et al., 2013). Cereals and root and tubers are among major staple food crops in this region, however having supply and value chains vertically or spatially, with inadequate secondary activities such as value-added processing, as well as proper coordination strategies (Elbehri et al., 2013).

The growth and expansion of value chains can create access to higher value niches towards broader market coverage internationally and for higher-end domestic markets (Staatz and Dembélé, 2008), more so in developing SSAn markets. Diversification in food chains potentially in value addition, product differentiation, substitute commodities can provide market and trade advantages in agri-food markets for farmers and their productivity efforts as consumers appreciate and place value on alternate food choices and commodity possibilities, the love of variety (e.g see Helpman and Krugman, 1985), hence providing possible opportunities for agri-food commercialisation endeavors and thus more pricing options in markets that can boost market performance for trade welfare.

This is further important, for smallholder farm producers who constitute a relevant proportion of farm production (Staatz and Dembélé, 2008). Hence, boosting their productivity welfares can be crucial in developing the agricultural sector and its market, given that agricultural policy strategies are key for the impending development needs in SSA (Staatz and Dembélé, 2008). Market opportunities in trade can expand farmer access to higher value chains and increased competitiveness internationally for African farmers as efforts are made to meet set agricultural commodity trade agendas (FAO and AUC, 2021) as it has been postulated that this is necessary for access to the advantages associated with globalisation (FAO, 2020). Hence, there is a need for smallholder farmers to be able to access global and higher value chains, for overall development (FAO, 2020).

Cereals and root and tubers are equally depended on as fundamental in basic food diets, in Benin (Elbehri et al., 2013). The expansion of markets provides potentials for higher and more diversified value chains (Elbehri et al., 2013). Staple food cereals such as maize are not only demanded for household consumption use but also for industry raw material and in other higher food value chains, also in Benin where feed uses alone account for a greater share of domestic supply (Elbehri et al., 2013), hence providing opportunities for market potentials that can be exploited nationally and internationally especially when markets are well performing.

Literature has been documented on agricultural markets and policy (De Gorter and Drabik, 2012; Reardon et al., 2003). In the cereal markets, Acharya et al. (2012) have shown the existence of differential short-run adjustments across spatial rice markets in India. Asche et al. (2014) in investigating supply chain linkages have shown that markets are integrated. Even more recently, on the value chain and differentiated product markets, evidence has been empirically revealed to support slower speeds of adjustments for more differentiated products

(Loy and Weiss, 2019; Bittmann et al., 2020). Theories have been posited on consumption demand preferences, competitive pricing and the substitutability of products; and differentiation of commodities in markets (see e.g Hotelling, 1929; Lancaster, 1966; von Weizsticker, 1984).

Literature on the transmission of prices in developing economies and emerging markets has also been documented (Baquedano and Liefert, 2014; von Cramon-Taubadel, 2017; Zamani et al., 2018). In developing country markets, Abdulai (2000) examined spatial price flows in the maize market of Ghana. Findings empirically show differential price change responses in agri-markets.

Summarily, development literature on agricultural markets continues to be relevant especially for developing and emerging market economies, where deeper policy insights can provide a pathway to navigate development agenda strategies.

3.3 Data

Data is obtained from the Ministry of Agriculture, Livestock and Fisheries in Benin. The study data is organised as presented in the summary in table 3.1.

Table 3.1: Sample communes used

Commodity	Region	Department	Commune/Market	Period
Local rice	Middle East	Borgu	Kalale	March 2011 to Feb. 2017
	Central	Collines	Glazoué	
Imported rice	Middle East	Borgu	Nikki	March 2011 to Feb. 2017
	Middle East	Borgu	Kalale	
Maize	Middle East&Northern	Borgu&Atacora	Nikki&Natitingou	Sept. 2009 to Feb. 2017
	Southern	Littoral&Zou	Dantokpa(Cotonou)&Bohicon	
Wheat flour	Middle East	Borgu	Parakou	Sept. 2009 to Jan. 2017
	Middle East	Borgu	Nikki	
White cereal(millet/sorghum)	Southern	Littoral	Dantokpa(Cotonou)	Sept. 2009 to Jan. 2017
	Northern	Atacora	Pehunco	
Red cereal(millet/sorghum)	Southern	Littoral	Dantokpa (Cotonou)	Sept. 2009 to Jan. 2017
	Northern	Atacora	Pehunco	

Snail	Southern	Plateau	Ketou	May 2010 to Dec. 2012
	Southern	Plateau	Yoko	
Freshwater fish	Middle East	Borgu	Parakou	May 2010 to Dec. 2012
	Southern	Zou	Bohicon	
Sea water fish	Middle East	Borgu	Parakou	May 2010 to Dec. 2012
	Southern	Zou	Bohicon	
Ordinary yam	Southern	Littoral	Dantokpa(Cotonou)	Dec. 2012 to May 2013: Nov. 2013 to May 2014: Dec. 2014 to May 2015
	Northern	Atacora	Pehunco	
Farine coss igname (Dried yam flour)	Southern	Littoral	Dantokpa(Cotonou)	Dec. 2012 to May 2013: Nov. 2013 to May 2014: Dec. 2014 to May 2015
	Middle East	Borgu	Parakou	

Taro	Southern	Plateau	Ifangni	Jan. to Oct. 2006: Nov. 2014 to Oct. 2015
	Southern	Plateau	Yoko	
Potato	Southern	Littoral	Dantokpa(Cotonou)	Jan. to Oct. 2006: Nov. 2014 to Oct. 2015
	Collines	Collines	Ouao	

Descriptive statistics for rice and maize staple food are presented in table 3.2.

Table 3.2: Summary statistics for rice and maize staple food crops

Commodity		Mean	Std. Dev.
Imported rice	Overall	483.732	37.509
	Between		16.234
	Within		35.696
Local rice	Overall	393.570	74.541
	Between		35.485
	Within		70.159
Maize Middle East&Northern	Overall	157.983	30.990
	Between		17.104
	Within		28.518
Southern	Overall	198.028	45.396
	Between		38.459
	Within		36.292

Source: Own computation.

Note: Prices are in CFA Franc (West African currency) per kilogramme. The CFA Franc is the official currency of West Africa, 1 XOF is equivalent to about 0.00181 USD

Domestic rice prices are generally more affordable (393.570) compared to imported rice prices (483.732). Spatial effects may be exhibited on prices as seen on domestic Southern average prices (198.028) compared to prices in the regions of the North and Middle East (157.983) in the maize market. Descriptive statistics for the cereal value chain is presented in table 3.3.

Table 3.3: Summary statistics for cereal value-chain

Commodity		Mean	Std. Dev.
White cereal (millet/sorghum)	Overall	250.808	90.437
	Between		118.650
	Within		33.170
Red cereal (millet/sorghum)	Overall	267.5	106.316
	Between		141.541
	Within		35.067
Wheat flour	Overall	527.163	62.300
	Between		44.293
	Within		53.803

Source: Own computation.

Note: Prices are in CFA Franc (West African currency) per kilogramme. The CFA Franc is the official currency of West Africa, 1 XOF is equivalent to about 0.00181 USD

Heterogenous pricing exist for sample average prices of differentiated cereals. The average price for white cereals is more affordable at 250.808 while the average price for red cereals is less affordable at 267.5 based on the data. Descriptive statistics for protein substitutes (meat and fish) is presented in table 3.4.

Table 3.4: Summary statistics for meat and fish

Commodity		Mean	Std. Dev.
Snail	Overall	1017.5	207.328
	Between		210.143
	Within		143.368
Freshwater fish	Overall	1717.891	452.132
	Between		438.517
	Within		326.725
Sea water fish	Overall	1059.141	155.855
	Between		115.457
	Within		132.363

Source: Own computation.

Note: Prices are in CFA Franc (West African currency) per kilogramme. The CFA Franc is the official currency of West Africa, 1 XOF is equivalent to about 0.00181 USD

While the sample average for freshwater fish is relatively more expensive (1717.891) to its counterpart sea water fish (1059.141), it is also relatively expensive compared to snails (1017.5). However, the snail substitute to fish is averagely more affordable. While freshwater fish may exhibit less affordable price differentials with snails as meat substitute, sea water fish prices maybe near similar with snail prices and the prices seemingly tend to move together. Descriptive statistics for root and tuber crop substitute commodities and value-added flour are presented in table 3.5.

Table 3.5: Summary statistics for root and tuber value-chain

Commodity		Mean	Std. Dev.
Ordinary yam	Overall	138.816	42.940
	Between		50.800
	Within		22.774
Dried yam flour	Overall	730	147.621
	Between		166.356
	Within		87.067
Taro	Overall	250.909	74.711
	Between		35.998
	Within		70.134
Potato	Overall	585.796	109.560
	Between		51.587
	Within		103.160

Source: Own computation.

Note: Prices are in CFA Franc (West African currency) per kilogramme. The CFA Franc is the official currency of West Africa, 1 XOF is equivalent to about 0.00181 USD

As seen on the table, downstream prices (730) are significantly appreciated as value is added to the product from its upstream price (138.816) as expected. Relevant price differences exist across substitute root and tuber commodities. For the trend of prices on the cereal value chain for differentiated cereal and value-added processed flour, as expected, upstream prices for raw material input are considerably lower compared to down stream prices. The prices for value-added commodities are significantly appreciated once the value is added. In line with the value chain as for cereals, the value chain for yam also exhibits significant differences in upstream pricing (lower) and downstream pricing (higher) as expected for value addition across

commodities. There are relevant price differentials across root and tuber substitutes with a relatively least affordable (potato) mean price, and most affordable (ordinary yam).

Cross-section dependence is tested following Pesaran (2004, 2015) as shown in Table 3.6, and subsequent unit root test when the null hypothesis of cross-sectional independence is rejected, following Pesaran (2007) as shown in Table 3.7a.

Table 3.6: Cross-Section Dependence test

Market	CD-test	p-value
Imported rice	-.151	0.880
Local rice	-3.848	0.000
Maize		
North and Middle East	7.189	0.000
South	7.976	0.000
White Cereal (Millet/Sorghum)	.311	0.756
Red cereal (Millet/Sorghum)	1.194	0.232
Wheat flour	3.243	0.001
Snail	.476	0.634
Freshwater fish	2.323	0.020
Sea water fish	4.075	0.000
Ordinary yam	.824	0.410
Dried yam flour	2.327	0.020
Taro	4.061	0.000
Potato	4.456	0.000

Source: Own computation

CD=Cross-section Dependence

The Hadri (2000) panel test of unit root for balanced panels is employed when findings fail to reject the null hypothesis of cross-sectional independence as shown in Table 3.7b.

Table 3.7a: Unit root test

Market	Local rice	Maize (Middle East and Northern-Southern)	Wheat flour	Freshwater fish	Sea water fish	Dried yam	Potato	Taro
	1%: -1.94	-	1%: -1.94	1%: -1.97	1%: -1.97	1%: -2	1%: -1.98	1%: -1.98
				5%: -1.72		5%: -		
Critical values	5%: 1.71	-	5%: -1.71	5%: -1.71	5%: -1.72	5%: 1.72	5%: -1.72	5%: -1.72
			10%: -1.56	10%: -1.56		10%: -1.58	10%: -1.57	10%: -1.57

Source: Own computation

Following Westerlund panel testing, we check for cointegration of the series (see Westerlund, 2007). Diagnostic test are presented in table 3.8 under the null hypothesis of no cointegration.

Table 3.7b: Test of unit root

Variable	Hadri test
$I_{i,t}^p$	24.09***
$dI_{i,t}^p$	-1.3337
$W_{i,t}^p$	4.7173***
$dW_{i,t}^p$	-1.3795
$R_{i,t}^p$	5.5270***
$dR_{i,t}^p$	-1.2343
$S_{i,t}^p$	5.5779***
$dS_{i,t}^p$	-1.0826
$O_{i,t}^p$	1.2905*
$dO_{i,t}^p$	-0.6501

Source: Own computation, ***p<0.01, *p<0.1

H0: All panels are stationary

Cereal crops exhibit no cross-sectional dependence, however once value is added (wheat flour), evidence is found of cross-sectional dependency in the food markets. Evidence of cross-sectional dependence is found in domestic markets (local rice prices) relative to imported rice prices. Cross-sectional independence in protein substitute markets is such that while the fish

markets exhibit dependency, this is not the case with the substitute meat. Series with cross-section independence are hence tested for unit roots using the Hadri (2000) panel unit root test for balance panels.

Table 3.8a: Cointegration test

Statistic	Value	Z-value	P-value
Imported rice-Local rice			
Group mean test			
G_t	-2.700	-1.452	0.073
G_a	-19.098	-3.106	0.001
Panel test			
P_t	-3.377	-1.337	0.091
P_a	-13.355	-2.907	0.002
Maize (Middle East and Northern-Southern)			
Group mean test			
G_t	-4.978	-5.038	0.000
G_a	-48.104	-10.642	0.000
Panel test			
P_t	-6.773	-4.753	0.000
P_a	-43.869	-12.627	0.000
Wheat flour-white cereal			
Group mean test			
G_t	-2.521	-1.171	0.121
G_a	-15.696	-2.222	0.013
Panel test			
P_t	-2.288	-0.242	0.404
P_a	-4.840	-0.194	0.423
Wheat flour-red cereal			
Group mean test			
G_t	-1.866	-0.140	0.445
G_a	-14.074	-1.801	0.036
Panel test			
P_t	-0.785	1.270	0.898
P_a	-2.496	0.552	0.710
Snail-freshwater fish			
Group mean test			
G_t	-3.385	-2.531	0.006
G_a	-14.361	-1.875	0.030
Panel test			
P_t	-4.473	-2.440	0.007
P_a	-13.812	-3.052	0.001
Snail-sea water fish			
Group mean test			

	G_t	-3.086	-2.059	0.020
	G_a	-12.625	-1.424	0.077
Panel test				
	P_t	-4.226	-2.191	0.014
	P_a	-12.444	-2.617	0.004
Dried yam flour-ordinary yam				
Group mean test				
	G_t	-0.824	1.501	0.933
	G_a	-2.933	1.093	0.863
Panel test				
	P_t	-1.724	0.325	0.628
	P_a	-3.402	0.264	0.604
Potato-taro				
Group mean test				
	G_t	-3.309	-2.411	0.008
	G_a	-7.462	-0.083	0.467
Panel test				
	P_t	-5.585	-3.558	0.000
	P_a	-8.718	-1.430	0.076
Source: Own computation				
H0: No cointegration				

Table 3.8b: Cointegration test

	Statistic	p-value
Wheat flour-white cereal	1.4268	0.0768
Wheat flour-red cereal	1.5712	0.0581
Dried yam flour-ordinary yam	-1.3072	0.0956
Source: Own computation		
H0: No cointegration		

3.4 Methodology

The study employs standard reduced form price transmission models as follows.

$$P_{i,t}^b = \beta_1 + \beta_2 P_{i,t}^a + \varepsilon_{i,t} \quad (1)$$

$$\Delta P_{i,t}^b = \gamma_1 + \sum_{i=1}^n (\gamma_2 \varepsilon_{i,t-1}) + \sum_{i=1}^n (\gamma_3 \Delta P_{i,t-1}^a) + \dots + \mu_{i,t} \quad (2)$$

Where $P_{i,t}^b$ is price in market b at time t, $P_{i,t}^a$ is price of market a at time t, and $\varepsilon_{i,t}$ is the disturbance. Δ represents a first-difference operator, and $\gamma_2\varepsilon_{i,t-1}$ is the error from equation (1). γ_1 is the intercept, γ_2 is the coefficient for the speed of adjustment back to the long-run equilibrium. β_1 and β_2 are long-run coefficients to be estimated.

Following the heterogenous error correction model (see Nagel, 2017) for estimating panel data that is cross-sectional dependent, the averages of cross-sections for variables under consideration are used to augment the error correction model, eliminating the differential impacts from the common factors that are unobserved. Following estimates of the individual error correction models, mean-group estimates are further computed for the long-run coefficients. The ability of the model to eliminate cross-sectional dependence from the model residual is additionally checked. We statistically test the following null hypothesis.

H1: No significant relationship across food market categories (root and tubers, cereals, meat and fish, and other relevant staples as maize and rice)

H2: No significant relationship across upstream and downstream food markets (a) millet/sorghum and wheat flour (b) yam and yam flour

H3: No significant relationship in substitute food markets (a) Staples; maize and rice (b) Meat; fish and snail (c) Root and Tuber; yam, taro and potato (d) Cereals; white cereal and red cereal

H4: No significant relationship between differentiated food categories (a) white cereal and red cereal (b) freshwater fish and sea water fish

H5: No significant relationship between local and imported food categories (local rice and imported rice)

H6: No significant relationship between domestic market prices (maize)

H7: No significant relationship in adjustment speeds of disequilibria to the long-run price equilibrium across food categories (root and tubers, cereals, meat and fish, and other relevant staples as maize and rice)

3.5 Results and Discussion

Mean group error correction estimates are presented in table 3.9 (see Nagel, 2017). Estimates show the plausible short-run adjustments from the cointegrating relationship as well as the long-run average coefficients. The model also outputs the t-bar statistic for cointegration as shown in the table. Our error correction coefficients are negative as expected. Long-run and short-run estimates for all commodities are significantly different from zero at one percent level. Long-run price transmission is faster for non-differentiated product markets (root and tuber substitutes) as suggested by the findings. This finding is in line with Loy and Weiss (2019).

Table 3.9: Estimates

	Long-run average coefficients	Error Correction ²
Rice (Imported-Local)	-0.067*** (3.77e-16)	-0.586*** (-5.092)
Maize (Middle East and Northern-Southern)	-0.027*** (4.89e-15)	-0.592*** (-5.412)
Wheat flour-white cereal	0.152*** (8.18e-10)	-0.378*** (-4.033)
Wheat flour-red cereal	-0.061*** (8.71e-16)	-0.336*** (-3.636)
Snail-freshwater fish	-0.071*** (9.08e-16)	-0.494*** (-3.017)
Snail-sea water fish	0.184*** (2.82e-15)	-0.482*** (-3.498)
Dried yam flour-ordinary yam	0.496*** (4.08e-15)	-0.259*** (-0.680)
Potato-taro	0.190*** (2.99e-15)	-0.840*** (-3.471)

Source: Own Computation

***p<0.01

Prices for local rice and imported rice seemingly tend to move in different directions. An increase in the price of local rice may solicit reduction in the prices of imported rice by about 6.7franc. Hence following the fifth null hypothesis, there is a significant and inverse relationship. Literature has posited that increasing the price of a substitute may mean an increase in sales of its counterpart substitute (Shocker et al., 2004). This may be through a reduction in pricing of the substitute. Findings therefore suggest the rejection of our fifth null hypothesis of no significant relationship. A similar finding is evidenced for the market of snail and freshwater fish. Relative to the market for snail and sea water fish hence, this finding maybe in line with the larger disparity in pricing of freshwater fish and snail compared to the close movement of prices between snail and seawater fish. Freshwater aquaculture has notably accounted for majority global production among main production environments (Delgado et

² T-bar statistic for cointegration in parenthesis

al., 2003). The study hence finds evidence to reject the fourth null hypothesis; and given the significance in the cereal markets.

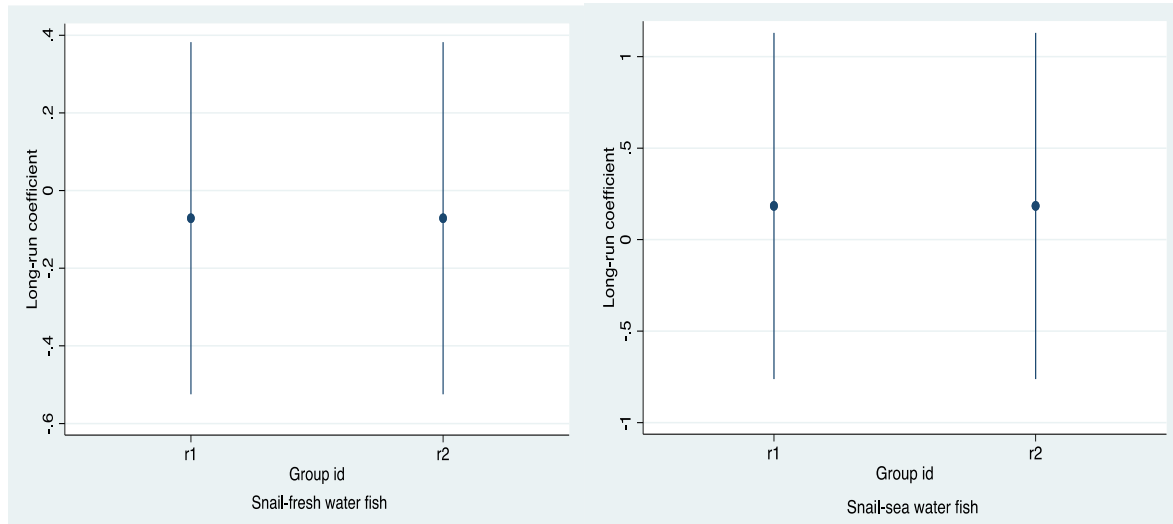


Fig. 3.1: Substitutes (meat and fish)

Differences in the transmission of cross-commodity prices for snails between the differentiated fish commodities (sea water fish and freshwater fish) exhibit differentials as further seen on the plot in figure 3.1. This is supported by the findings of the cereal value chain where differentiated cereals (white and red) transmit prices to a value-added counterpart (wheat flour) in different directions. The finding provides suggestive evidence for the rejection of the second null hypothesis.

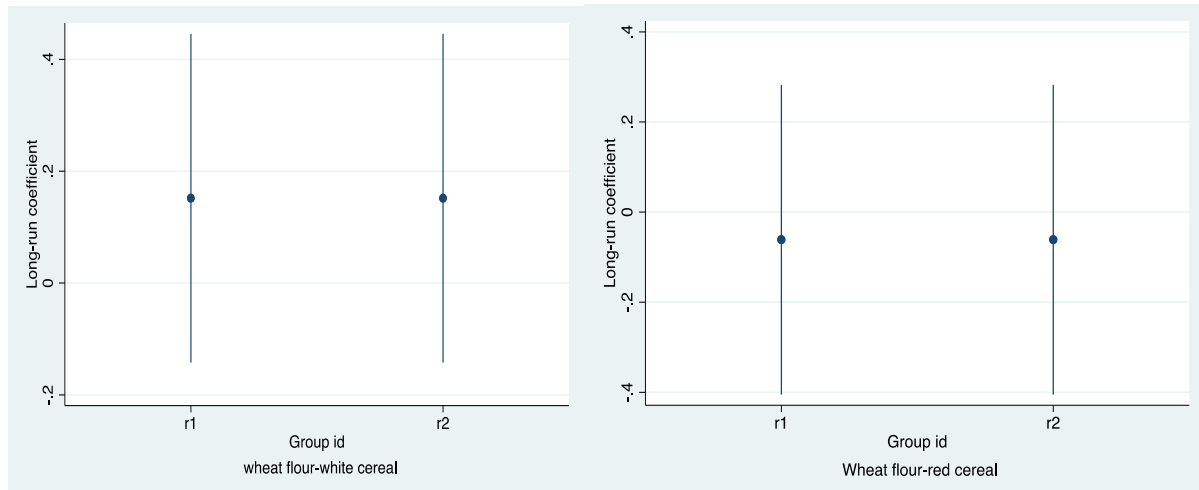


Fig. 3.2: Cereal value chain

While the prices for white cereals are positively associated with the prices of wheat flour, the prices for red cereals show a negative association. This is demonstrated in figure 3.2. In a similar light furthermore for domestic maize markets, an increase in the price of maize in the Northern and Southern regions may mean a reduction in prices in the regions of the Middle East by 2.7franc. Domestic maize markets maybe inversely associated. The findings favour the rejection of our sixth null hypothesis.

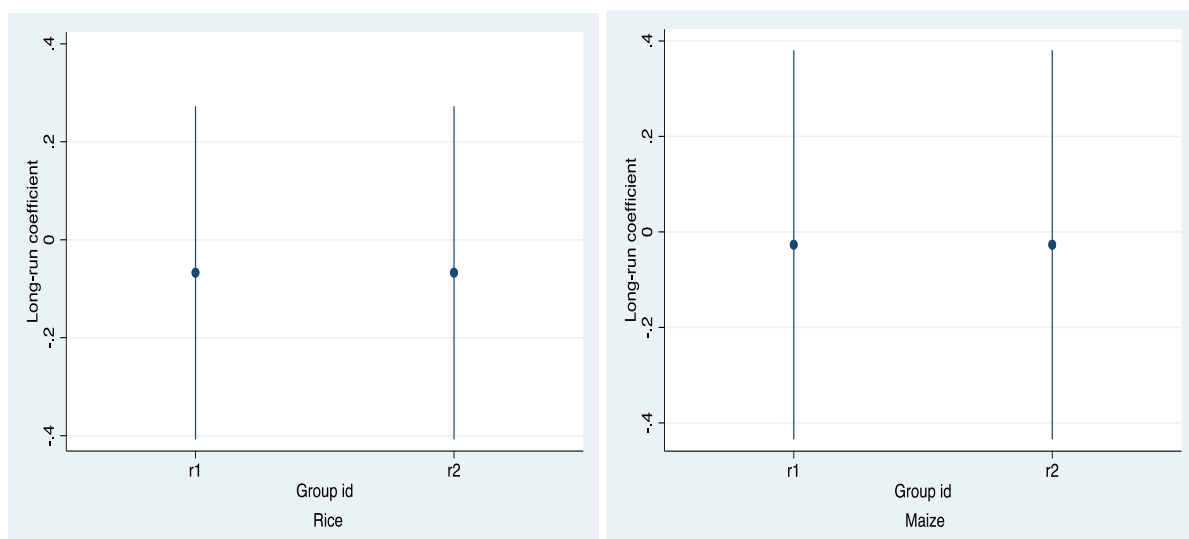


Fig. 3.3: Maize and rice staple food crops

As further seen on figure 3.3, long-run price transmission is generally lower in the rice markets compared to the maize market. While root and tuber crops seem to trend in the same direction of transmission of prices, this is also the case on their value-added chain where price increases for ordinary yam upstream are associated with price increases downstream for dried yam flour. An increase in the price of taro is positively associated with prices for potato.

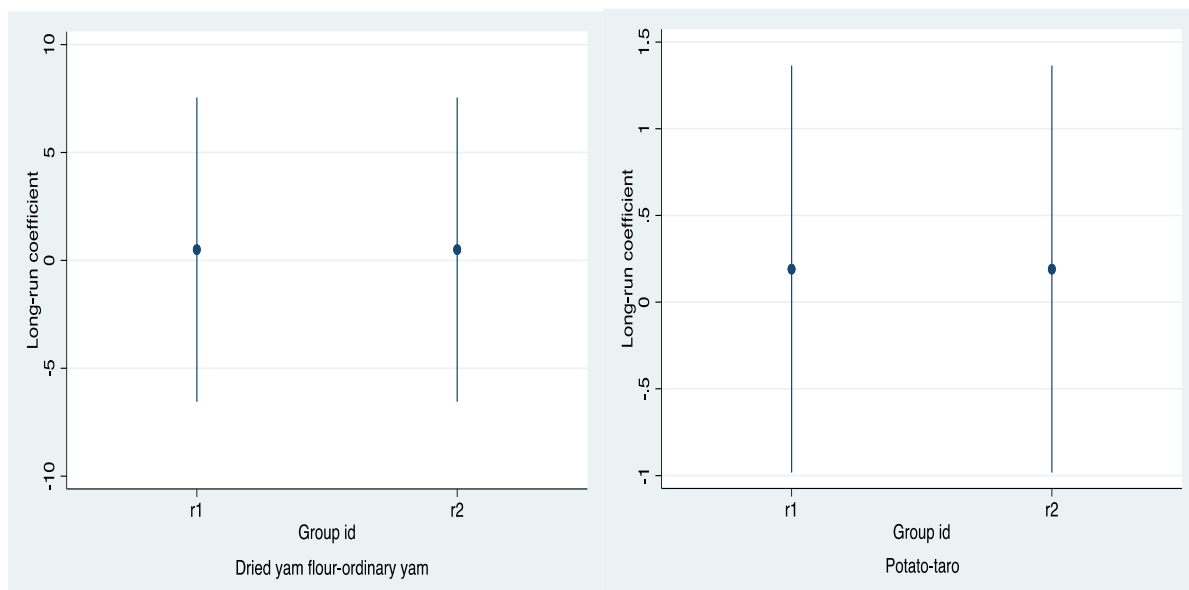


Fig. 3.4: Root and tuber substitutes and value-added product form

The value chain for yam, and the other root and tuber substitutes of potato and taro all have positive long-run coefficients. This is illustrated in figure 3.4. Evidence is thus found to reject the first null hypothesis of no significant relationship across various food category markets. The finding for the yam value chain further supports rejection of the second null hypothesis. Prices of maize and rice seemingly move in the same direction as suggested by the findings. This supports the rejection of the third null hypothesis. A significant relationship exists between the snail and meat markets. This further favours rejecting the third null hypothesis as this is the case for the cereal and root and tuber markets.

Adjustments from disequilibria in the short-run are seemingly more corrected on cross-commodity price transmissions (taro-potato) compared to their value chain (ordinary yam-dried yam flour). Short-run adjustments seem lowest for value-added chains (yam and cereal). Price responses to disequilibrium among domestic markets (maize) are faster than for domestic-international market commodities (rice). Speed of adjustments for differentiated commodities (freshwater and sea water fish; white cereal and red cereal) are almost similar. The study hence finds evidence to reject the seventh null hypothesis of no difference in adjustment speeds back to the long-run price equilibrium across food categories.

3.6 Policy Implications

Developing the agricultural sector is of primal importance to drive overall development measures and policy yet pending in SSA. While the agricultural sector in this continent is richly endowed with diverse factor inputs, its growth is hence important for global resource markets that use these inputs across a variety of sector markets. Hence, this provides potential market opportunities for agrarian engagers in this continent, more so small and rural farmers who despite these potentials, may still be vulnerable and poor.

Diversification in farm output endeavors, particularly food outcomes can further substantiate the expansion of markets in this region if performance is boosted, also through facilitated policy interventions and enabling environments. This can be seen as since 2006, the government of Benin tailored strategic measures towards promoting diversification efforts in agriculture, with more recent support towards the initiative by the World Bank's PADA (Agricultural Productivity and Diversification Project). The need for policy has been posited (MAEP, 2011).

As hunger is yet a concern in developing countries and SSA, and proportions of the population yet undernourished and/or malnourished and food needs are yet unmet, examining the markets of food in this region is essential as this can potentially inform policy on state of the markets towards the accessibility, affordability, and availability of various food for consumption. More so and importantly, local food staples.

This is also important to support the trade and markets of these commodities and promote welfare that can sustain survival as a relevant proportion of the dwellers in this region are engaged in agrarian activities. Given population pressures and globalisation amongst others, the need and opportunities for well performing agri-food markets and their trade expansion can be essential in sustaining the food system and other factor input resources.

Well performing markets may boost actor welfare on the food system and promote market growth through expanded food chains (supply chain lines/substitutes and value chain lines/diversification), and consequently encourage competitiveness through growth that is important for globalisation in these food markets. This is more so even especially important for SSAn agri-food markets, farmers and the smallholder farmers with yet unexploited market caveats and niches especially cutting-edge domestically or internationally. Hence, policy informed insights on these markets may be relevant to support the trade development of the agri-food sector to enhance the achievement of broad development plans in place.

3.7 Conclusion

The performance of agricultural markets and stability of food prices is essential in the strategy towards development in Sub-Sahara Africa. Using panel data for thirteen food commodities, panel estimation techniques are used to establish price linkages across food markets. The two-

stage reduced form price model augments the error correction for plausible adjustments of short-term disequilibria. Findings suggest differential impacts across food markets, value-chains and cross-commodity price flows. Tailored trade development policy across commodities and spatial trade infrastructural allocations across these markets have implications for their overall performance and the stability and expansion of food chains. Findings may have bearings for a developing economy market perspective.

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Chapter 4

Functional Food Markets: Panel Evidence from Benin

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Abstract

Well performing agricultural markets are fundamental in food chains. Especially for poorer nations like developing Sub-Saharan African countries, food prices have a key role in food markets. The consumption of healthy food leaves more to be desired in meeting recommended consumption requirements. Using panel data, a recent model that augments the error correction on disequilibrium market relationships examines fruit and vegetable markets. The leafy vegetable and fruit market exhibits positive associations. Trade development policy interventions can facilitate better market services to enhance prices and the markets for food in poorer nations, especially South of the Sahara in Africa.

Keywords: agricultural market, fruit, panel error correction, price mechanism, vegetable

4.1 Introduction

Agricultural markets are crucial for pro-growth and pro-development strategies in Sub-Saharan Africa (SSA) (World Bank, 2008; Barrett, 2008; Sibbhaitu and Qaim, 2017). Further, food and agricultural markets have links and associations for public health (Hawkes and Ruel, 2007). However, more is still left to be desired in linking agricultural policy towards public health (Hawkes and Ruel, 2006). Fruits and vegetables as a case in point portend enormous health benefits (Van Dyun and Pivonka, 2000; FAO, 2020). Their intake for multi-purpose nutrient supplies for the body and dietary aspirations on a variety of choices for idiosyncratic purposes (e.g., see literature by Liu et al., 2000; Rolls, et al., 2004; Ruel, et al., 2005; Boffetta et al., 2010; Bellavia et al., 2013) and/or based on other factors such as food expenditures (Seale et al., 2003; Muhammad et al., 2011) can be linked with the theoretical underpinnings of the theories of industrial organisation (e.g., see Hotelling, 1929; Lancaster, 1966; Eaton and Lipsey, 1975; Dixit and Stiglitz, 1977).

Economic health literature has provided evidence on the important role of fruits and vegetables in fighting the advent of chronic and fatal diseases (Lock et al., 2005; Agudo and Joint FAO/WHO Workshop on Fruit and Vegetables for Health, 2005; FAO, 2020). Hence, the consumption of fruits and vegetables has been encouraged (Agudo and Joint FAO/WHO Workshop on Fruit and Vegetables for Health, 2005; FAO, 2020) and there is a consequent need for empirical policy insights especially for developing countries (Agudo and Joint FAO/WHO Workshop on Fruit and Vegetables for Health, 2005).

More affordable pricing can increase consumption of these fruits and vegetables especially for low-income households like in SSA (Ruel et al., 2005) as poorer countries have been noted to be more sensitive to price and income changes (Seale and Regmi, 2006). However, considering

that consumption leaves more to be desired (FAO, 2003) despite a plethora of health benefits, the productivity outcomes and measures are significantly supported by the performance of their markets as an important factor, and it is hence essential to consider these economic related analyses for aggregate understanding attempts of these food systems (FAO, 2020).

While the fruit and vegetable sector activities are of crucial importance to livelihoods in developing economies where many are engaged in their agrarian production as livelihood means in fetching income and providing employment (FAO, 2020) among other subsistence activities, agricultural markets in developing countries have been noted to be seemingly not well performing (Dillon and Barrett, 2017), thus affecting the food system.

Trade challenges including unaffordable pricing hamper food security attempts for the fruit and vegetable agricultural output especially in developing economy markets (FAO, 2020). This can compromise the broad development attempts and efforts for Sub-Saharan Africa, which have been long-standing (Barrett, 2008). Hence understanding the markets for these commodities can provide empirical policy insights to augment output and coordination in this food system through better pricing and markets among others that support market participation by boosting the welfare of actors. Market supply side welfare activities can leverage better output while consumer welfare can be promoted through variety availability, accessibility, and affordability, a step towards Sustainable Development Goal two.

As pricing is a main factor in food preferences especially for lower-income consumers (Cassady, et al., 2007), understanding these markets is critical and necessary in promoting public health given that it may affect production, accessibility, affordability (FAO, 2020), and

the general intake levels of fruits and vegetables that is still below recommendation according to the Food and Agriculture Organization (FAO, 2013).

Understanding the functioning of their markets therefore, considering better trade development measures towards the poor and vulnerable farmers especially, many of whom reside in rural areas and are actively involved in agrarian production activities, can provide an avenue in fostering already existing developmental efforts in sub-Saharan Africa. This may also enhance food security measures especially in SSA where even recently, countries have been flagged as critical food insecurity spots (WFP and FAO, 2021), and given that market challenges and non-constant price trends of fruit and vegetables are notably relevant that can compromise food security attempts in the region (FAO, 2020). Welfare on the demand and supply sides can be boosted through better market performance.

The study uses producer price data for six vegetable and a fruit commodity to examine their market mechanisms. Cachia (2017) has posited that these agricultural markets may converge with free arbitrage of producers. The study assesses the fruit and vegetable markets individually for comparison purposes and deeper empirical insights.

The study attempts to contribute to extant literature in the following ways: (a) establish the market links for fruit and vegetable agricultural outputs (b) focus on a developing SSA market and farm(er) prices (c) examine price disequilibrium responses for these markets (d) provide policy insights on trade development towards efforts for the broader development strategy for SSA.

The rest of the paper is organised as follows: Section 4.2 presents the literature and conceptualisation, section 4.3 presents the data, section 4.4 presents the method, section 4.5 presents the results and discussions, and section 4.6 ends the study with the conclusion from the findings and policy implications.

4.2 Literature and Conceptualisation

Market analysis of prices for leafy vegetables have been found to suggest disproportionate food insecurity repercussions for the poor (Gockowski et al., 2003). However, studies have documented seemingly inverse relationships of vegetables and cabbage notably (see Kiremere et al., 2006; Mbugua et al., 2011). Well-functioning fruit markets can portend market expansion opportunities and diverse value chains that promote market participation and welfare, further through international markets (Ramadan, 2019). The vegetables indigenous to Africa have been posited to positively impact development and act to save food needs (Grivetti and Ogle, 2000; Gockowski et al., 2003; Kiremere et al., 2006), and their expanded supply chains promote welfare for rural farmers (Minten, et al., 2009). Existing literature on price transmission has continued to attract interest across diverse food market niches. Diverse literature has been documented across vertical and spatial market chains in agri-food markets (Berck et al., 2009; Leibtag, 2009; Baquedano and Liefert, 2014; Timothy et al., 2014; von Cramon-Taubadel, 2017). Gilbert et al., (2017) examine seasonality trends among thirteen commodities in seven African countries. They empirically reveal that seasonality gaps for the African food markets are most sizeable in vegetables and fruit commodities. Götz et al., (2014) found existing asymmetries in their study of the grapefruit market in Israel. Similarly, Santeramo (2015) have not found evidence for symmetry in the price flows for fresh vegetables spatially, specifying an asymmetric threshold autoregressive model. In the Egyptian tomato

market, Ahmed (2018) has further found the existence of asymmetric dependence across actor chain niches.

Still on perishable product markets, Santeramo and von Cramon Taubadel (2016) employing error correction estimation for different fruit and vegetable commodities found that symmetric and asymmetric transmission on vertical chains may vary with the extent of product perishability. Otherwhere FAO/LEI (2015) examine price flow effects and empirically find evidence that broadly, the impact on reduced food waste and loss in EU may not be beneficial to SSA. Ward (1982) also documented evidence of asymmetric responses on fresh vegetables.

Ard et al., (2007) have found that availability of fruit and vegetables is inversely affected by cost. Elsewhere, dietary aspirations for fruits and vegetables have also been linked to gender aspects of the community (Williams et al., 2012; Kehoe et al., 2019). Developing the sector of fruits and vegetables in developing economies can be positively associated with food and nutrition security of market actors (Joosten et al., 2015).

While better performing markets of fruits and vegetables can provide potential opportunities outside of primary agrarian activities, access to higher value chains (e.g., see Taylor et al., 2009) for farmers may also still be affected if the markets are not properly coordinated, especially for secondary and tertiary activities despite the potentials for diversification.

According to Aksoy and Beghin (2005), comparatively, more dynamic trade has been seen for various tropical fruits including pineapple amongst others. The study utilises data for producer prices of six vegetable commodities, cabbage (*Brassica oleracea var. capitata*), carrot (*Daucus*

carota var. sativus), pepper (*Capsicum*), tomato (*Solanum lycopersicum*), okra (*Abelmoschus esculentus*), leafy vegetables, and a fruit pineapple (*Ananas comosus*).

In line with Abdulai (2000), spatial domestic markets in a developing SSA economy are engaged in this study, however, the current study differs in employing panel estimation techniques as opposed to time series techniques in his study. Recent studies have employed panel estimation techniques in differentiated agri-food markets (Loy and Weiss, 2019; Bittmann et al., 2020). Zamani et al. (2018) examined pass-through in the Iranian poultry market. The authors empirically show that reducing the cost of searching in developing country markets can lead to more affordable prices.

The current study makes use of a recent mean group error correction estimation that augments the error correction model (see Nagel, 2017) for the existence of possible short-run adjustments, in the fruit and vegetable market of Benin. Market and trade development literature in developing SSA economies continues to be of importance towards the broad development strategies. The welfare of market actors and the performance of markets can direct focus on trade development policy detail.

4.3 Data

The study employs a recent panel data set from the Ministry of Agriculture, Livestock and Fisheries in Benin that covers producer prices for fruit and vegetable commodities. Summary market samples that constitute the study are presented in table 4.1. Based on data availability, spatial markets for a fruit commodity are examined, as well as six vegetable commodities.

Table 4.1: Data sample description

Commodity	Region	Department	Commune/Market	Reference Period
Cabbage	Central Southern	Collines Zou	Ouao Houjro	June 2010 to October 2015
Leafy vegetable	Southern Central	Zou Collines	Bohicon Glazoué	June 2010 to October 2015
Tomato	Northern Central	Alibori Collines	Malanville Glazoué	March 2010 to January 2017
Okra	Southern Northern	Zou Atacora	Bohicon Péhunco	March 2010 to January 2017
Pepper	Southern Northern	Littoral Atacora	Cotonou(Dantokpa) Péhunco	June 2009 to October 2015
Carrot	Southern Central	Littoral Collines	Cotonou(Dantokpa) Ouao	June 2009 to October 2015
Pineapple	Southern Southern	Plateau Zou	Yoko Bohicon	March 2010 to October 2015
	Southern Central	Littoral Collines	Cotonou(Dantokpa) Ouao	March 2010 to October 2015

Summary statistics of commodities are provided in table 4.2. On average, cabbage prices are less affordable compared to the prices of other leafy vegetables. Following similarly, their price offers seemingly consider a broad range interval compared to other leafy vegetables.

Table 4.2: Summary statistics

Commodity		Mean	Std. Dev.
Cabbage	Overall	543.785	219.149
	Between		299.879
	Within		52.097
Leafy vegetable	Overall	197.269	91.738
	Between		31.058
	Within		89.050
Tomato	Overall	390.723	180.436
	Between		73.778
	Within		172.682
Okra	Overall	351.807	157.314
	Between		98.313
	Within		141.016
Pepper	Overall	565.779	126.900
	Between		56.569
	Within		120.388
Carrot	Overall	2618.831	1342.672
	Between		514.811
	Within		1292.048
Pineapple	Overall	124.625	39.477
	Between		44.912
	Within		23.291
	Overall	103.654	21.096
	Between		10.742
	Within		19.671

Source: Own computation. Prices are in CFA Franc (West African currency). The CFA Franc is the official currency of West Africa, 1 XOF is equivalent to about 0.00181 USD

However, in the fruit vegetable markets, diet fundamentals (see Katsumata et al., 2007) like tomato and okra seemingly trend together, while a quite distinctive price market exist for the pepper vegetable.

The study employs the Pesaran (2004; 2015) cross-section dependence test to establish dependency relationships across spatial markets. Estimates of the Pesaran (2004; 2015) test of cross-section dependence are displayed in table 4.3.

Table 4.3: Cross-section dependence test

Market	CD-test	p-value
Cabbage	-1.079	0.281 ³
Leafy vegetables	2.476	0.013
Tomato	2.186	0.029
Okra	0.533	0.594
Carrot	-2.868	0.004
Pepper	8.066	0.000
Pineapple	1.568	0.117
	-2.181	0.029

Source: Own computation

CD=Cross-section Dependence

Based on the estimates, the presence of cross-section dependence among markets leads us to the unit root test in the presence of cross-section dependence (Pesaran, 2007) and Hadri (2000) panel test in the presence of cross-sectional independence. Table 4.4 further also presents a biased-adjusted test of residual cross-section independence (Breusch and Pagan, 1980; Pesaran et al., 2008; Pesaran, 2004) in commodity markets. Findings are robust for the test by Pesaran et al., (2008). The test rejects the null hypothesis of no correlation among the commodity markets (see Burdisso and Sangiácomo, 2016).

³ Hence Hadri (2000) panel unit root test for balanced panels

Table 4.4: Residual cross-section independence

Test	Statistic	<i>p</i> -value
Cabbage-Leafy vegetables		
LM	.0363	0.8490
LM adj*	-3.166	0.0015
LM CD*	.1904	0.8490
Tomato-Okra		
LM	1.833	0.1758
LM adj*	2.919	0.0035
LM CD*	1.354	0.1758
Carrot-Pepper		
LM	3.514	0.0609
LM adj*	8.559	0.0000
LM CD*	-1.875	0.0609
Pineapple		
LM	.4413	0.5065
LM adj*	-1.912	0.0559
LM CD*	.6643	0.5065

Source: Own computation

*two sided test

Findings are presented as shown in table 4.5 for the Pesaran test of unit root in markets with cross-section dependence.

Table 4.5: Unit root test

Market	Leafy Vegetables	Tomato	Carrot	Pepper	Pineapple (x_{it})
	1%: -1.95	1%: -1.94	1%: -1.94	1%: -1.94	1%: -1.95
Critical Values	5%: -1.71	5%: -1.71	5%: -1.71	5%: -1.71	5%: -1.71
	10%: -1.57	10%: -1.56	10%: -1.56	10%: -1.56	10%: -1.57

Source: Own computation

Table 4.5 is the Pesaran (2007) unit root test in the presence of cross-section dependence.

Findings of the Hadri (2000) unit root test for balanced panels are shown in table 4.6.

Table 4.6: Test of unit root

Variable	Hadri test
$C_{i,t}^p$	2.1544**
$dC_{i,t}^p$	-1.3985
$O_{i,t}^p$	5.8075***
$dO_{i,t}^p$	-1.4203
$P_{i,t}^p$	6.5609***
$dP_{i,t}^p$	-1.2765

Source: Own computation, ***p<0.01, **p<0.05
HO: All panels are stationary

Following first differenced stationarity of variables, the study employs the Westerlund (2007) test for cointegration. Findings are displayed as shown in table 4.7. The null hypothesis of no cointegration is rejected at 1% level in all markets.

Table 4.7: Cointegration test

Statistic	Value	Z-value	p-value
Cabbage-leafy vegetables			
Group mean test			
G_t	-4.102	-3.659	0.000
G_a	-35.843	-7.456	0.000
Panel test			
P_t	-6.812	-4.793	0.000
P_a	-45.216	-13.056	0.000
Tomato-Okra			
Group mean test			
G_t	-4.550	-4.365	0.000
G_a	-41.947	-9.042	0.000
Panel test			
P_t	-7.385	-5.368	0.000
P_a	-51.065	-14.919	0.000
Carrot-pepper			
Group mean test			
G_t	-4.174	-3.772	0.000
G_a	-31.160	-6.239	0.000
Panel test			
P_t	-5.936	-3.912	0.000
P_a	-34.256	-9.565	0.000
Pineapple			
Group mean test			
G_t	-4.082	-3.627	0.000
G_a	-27.442	-5.274	0.000
Panel test			
P_t	-5.959	-3.934	0.000
P_a	-28.387	-7.695	0.000

Source: Own computation

Establishing the existence of cointegration among our variables, the study can hence proceed in applying the second stage error correction model for potential short-run adjustments back to the long-run equilibrium from short-term disequilibria.

4.4 Methodology

Establishing cointegration links for variables, the reduced form model is specified as follows:

$$(1) \quad P_{i,t}^b = \beta_1 + \beta_2 P_{i,t}^a + \varepsilon_{i,t}$$

$$(2) \quad \Delta P_{i,t}^b = \gamma_1 + \sum_{i=1}^n (\gamma_2 \epsilon_{i,t-1}) + \sum_{i=1}^n (\gamma_3 \Delta P_{i,t-1}^a) + \dots + \mu_{i,t}$$

Where $P_{i,t}^b$ is price in the outcome market at time t , $P_{i,t}^a$ is price of the predictor market at time t , and ϵ_t is the error. Δ is the first-difference operator, β_1 and β_2 are the first stage coefficients to be estimated, $\epsilon_{i,t-1}$ is the equilibrium distortion from the first stage (1). γ_1 is the intercept, γ_2 is the coefficient for the speed of adjustment back to the long-run equilibrium.

4.5 Results and Discussion

Estimates for the long-run and adjustment coefficients are shown in table 4.8. The findings are all statistically different from zero at 1% level of significance. Magnitudes of short-run estimations are all negative as expected.

Table 4.8: Estimates

Market	Long-run Coefficients	Average	Error Correction ⁴
Cabbage-leafy vegetables	0.209*** (6.93e-16)		-0.706*** (-5.563)
Tomato-okra	0.700*** (4.90e-16)		-0.335*** (-3.762)
Carrot-pepper	-0.126*** (3.51e-15)		-0.399*** (-3.551)
Pineapple	0.274*** (2.09e-16)		-0.665*** (-5.003)

*** $p \leq 0.01$

Source: Own computation

Price transmission is fastest in the tomato-okra market. This may be in line with the importance of the commodity in the livelihood of the people as indispensable and fundamental for food diets (Katsumata et al., 2007).

⁴ T-bar statistic for cointegration in parenthesis

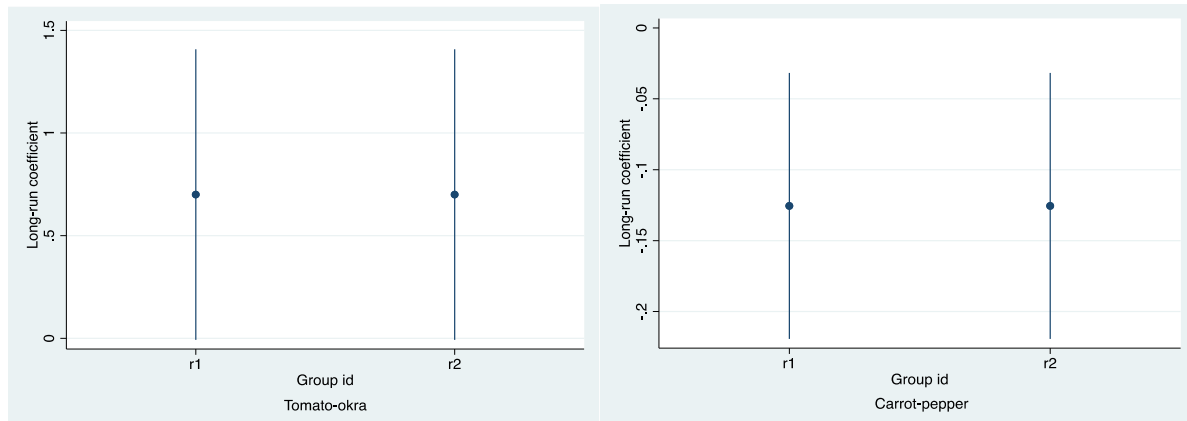


Figure 4.1: Fruit vegetables

The cross-commodity price transmission between carrot and pepper is negative suggesting that the flow of prices in these markets may be inversely related (see 4.1). An increase in the price of pepper may mean a reduction in carrot prices by about 12.6franc. The markets for leafy vegetables (see figure 4.2) on the other hand are positively associated such that an increase in the price of leafy vegetables may mean an increase in cabbage prices by about 20franc.

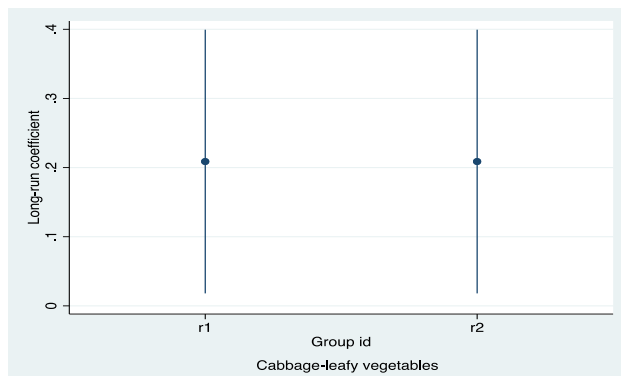


Figure 4.2: Leafy vegetables

Leafy vegetables may display coordination in their markets. Similarly in the domestic spatial fruit markets for pineapples, prices are positively associated in the Southern and Central regions as shown further on the plot of figure 4.3. An increase in the price of pineapples in

some Southern regions may mean an increase in the price in other Southern and Central regions. There is evidence that markets are positively correlated spatially.

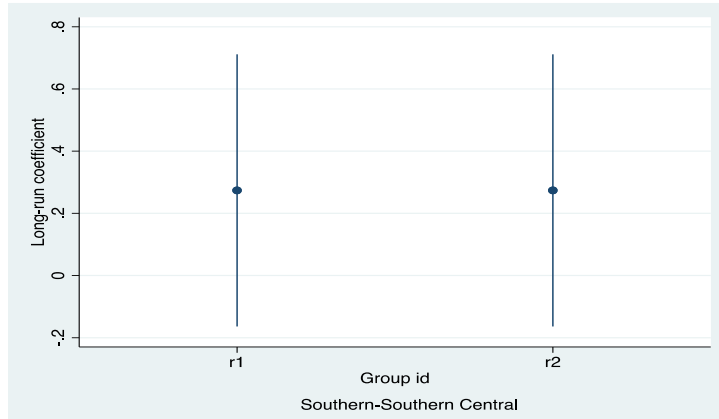


Figure 4.3: Fruit market

While the long-run price transmission is fastest in the tomato and okra markets, the error correcting speed for disequilibrium is fastest in the markets for leafy vegetables. The tomato and okra market exhibit the least disequilibrium adjustments of negative deviations from the long-run equilibrium, which is corrected for by about 33.5% in the following month.

4.6 Conclusion

The price mechanism of fruit and vegetable markets is important for broad trade development in food markets and enhancing access to these food through pricing. Using panel data for seven vegetable and fruit commodities in Benin, panel estimation techniques were employed.

Price transmission is slow in more of the vegetable markets, and fruit market. Better market mechanisms that can facilitate more symmetric price responses in these markets can augment market performance for broader outcomes. In this light market policy directed towards service infrastructure and facilities in these agricultural markets may boost the functioning of markets

for better performance and outcomes. Factors and challenges towards establishing secondary activities across fruit chains may be an interesting area to expand literature on the supply and value chains of these markets.

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Chapter 5

Mobile money and vertical price transmission: Evidence for the Palm Oil Market in Cameroon

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Abstract

Mobile payment increases access to financial services, especially for less wealthier segments of the population in Sub-Saharan Africa. This study evaluates the impact of mobile payment usage on vertical price transmission from wholesale to retail. Using a monthly panel data set from Cameroon, we estimate the relationship between retail and wholesale prices for palm oil and find that price transmission is incomplete in the long-run. Mobile payment reduces average equilibrium mark-ups and increases price transmission. A panel error-correction model is employed to examine short-run adjustments. The usage of cashless payments is associated with faster speeds of adjustment back to the long-run equilibrium. The results are in line with theory of mobile money reducing transactions cost by creating more financial transparency and reducing asymmetric information, which can promote more competitive markets.

Keywords: Mobile money, price transmission, panel error correction, Cameroon

5.1 Introduction

Most transactions in modern economies result in a monetary payment. In making these payments, households and businesses use different processes. Traditionally cash payments dominated; today, however, payments are increasingly becoming cashless. The use of different processes is subject to innovations in payment transactions and to changes in the payment consumer habits and business practice. Mobile Money is such an innovation. Mobile Money is a service that stores funds in an electronic account linked to a cell phone number. The service allows users to store, send and receive money and other related services using their cell phone. They can make purchases in stores or online, and to pay bills.

Much empirical research has been done on the impact of mobile money systems as means to access financial services. For example, access to financial services, for less wealthier segments of the population is an important topic especially for developing countries (Suri, 2017). Further, in developing countries, Mobile Money lowers transaction costs especially when transaction partners are largely geographically separated (Suri, 2017). For example, transaction costs in terms of travelling cost might be high and can be saved (Jack and Suri, 2011). On the other hand, holding cash might be risky when crime is high (Economides and Jeziorski, 2017), especially for high value transactions. The use of Mobile Money is associated with increases in household savings (Suri and Jack, 2016) and consumption (Munyegera and Matsumoto, 2016). In addition, mobile money helps to maintain explicit credit and informal insurance arrangements (Jack et al., 2013).

To the best of our knowledge, there is no study that investigates the impact of mobile money on price transmission rates along the value chain. The objective of this study is to fill this gap.

Studying the price transmission between markets is important in characterising market efficiency and studying market structures, giving insights into the division of economic rents among participants and overall welfare (Weyl and Fabinger, 2013).

A substantial body of empirical studies attempt to quantify price transmission or pass-through rates in developing countries. Given that Mobile Money is argued to influence transaction costs across time and space, we highlight some studies on price transmission related to infrastructure and markets, which are geographically separated. For a detailed review of literature on price transmission and market integration in the context of African countries see Cramon-Taubadel, 2017.

Abdulai (2000) employed a threshold cointegration test with asymmetric adjustments to examine spatial price linkages between local markets in Ghana. Using monthly price data, he found evidence of asymmetric price transmission. Kouyaté and Cramon-Taubadel (2016) examined the distance and border effects on price transmission. Shively and Thapa (2017) found that transportation infrastructure has an important impact on price determination, spatial and temporal price transmission in Nepal. Zamani et al. (2018) found incomplete transmission rates of farm gate prices to retail prices in the Iranian poultry market and conclude that lower consumer search costs are associated with lower prices, a more complete and faster price transmission.

We contribute to the literature on vertical price transmission by estimating the impact of mobile money usage on wholesale to retail for palm oil in Cameroon. We use a unique panel data set that covers the period from January 2016 to December 2019. We utilise a panel dataset from individual palm oil traders in the Southwest region of Cameroon. We match price data on retail

and wholesale level with a variable that measures the average monthly transactions using mobile money. We find that Mobile Money usage leads to lower retail prices and smaller mark-ups, more complete price transmissions and speedier adjustments back to long-run price cost equilibria.

The rest of the paper is organised as follows. Section 5.2 provides an overview of the palm oil market in Cameroon. Section 5.3 highlights the importance of Mobile Money as a tool of financial inclusion in Cameroon. Section 5.4 discusses the data employed in analysis and section 5.5 outlines the empirical strategy. The empirical findings for the long-run and short-run dynamics are presented in the fifth section. Finally, in section 5.6, we summarise and conclude.

5.2 The Palm Oil Market and Mobile Money

The palm oil sector is important for Cameroon's economy and has raised some attention in the context of international trade. According to Voituriez (2005), palm oil is the most important vegetable oil in terms of volume. There is a projected increase in demand for palm oil uses as it becomes the most important vegetable oil worldwide, accounting for about 39% of global vegetable oils production and leading vegetable oils trade (USDA, 2011). There is also a recent debate about declining marginal total vegetable production; and declining trends in biofuels use, from rising competitiveness with animal fats and recycled oils (USDA, 2018).

Cameroon remains one of the major exporters of oil palm in Middle Africa. The value of agricultural production has fluctuated in the past decades, but the country has yet boosted export value-based quantity in Africa (Ngando et al., 2011). Attempts on market liberalisation policies have tried to stabilise and boost the agricultural sector. The palm oil sector constitutes

an important segment of Cameroon's economy, two folds in both exports and domestic consumption. 80% of the population is actively engaged in its consumption as a staple cooking ingredient (Ngando et al., 2011).

One of the main palm oil producing regions is Tiko. Oil palm production in the Tiko area is typically in the hands of individuals and privately-owned artisanal mills. Artisanal processing dominates transformation activities. Marketing activities attract distribution channels to other regions of the country for household consumption and as raw material input to industrial uses. Palm farmers in the area are major partakers in oil palm production activities and distribute to buyers at different scales from wholesale sales to retail sales. Individual palm oil producers (non-industrial palm oil sector) produce for subsistence and mainly domestic commercial ends, having a chain distribution inclusive of wholesalers and retailers. Company production (industrial production) constitutes export and domestic ends.

5.3 The Mobile Money infrastructure in Cameroon

As mentioned, access to financial services, for less wealthier segments of the population is an important topic especially for developing countries. There are costs and institutional challenges to access formal banking services especially in largely cash-based emerging economies (Aron, 2018). Demirgüç-Kunt et al. (2015) found that insufficient funds, access to the financial institution, and lack of necessary documentation are among the barriers that prevent adults in Sub-Saharan Africa from having an account at a financial institution. Only 7% of adults reported the use of credit or debit cards in the region, and with the share of mobile phone ownership being three and a half times higher than debit card ownerships, mobile phones will potentially keep providing more of digital payment solutions (Demirgüç-Kunt et al., 2015).

Mobile Money is an instrument of mobile financial services providing payment services through digital means on mobile phones. The alternative means of payment in Cameroon is typically cash, which has been the main payment means prior to the added alternative of Mobile Money.

In Cameroon, Banks may require a minimum of FCFA 25,000 (approx. 38 euro) and FCFA 250,000 (approx. 381 euro) to create current and deposit accounts respectively, indeed significant sums for the lower income proportions of inhabitants (de Bruijn et al., 2017). Hence the Mobile Money service is of benefit and expands financial services far reaching to poorer segments of the population.

Two service providers which are also mobile network operators dominate the mobile money market coverage in Cameroon (MTN and Orange), accounting for 5.4 million registered users, which is about three times more than bank account ownerships in the country (Talom and Tengeh, 2019). While the Mobile Money service is provided in partnership with a commercial bank due to rights on the distribution of electronic money, expansion in the rate of financial inclusion has risen by about 20% in less than a decade, between 2012 from the time of its official launching by MTN and Orange, and 2017 (Business in Cameroon, 2015; BEAC, 2017; FINMARK Trust, 2017; Business in Cameroon, 2018; Talom and Tengeh, 2019). Attempts in infrastructural upgrades and market linkages have been made, however inadequate infrastructural and institutional services such as unreliable electricity supplies, unstable networks and interrupted transmissions are still challenges for mobile money users (Talom and Tengeh, 2019).

5.4 Data

Monthly observations of wholesale and retail price series for palm oil (*Elaeis guineensis*), as well as the use of cashless payment (mobile money) based on data from the agricultural post Mondoni-Tiko Sub-Division is used. The panel data set covers the period from January 2016 to December 2019 summing up to 960 observations. The data was collected in the Southwest Region of Cameroon, Mondoni-Tiko. Tiko is a prominent palm oil production zone in Cameroon, and home to both industrial as well as non-industrial palm oil production. Figure 5.1 presents the map of Tiko showing palm producing villages and the areas sampled for the current study.

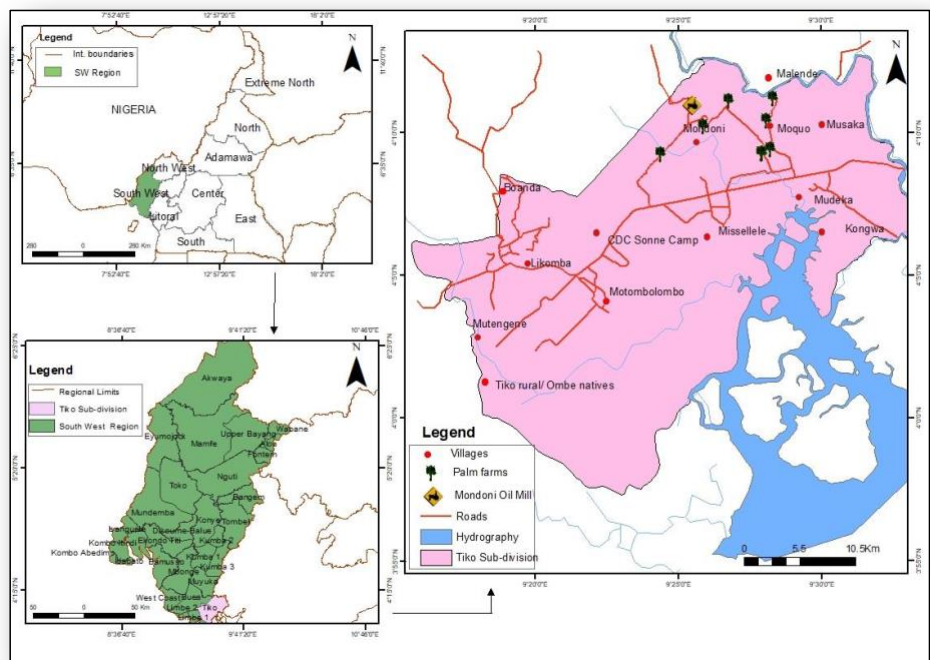


Fig. 5.1: Map of Tiko area showing palm producing areas (Source: Own representation using data from the National Institute of Statistics Cameroon, 2020)

The data was obtained through a multistage sampling procedure. Two palm oil producing villages (Mondoni and Moquo) were selected in the first stage within Tiko. Two farming areas were each randomly selected from these villages (Njopongo farming area and Mukunda farming area from Mondoni; Njock farming area and small Moquo farming area, from Moquo), and a further eight palm oil traders (dealing in both wholesale and retail) each randomly

selected from the farming areas. Thirty-two traders constituted the original rounds of the survey but due to missing and other inconsistent observations, the final balanced panel constitutes of 20 traders. These traders distribute to buyers at different scales from wholesale sales to retail sales. Participants were asked on a monthly basis to state information about market transactions including the wholesale, retail price and the payment method, i.e. cash or cashless. Thus, a price observation in our panel represents the average retail price and wholesale price for a litre of palm oil in one month. A higher frequency of transactions is not available to us.

Several mobile money providers exist across Sub-Saharan Africa. Typical for respondents during the sample period was the use of MTN Mobile Money, whose telecommunication service is the main provider in the country (New Faces New Voices et al., 2020).

Measuring the use of Mobile Money is not trivial. For example, measuring the use of Mobile Money by user accounts can lead to multiple counting if several accounts are held with different providers. If registered customers are inactive, this leads to an overestimation of actual participation. If unregistered customers use the service intensively, total usage is underestimated (Aron, 2018).

We measure the use of mobile money and the alternative use of cash paying directly in days per month. All transactions during a day were made either in cash or cashless or at least most transactions during those days. Information that is more detailed, i.e. on single transactions, is not available. The alternative payment means was cash, which constituted the regular payment means. To capture the relative effect of cashless transactions to other payment means, the variable $D_{i,t}$ is the percentage use of mobile money in trade transactions relative to cash in a

month: $D_{i,t} = \frac{Mobile}{Mobile+Cash}$. Table 5.1 presents the descriptive statistics.

Table 5.1: Descriptive Statistics

		Mean	Std. Dev.	Min.	Max.
Retail price ($P_{i,t}^r$)	Overall	554.167	49.852	500	600
	Between		24.173	516.667	587.5
	Within		43.926	466.667	637.5
Wholesale price ($P_{i,t}^w$)	Overall	442.216	55.282	381.3	564
	Between		29.876	400.05	515.633
	Within		46.981	307.883	588.049
Digital payment ($D_{i,t}$)	Overall	.431	.182	0	.8
	Between		.027	.377	.468
	Within		.180	-.037	.834

N = 960; Source: Own computation from data from Mondoni (2020) using STATA 15.1.

Note: Prices are in fca (Central African currency) per kilogramme of palm oil sales. The CFA Franc is the official currency of Cameroon, 1 CFA is equivalent to about 0.00166395 USD.

The average percentage use of cashless payments relative to cash payments is 43 percent. While daily transactions using cash is the regular routine, the use of mobile money, a cashless means is still not yet as frequent. The variation of use is more pronounced over time (.104) than across individuals (.013). Based on the data, cash payments occur least frequently at a transaction ratio of 0.8, on the days where mobile money was used most frequently and at maximum, over time. Cashless payments occur least frequently at a transaction ratio of zero, where all payment transactions were done using cash only.

The fluctuations are considerable over time. The high fluctuation can be explained by unreliable electricity supplies, which commonly affect the efficiency of the service provision (Aker and Mbiti, 2010). Unstable networks and interrupted transmissions lead to high spikes in the use of mobile money. Irregular power transmissions from the electricity supplier also have a negative impact on users of Mobile Money services. During power outages, the loss of mobile signals makes it impossible to conduct transactions. In some cases, mobile devices are irreparably damaged (Talom and Tengeh, 2019).

Based on the data, the average price per litre of palm oil is 442frs at wholesale level and about 554frs at the retail level. The variation in the retail and wholesale prices is more pronounced over time than between the traders. The minimum retail price per litre of palm oil is given at 500frs and the maximum at 600frs. The minimum wholesale price per litre is given at about 381frs and the maximum at about 564frs.

Price series are often found to be non-stationary. We test the hypothesis of non-stationarity of our price series and the share of digital payments. The Hadri (2000) test employs a lagrange multiplier statistic with the null hypothesis that all panels are stationary against the alternative of at least one panel containing unit root. Findings are presented in table 5.2.

Table 5.2: Test of unit root

Variable	Hadri test
$P_{i,t}^r$	18.073***
$dP_{i,t}^r$	-4.385
$P_{i,t}^w$	24.977***
$dP_{i,t}^w$	-4.353
$D_{i,t}$	9.432***
$dD_{i,t}$	-4.395
$P_{i,t}^w \cdot D_{i,t}$	11.458***
$dP_{i,t}^w \cdot D_{i,t}$	-4.321

Source: Own computation from data from Mondoni (2020) using STATA 15.1.

Note: The values are significantly different from zero at *** $p < 0.01$

HO: All panels are stationary

The test of non-stationarity supports the presence of unit root in levels. The differenced variables are stationary. The unit root tests including a deterministic trend can be found in the appendix.

We can hence proceed with our test of cointegration given that the price series and digital payments are integrated of the order 1, $I(1)$. If there is a linear combination, which is $I(0)$, then digital payments, retail and wholesale prices are said to be cointegrated (Engle and Granger,

1987). The null hypothesis of no cointegration can be tested using the augmented Dickey Fuller test on the residuals of the regression of retail prices on wholesale prices. Rejecting the null hypothesis implies that residuals are stationary, i.e. there is a long-run relationship between the price series. We employ a straightforward generalisation of this test idea in a heterogeneous panel context (Pedroni, 1999, 2004). The tests perform well in panels with smaller cross-sectional dimension compared to time dimension (Pedroni, 2004), which is the case here. The alternative hypothesis of the tests is that the variables are cointegrated in all panels. All three statistics presented in Table 5.3 are adjusted for serial correlation (Newey and West, 1987).

Table 5.3: Cointegration test

Test	Statistic
Modified Phillips-Perron	-16.552***
Phillips-Perron	-33.260***
Augmented Dickey Fuller	-31.979***

Source: Own computation from data from Mondoni (2020) using STATA 15.1.
Note: The values are significantly different from zero at ***p<0.01, **p<0.05, *p<0.1.
HO: No Cointegration

We reject the null hypothesis of no cointegration. Given that the price panel is non-stationary and cointegrated, there exists a long-run relationship between the variables, which motivates the empirical model in the next section.

5.5 Empirical Model

To test the impact of cashless payment on price transmission we start with a standard reduced form model for $i=1, \dots, n=20$ panel members in month $t=1, \dots, T=48$:

$$P_{i,t}^r = \alpha_1 + \alpha_2 P_{i,t}^w + \alpha_3 D_{i,t} + \alpha_4 (P_{i,t}^w D_{i,t}) + v_i + \epsilon_{i,t} \quad (1)$$

where $P_{i,t}^r$ denotes the retail price of region i at time t , $P_{i,t}^w$ denotes the corresponding wholesale price, $D_{i,t}$ is the share of cashless payment used in transactions. v_i is a random effect that is uncorrelated with the explanatory variables and the error term $\epsilon_{i,t}$. We interpret the error term as deviation from long-run equilibrium. If prices are non-stationary and $\epsilon_{i,t}$ is stationary, then retail and wholesale prices are said to be cointegrated (Engle and Granger, 1987). Retail prices are assumed to be exogenous.

Transaction costs include the transportation costs of travel, coordination costs between individuals, firms, suppliers or customers, and the costs of time delays. The share of Mobile Money used in all transactions is denoted by $D_{i,t}$. Automated delivery of cash transfers is assumed to reduce uncertainty, coordination costs, and delays. Thus, we assume that $D_{i,t}$ is associated with a reduction of transactions costs.

Neglecting transaction costs for a moment, the coefficient α_2 refers to the long-run price transmission from wholesale to retail, and the constant α_1 is the average difference between retail and wholesale price for any cost level. Retailers compete on prices earning zero profit ($\alpha_1 = 0$), a cost shock is completely transferred to the final price if ($\alpha_2 = 1$). In the presence of transaction costs, the equilibrium is characterised by price dispersion ($\alpha_1 > 0$; $\alpha_2 \neq 1$).

The coefficient α_3 measures the average impact of transaction costs on the cost-price equilibrium. A negative sign indicates a reduction in equilibrium retailer's mark-up. The coefficient for the interaction term α_4 indicates how long-run price transmission changes with transaction costs. A positive sign indicates that price transmission decreases with transaction cost.

Further, we specify the following panel error correction model,

$$dP_{i,t}^r = \gamma_1 + \gamma_2 \epsilon_{i,t-1} + \gamma_3 (\epsilon_{i,t-1} \cdot D_{i,t-1}) + \dots + \mu_{i,t} \quad (2)$$

where d represents a first-difference operator, lag lengths of first differenced retail and wholesale prices are chosen such that the error $\mu_{i,t}$ is serially uncorrelated, and $\epsilon_{i,t-1}$ is the error correction term from equation (1). γ_2 is the short-run price transmission rate, i.e. the speed of adjustment back to equilibrium, given that the transaction cost measure is zero. γ_3 measures the change in adjustment back to equilibrium for any given transaction cost level given by $D_{i,t-1}$. A negative sign indicates that retail prices move back to equilibrium faster when transaction costs are lower. We test the following hypotheses, which are in line with the idea that the use of Mobile Money facilitates price formation and price movements:

- 1) We expect that lower cost of Mobile Money usage is associated with lower retail prices, $\alpha_3 < 0$.
- 2) The use of Mobile Money increases price transmission, $\alpha_4 > 0$.
- 3) Mobile Money usage is associated with higher speed of adjustments back to long-run equilibrium, $\gamma_3 < 0$.

5.6 Estimation results

Table 5.4 shows the results of the long-run relationship between retail and wholesale prices as stated in equation (1). Wholesale prices are set exogenous. As shown in the appendix, panel Granger causality tests support this assumption. We report robust standard errors and the estimates of the Random Effects model. The Random Effects (RE) model is valid given that the Hausman test does not reject the hypothesis of no systematic difference between the fixed effects and random effects model.

Table 5.4: Estimates of the Long-run Model

Variables	Retail price $P_{i,t}^r$
Wholesale price ($P_{i,t}^w$)	.655*** (0.051)
Mobile Money ($D_{i,t}$)	-87.435** (35.532)
Interaction ($P_{i,t}^w \cdot D_{i,t}$)	.159** (0.075)
Intercept	271.781*** (23.108)
R ² Overall (within) (between)	.62(.60)(.68)
Wald χ^2 (3)	512.89***
Hausman test χ^2 (3)	0.66

Robust standard errors are in parenthesis. ***p<0.01, **p<0.05, *p<0.1.

Source: Own computation from data from Mondoni (2020) using STATA 15.1.

The null hypothesis that the model has no explanatory power is rejected at 1% significance. The model shows good sample fit. 62 percent of the overall variation in the retail price is explained by the model. Explained variation across panel members (68%) and within time (60%) are also within reasonable ranges.

The negative sign of the coefficient on Mobile Money usage confirms the hypothesis that cashless payments reduce transaction costs. The negative coefficient indicates that the average mark-up between the retail and wholesale price decreases with cashless payments leading to a lower retail price. The constant gives the average mark-up if no Mobile Money is used, i.e. 272 frs. If half of the transactions are paid with Mobile Money, the average mark-up is reduced c.p.

by 43.717 frs, which is roughly 15 percent. This means that access to Mobile Money introduces considerable variation in equilibrium mark-ups. Less price dispersion over time and in space has also been associated with mobile phone coverage in Sub-Saharan Africa (Aker and Fafchamps, 2015). In line with our results, Zamani et al., (2018) find that access to mobile internet decreases the equilibrium mark-up between retail and farm prices.

Ceteris paribus, an increase of the wholesale price by 1 frs CFA is associated with an average increase of the retail price by 0.66 frs. Price transmission is incomplete. This is the reference price transmission if no Mobile Money is used. If for half of the transactions Mobile Money is used, the model predicts price transmission to increase to 0.74, bringing the absolute price transmission rate closer to one.

Figure 5.2 shows simulations of long-run price transmission. The average wholesale price prior to the shock is 442 frs. Simulations for predicted retail prices are done for three scenarios: All payments are done in cash ($D=0$), half of the payments are cashless ($D=0.5$) and all payments are done with Mobile Money ($D=1$). For example, the predicted retail price when half payments are cashless is 552.711 frs ($442*0.655-87.435*0.5+442*0.5+0.159+271.781$), which is between 561.29 for no cashless payments and 544.13 with all payments being done with Mobile Money.

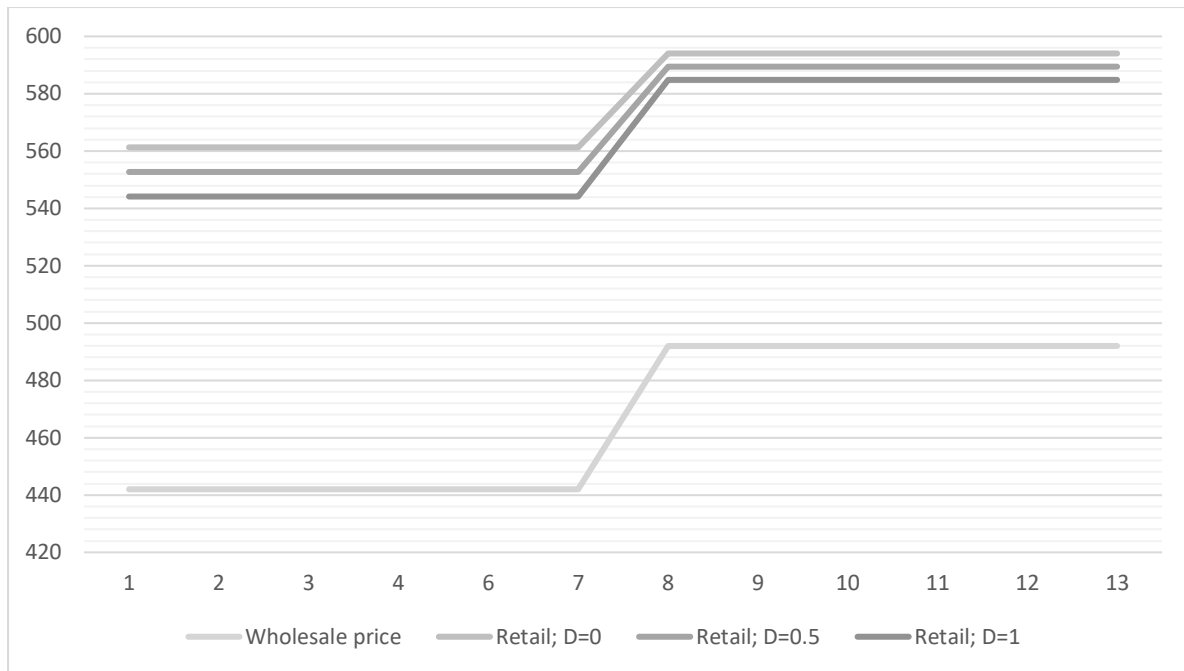


Fig. 5.2: Long-run price transmission simulations (Source: Own computation with data from Mondoni, 2020)

The average wholesale price prior to the shock is 442 frs. The cost shock is one standard deviation of the wholesale price (50 frs.).

In period 8, we simulate the retail price after a shock of a standard deviation of the wholesale price (50 frs). We neglect the adjustment paths over time, which we simulate in a second step. The retail price after the cost shock is 595.04, 589.437 and 544.133 for $D=0$, $D=0.5$ and $D=1$ respectively.

The slope of the wholesale price series is higher than all simulated retail prices, which means that price transmission of a wholesale price shock is incomplete. The slope of the dark shaded retail price (all payments are done cashless) is higher compared to the slopes when only a share of transactions is done with Mobile Money. Thus, the transmission of wholesale price changes is higher when more transactions are done via Mobile Money.

For a higher wholesale price (e.g. after the cost shock) the average mark-up goes down. Further, the average mark-up is lowest for the simulated retail price when all payments are assumed being cashless. Thus, the model predicts to reduce the retail-wholesale mark-up when more payments are cashless, which leads to a lower retail price.

Estimates of the panel error correction model are presented in table 5.5. Selecting an appropriate lag length was done with the Akaike Information Criteria (AIC), Bayesian Information Criteria (BIC) and Hannan-Quinn Information Criteria (HQIC). We selected a lag length of seven in accordance with the AIC and HQIC information criteria. The results are robust to the other lag lengths leading to very similar results.

Table 5.5: Estimates of the Short-run Model

Variables	$dP_{i,t}^r$
Error-Correction Term (ECT_{it-1})	-.127** (.060)
Interaction ($ECT_{it-1} \cdot D_{i,t-1}$)	-.195*** (.058)
First difference wholesale price ($dP_{i,t}^w$)	.698*** (.055)
:	:
:	:
Intercept	-9.947 (3.657)
R^2 Overall (within)(between)	.85(.85)(.27)

Robust standard errors are in parenthesis, ***p<0.01, **p<0.05, *p<0.1.

Source: Own computation from data from Mondoni (2020) using STATA 15.1.

The error correction term is negative as expected. This implies disequilibria of the long-run equilibrium are corrected for at about 12.7% in the following month.

The interaction between the error term and relative share of Mobile Money use is negative as expected, confirming to our third hypothesis that cashless payments are associated with faster speeds of adjustment back to the long-run equilibrium. This indicates that price transmission rates are influenced by the type of payment mediums used for transactions. If half of the transactions are cashless, then long-run disequilibria are adjusted by 9.75% faster, which roughly doubles the speed of adjustment compared to the case with only cash transactions. Figure 5.3 shows stylised adjustment paths for the share of digital payments being 0, 50 and 100 percent.

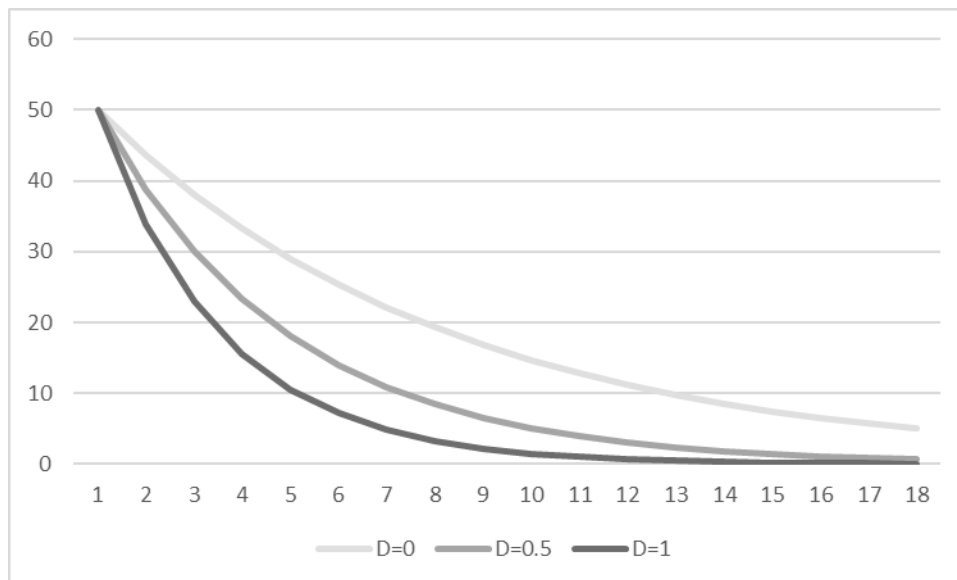


Fig. 5.3: Stylised adjustment paths of retail prices after a wholesale price shock of one standard deviation (50 frs) (Source: Own computation based on data from Mondoni, 2020).

The dark line shows the adjustment path when digital payments are assumed to be 100 percent. We observe that the simulated disequilibrium after five months is only 10 frs compared to 30 frs in the light shaded adjustment path (cashless payments are zero). After 10 months the disequilibrium is largely corrected, which contrasts the adjustment paths back to equilibrium when payments are done in cash. The findings are also in line with earlier findings of Zamani

et al., (2018), who find that access to mobile internet increases speed of adjustment back to equilibrium in the Iranian poultry market.

5.7 Conclusion

In this study, we test the impact of Mobile Money on price transmission for a unique data set of palm oil retail and wholesale prices in the Southwest region of Cameroon. Empirical work is carried out with a standard reduced form model of price transmission within a panel cointegration framework. We find that Mobile Money is associated with a lower retail-wholesale price spread, a higher price transmission from wholesale to retail and faster speed of adjustment back to the long-run equilibrium. The functional capability of networks has impact on the economy. Examples include roads, electricity, oil, gas, mobile phone coverage and finally payment networks. This is both of relevance to policymaking and are of interest to the parties involved in the payment cycle. Unreliable electricity supplies affect the efficiency of the service provision and unstable networks lead to additional cost in the use of Mobile Money.

The results speak in favour of digital payment solutions as means to reduce transaction costs and improve market functioning. Based on our results, investments in infrastructures and associated improvement of network systems would improve price formation and welfare to agents along the value chain. Mobile Money can possibly facilitate financial inclusion in Sub-Saharan Africa and Cameroon, where many among the population cannot afford formal banking services. Over time, there are likely to be shifts in technology with cheaper smartphones and more reliable and secure transmission techniques, which would especially benefit the rural population.

Further research should address systematically the impact of other network structures and examine how these interrelate with specific supply chain characteristics and distribution structures for a broader range of commodities and markets. One caveat to the research presented here is that potential asymmetries in cost pass-through were not examined.

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Appendix

Table 5.6 A-1: Test of unit root with time trend

Variable	Hadri test
$P_{i,t}^r$	11.653***
$dP_{i,t}^r$	-5.911
$P_{i,t}^w$	19.041***
$dP_{i,t}^w$	-5.968
$D_{i,t}$	1.769**
$dD_{i,t}$	-5.265
$P_{i,t}^w \cdot D_{i,t}$	2.424**
$dP_{i,t}^w \cdot D_{i,t}$	-5.204

Source: Own computation from data from Mondoni using STATA 15.1 (2020).

Note: The values are significantly different from zero at *** $p < 0.01$

HO: All panels are stationary

Table 5.7 A-2: Panel Granger causality test

Equation	Excluded	chi2	df	P-Value
$P_{i,t}^r$	$P_{i,t}^W$	53.639***	7	0
	ALL	53.639***	7	0
$P_{i,t}^W$	$P_{i,t}^r$	11.334	7	0.397
	ALL	11.334	7	0.397

Source: Own computation from data from Mondoni using STATA 15.1 (2020) and the command by Abrigo and Love (2016).

Note: Panel Granger causality Wald test with seven lags and removed fixed effects and cross-sectional means. Lag selection is according to Hannan and Quinn information criterion.

Ho: Excluded variable does not Granger-cause Equation variable

Ha: Excluded variable Granger-causes Equation variable

Chapter 6

Mobile Money and Asymmetric Price Transmission: Panel Evidence from Cameroon

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Abstract

There have been recent advances in the use of digital payment solutions in agri-food markets. Mobile Money is a revolutionary tool for increasing access to digital payment solutions in developing countries. Using a reduced-form asymmetric price transmission model we estimate the impact of cashless payments on the speed of adjustment back to equilibrium. The speed of adjustment becomes more symmetric when more transactions are done cashless. This suggests that cashless payments foster competition, which stimulates market efficiency.

Keywords: Mobile money, Asymmetric price transmission, palm oil market, Cameroon

6.1 Introduction

Rapid advances in www-based information technologies have the potential to improve the economic performance of markets and techno-economic development (Jack & Suri, 2014; Aker & Fafchamps, 2015). Empirical evidence suggests that new information technologies lower transaction cost and foster competition, which stimulates market efficiency (Jensen, 2010; Zamani et al., 2018). In line with these findings, Mobile Money has been found to reduce transaction cost in markets (Suri, 2017). One channel how the use of Mobile Money reduces transactions cost is by creating more financial transparency and reducing asymmetric information (Aron, 2018).

Mobile Money is a service that stores funds in an electronic account linked to a cell phone number, which allows users to store, send and receive money using their cell phone.

This is an important technological advancement because less wealthy people especially in developing countries struggle to access financial services (Suri, 2017).

A substantial body of empirical studies attempt to quantify vertical price transmission or cost pass-through rates in developing countries (Cramon-Taubadel, 2017). Asymmetric price transmission is often investigated in terms of speed of adjustment that might differ depending on the sign and size of the disequilibrium (e.g., Abdulai, 2000). Empirical evidence shows that adjustment paths are influenced by the degree of asymmetric information across market participants (Richards et al., 2014).

To the best of our knowledge, there is no study that investigates the impact of Mobile Money on asymmetric price transmission. We study the vegetable oil market using a unique panel data set that covers the period from January 2016 to December 2019. The vegetable oil markets

have received prominent interest recently (OECD-FAO, 2019). Demand prospects for palm oil are notable not only in food uses, but also for industry and biofuels (USDA, 2018). Market supply-side activities play a key role in the availability, affordability and accessibility, especially in the face of upward trends in demand and declining prices (OECD-FAO, 2019).

The rest of the paper is organised as follows: Section 6.2 presents the data and model, section 6.3 presents the findings, and section 6.4 concludes with policy recommendation.

6.2 Data and Model

The study employs a recent panel data set of monthly wholesale and retail prices for palm oil from 2016 to 2019. Data is obtained from the agricultural post in Mondoni, Tiko, Southwest region of Cameroon. The data include usage of Mobile Money as a payment tool as opposed to traditional cash. We measure the use of Mobile Money and the alternative use of cash paying in days per month. All transactions during a day were made either in cash or cashless or at least most transactions during those days. The alternative payment means was cash, which constituted the regular payment means. To capture the relative effect of cashless transactions to other payment means, the variable $D_{(i,t)}$ is the percentage use of Mobile Money in trade transactions relative to cash in a month: $D_{(i,t)} = \text{Mobile} / (\text{Mobile} + \text{Cash})$. Table 6.1 presents the descriptive statistics.

Table 6.1: Descriptive Statistics of Data

	Mean	Std. Dev.	Skewness	Kurtosis
Retail price ($P_{i,t}^r$)	554.167	49.852	-.167	1.028
Wholesale price($P_{i,t}^w$)	442.216	55.282	.420	1.857
Digital payment($D_{i,t}$)	.431	.182	-.695	3.378

N = 960; Source: Own computation from data from Mondoni (2020) using STATA 15.1.

Note: Prices are in fcfa (Central African currency) per kilogramme of palm oil sales. The CFA Franc is the official currency of Cameroon; 1 CFA is equivalent to about 0.00166395 USD.

We utilise an asymmetric panel error correction model approach to obtain short-run price movements for $i=1, \dots, n=20$ panel members in month $t=1, \dots, T=48$: In the long -run,

$$P_{i,t}^r = \alpha_1 + \alpha_2 P_{i,t}^w + \alpha_3 D_{i,t} + \alpha_4 (P_{i,t}^w D_{i,t}) + v_i + \epsilon_{i,t} \quad (1)$$

Where $P_{i,t}^r$ is the retail price of region i at time t , $P_{i,t}^w$, the corresponding wholesale price, $D_{i,t}$, the share of cashless payment used in transactions and v_i a random effect that is uncorrelated with the covariates and the error term $\epsilon_{i,t}$. We interpret the error term as deviation from long-run equilibrium used in equation (2) as shown below.

$$\Delta P_{i,t}^r = \gamma_1 + \gamma_2 (\epsilon_{i,t-1})^+ + \gamma_3 (\epsilon_{i,t-1})^- + \gamma_4 (\epsilon_{i,t-1} D_{i,t-1})^+ + \gamma_5 (\epsilon_{i,t-1} D_{i,t-1})^- \dots + \mu_{i,t} \quad (2)$$

Where $P_{i,t}^r$ is the retail price for each panel at time t , $P_{i,t}^w$ is the wholesale price of I at time t , $D_{i,t}$ the proxy for Mobile Money use. The error correction term is a function of long-run retail-wholesale price relationship ($\epsilon_{i,t} = P_{i,t}^r - \alpha_1 - \alpha_2 P_{i,t}^w - \alpha_3 D_{i,t} - \alpha_4 (P_{i,t}^w D_{i,t}) - v_i$).

Delta (Δ) is the first difference operator, and the error correction term from the first stage estimation is the split into positive and negative deviations ($(\epsilon_{i,t-1})^+$, $(\epsilon_{i,t-1})^-$). γ_2 and γ_3

capture the adjustments for increasing and decreasing prices in the short-run for adjustments back to the long-run equilibria if only cash is used in transactions ($D_{i,t} = 0$). The coefficients γ_4, γ_5 measure the impact of cashless payments on adjustment paths back to equilibrium. To check the panel properties of the data we employ a panel unit root (Hadri, 2000) and a panel cointegration test (Pedroni, 1999).

Panel-based unit root test by (Hadri, 2000) support that panels are integrated of order one.

Table 6.2 shows that the panels are stationary after differencing the data.

Table 6.2: Test of unit root

Variable	Hadri test
$P_{i,t}^r$	18.073***
$dP_{i,t}^r$	-4.385
$P_{i,t}^w$	24.977***
$dP_{i,t}^w$	-4.353
$D_{i,t}$	9.432***
$dD_{i,t}$	-4.395
$P_{i,t}^w \cdot D_{i,t}$	11.458***
$dP_{i,t}^w \cdot D_{i,t}$	-4.321

Source: Own computation from data from Mondoni (2020) using STATA 15.1.

Note: The values are significantly different from zero at *** $p < 0.01$

H₀: All panels are stationary

The Pedroni (1999) test results a cointegration relationship between the variables as indicated in table 6.3.

Table 6.3: Cointegration test

Test	Statistic
Modified Phillips-Perron	-16.552***
Phillips-Perron	-33.260***
Augmented Dickey Fuller	-31.979***

Source: Own computation from data from Mondoni (2020) using STATA 15.1.

Note: The values are significantly different from zero at *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

H₀: No Cointegration

For all test statistics we reject the hypothesis of no cointegration.

6.3 Results

Long-run findings are presented as shown on table 6.4, whereby Mobile Money is found to be associated with faster price transmission rates.

Table 6.4: Estimates of the Long-run Model

Variables	$P_{i,t}^r$
Wholesale price ($P_{i,t}^w$)	.655*** (0.051)
Mobile Money ($D_{i,t}$)	-87.435** (35.532)
Interaction ($P_{i,t}^w \cdot D_{i,t}$)	.159** (0.075)
Intercept	271.781*** (23.108)
R ² Overall (within) (between)	.62(.60)(.68)
Wald χ^2 (3)	512.89***
Hausman test χ^2 (3)	0.66

Robust standard errors are in parenthesis. ***p<0.01, **p<0.05, *p<0.1.

Source: Own computation from data from Mondoni (2020) using STATA 15.1.

Findings of the short-run fixed effects model are presented in table 6.5 below.

Table 6.5: Short-run Estimates

Variables	$\Delta P_{i,t}^r$
Error-Correction Term (ECT_{it-1}) ⁺	-.907***(.128)
Error-Correction Term (ECT_{it-1}) ⁻	-.571***(.121)
Interaction ($ECT_{it-1} \cdot D_{i,t-1}$) ⁺	.348**(.142)
Interaction ($ECT_{it-1} \cdot D_{i,t-1}$) ⁻	-.431***(.132)
First difference wholesale price ($dP_{i,t}^w$)	.588***(.027)
:	:
:	:
Intercept	-14.122***(3.692)
R ² Overall (within)(between)	.93(.95)(.01)
Wald χ^2 (DF) \pm	1.21e+06***

Robust standard errors are in parenthesis. ***p<0.01, **p<0.05, *p<0.1.

Source: Own computation

Short-run estimates are all statistically different from zero. The R-squared overall shows a good fit.

Findings reveal relevant differences between the use of cash payments and Mobile Money in payment transactions. For negative deviations of disequilibria, i.e. after an increase in the wholesale price, figure 6.1 shows simulations of the adjustment path for cash payments only (D=0), half transactions done by mobile money (D=0,5), and all payments done by mobile money (D=1).

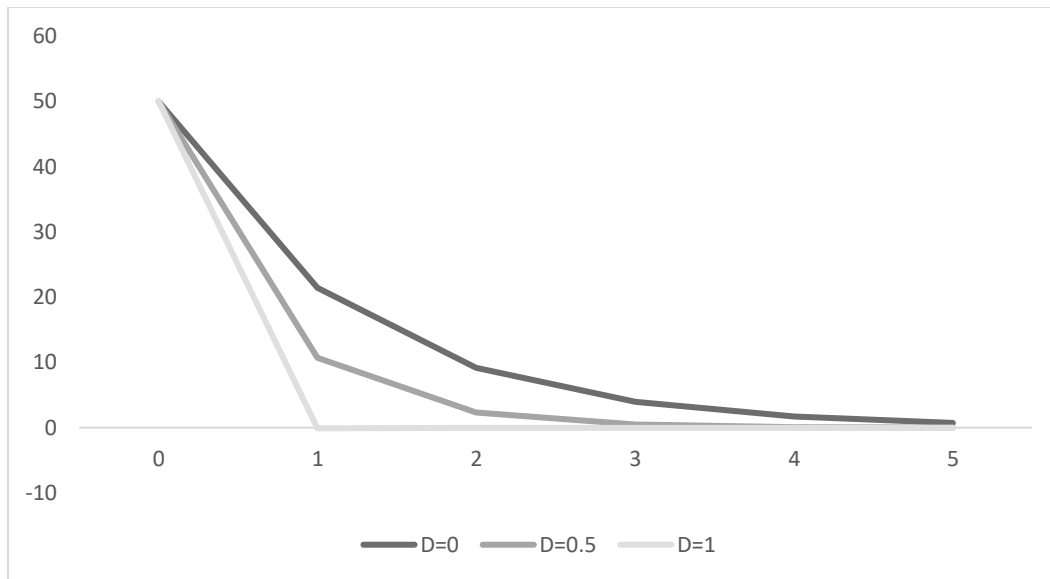


Fig. 6.1: Stylised Adjustment paths for negative shocks of a standard deviation (50frs)
(Source: Own computation based on data from Mondoni, 2020)

After a wholesale price shock of one standard deviation, the disequilibrium is sharply restored after 1 month, when all transactions are done using Mobile Money ($D=1$). The speed of adjustment is considerably slower when transactions are done using cash only ($D=0$). In this example about 90 percent of the disequilibrium is corrected after two months.

As shown in figure 6.2 however, we observe the reverse effect when retail prices go back to the long-run equilibrium after a price increase in the wholesale price. Here, the retail price is below equilibrium and speed of adjustment is fastest when all transactions are done using cash ($D=0$). The disequilibrium is corrected after the second month. Cashless transactions ($D=1$) are less speedy in correcting for adjustments of disequilibria. Corrections of long-run price disequilibrium are done by the fifth month.

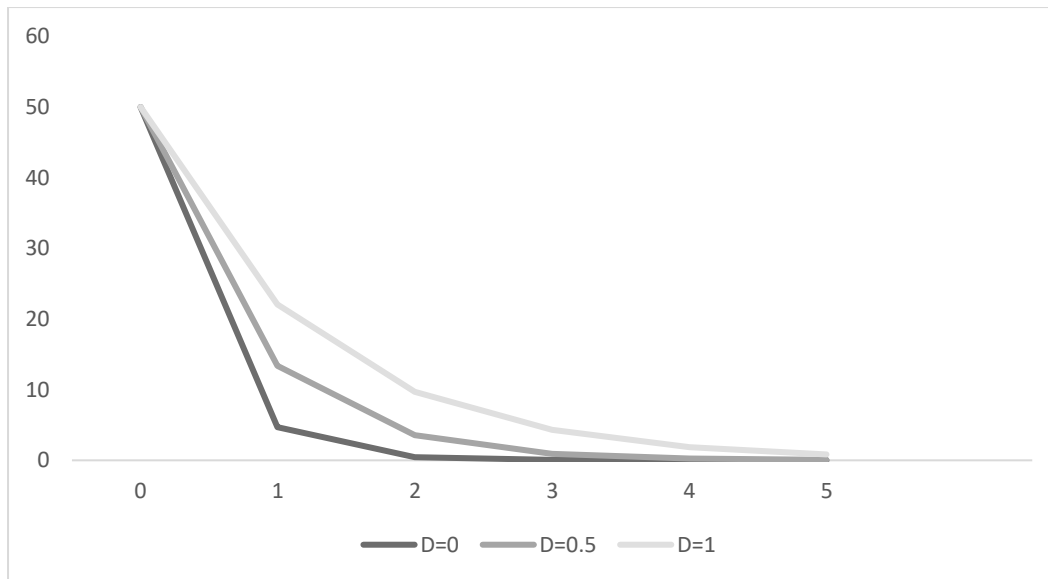


Fig. 6.2: Stylised Adjustment paths for positive shocks of a standard deviation (50frs)
(Source: Own computation based on data from Mondoni, 2020)

While the two scenarios represent the two corner cases of simulations, we now compare the adjustment paths, using the moments of the sample. For an average use of Mobile Money in payment transactions, the speed of adjustment is speedier at 21.55 percent ($50 \cdot .431$) compared to 17.4 percent ($50 \cdot .348$) for rising prices.

We observe asymmetric speed of adjustments: Without Mobile Money price adjustments paths favour the wholesaler, which shifts towards the retailer as Mobile Money use increases. The speed of adjustment becomes more symmetric when more transactions are done through the cashless medium of Mobile Money.

6.4 Conclusion

Payment mediums impact the transmission of prices in agri-food markets. Cashless payments are associated with faster price transmission rates. Mobile Money as cashless payment instruments facilitate reduced cost of searching in markets. Findings suggest asymmetric responses of Mobile Money to long-run price transmission. Additionally, non-linearities exist

in correcting for adjustment speeds of long run disequilibrium for positive and negative shocks across payment mediums. Cashless payments support faster corrections for negative shock impacts on price disequilibrium. Hence, the adoption of new technology and information on wide coverage especially in developing country markets can boost market performance and welfare of market actors.

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Chapter 7

Cost Pass-through on Nut Value Chains: Panel Evidence for West Africa

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Abstract

Vegetable oil is among top in trade share of agricultural commodities. Its declining marginal production despite its prominent household and industrial use, with its food uses on a steadily upward pattern has attracted recent debates. Their grain and oil output witnesses declining prices with a potential for increase in the next decade. While Sub-Saharan Africa yet occupies a small niche in the global market, it continues to witness expansion especially in West Africa. Using a recent panel data set, the study employs reduced-form price models to examine domestic and regional price relationships. The study uses six vegetable oil commodities in five West African countries. Symmetric and asymmetric evaluations are considered for the commodities. Findings suggest that asymmetric behaviour varies across the commodity as it becomes processed. Spatial infrastructural allocations may have implications for market participation, outcomes, and welfare. Tailored market and trade development policies especially in developing countries that ensures total market participation, and an enabling international market environment may present an opportunity towards market expansion and facilitate economic and per capita outcomes while closing the demand-supply gap, for an important commodity with food and industrial uses such as vegetable oil. Findings have implications to promote diversification in these agri-food markets with potential and similar health benefits across alternate commodities, hence prospects for improved food, market and nutrition outcomes in these developing countries.

Key words: Vegetable oilseeds, vegetable oil, domestic and regional markets, price linkages, West Africa

7.1 Introduction

Vegetable oil is among the top in trade share (40%) production of all agricultural commodities (OECD/FAO, 2019). Declining marginal production in its output has attracted recent debates (USDA, 2018; OECD/FAO, 2019). Global production growth is dependent on crushing of oil seeds, which with somewhat lower output, is in line with decreasing vegetable oil output (USDA, 2018; OECD/FAO, 2019). Vegetable oils are prominent in household and industrial uses, remaining of much importance. Food uses are on a steadily upward pattern (USDA, 2018). Per capita availability is projected to increase by 1.2% per annum (p.a) in least developed countries by 2028 (OECD/FAO, 2019).

However, their oil and seeds have witnessed declining prices in the past decade with a potential to increase in the next decade (OECD/FAO, 2019). Global production is projected to expand for soybean and other oil seeds in the next decade at 1.6% p.a and 1.4% p.a respectively, and the majority of the total output to be crushed by the end of the next decade (OECD/FAO, 2019). Availability of substitutes and relative pricing consequently influences demand, which is a factor for the production of crush (USDA, 2018). There is a significant degree of substitutability between vegetable oils (Barthel et al., 2018).

The global palm oil production that outpaced other vegetable oils in the past years is nevertheless not expected to remain steady in growth in the coming decade (OECD/FAO, 2019). The production of peanut oil seeds is however expected to have a slower growth rate compared to soybean oil seeds (OECD/FAO, 2019). Also, about 75% of global soybean consumption is for processing, with a minority amount for eating. Soybean is highly traded internationally (over 40%) and a decrease in its trade expansion is expected in the next decade (OECD/FAO, 2019), however, African soybean output levels are rising at a faster growth rate

per year compared to worldwide production since 1961 (Cornelius and Goldsmith, 2019). The utility of palm kernel oil and palm oil provide variety and dietary aspirations to consumer commodity options, especially in developing countries (Barthel et al, 2018).

Soybean growth witnessed significant expansion in West Africa (Katsumata et al., 2007). However, yields are not significant in the world market as African soybean output accounts for less than a percent of global output, with about 1t/ha (tonne per hectare) compared to 2.2t/ha average yield respectively, perhaps due to inadequate and/or inefficient improved varieties and inputs given the prominence of small-scale cultivation (Katsumata et al., 2007). Production expansion activities for soybean have been notable in the Southern and Northern parts of Benin (Katsumata et al., 2007), hence these areas are broadly considered as covariates in our analysis, and for comparative evaluation with other grains and oil in the same areas.

Patterns that assimilate the concentration of oilseed production to major producing countries can expand price volatility due to declining stock-to-use ratio (OECD/FAO, 2019). Processing/transformation activities are also enhanced in seemingly fetching more income for farmers/producers, with a potential for non-seasonal income smoothing in the case of palm oil (Barthel et al., 2018). Price competitiveness and substitutability of products drives market activities based on market forces such as demand and supply. Theoretical underpinnings have been made on competitive pricing and product substitutability (von Weizsticker, 1984). If more of a commodity form is demanded, producers may be more attracted to increased concentration on the product form or quality, hence demand preferences may attract differentiated products and non-price competing factors. Theories of demand choices and consumer preferences have been put forward in trade models (Hotelling, 1929; Lancaster, 1966; Eaton and Lipsey, 1975; Dixit and Stiglitz, 1977; Eaton and Lipsey, 1989).

Pricing and integration among markets, and the transmission of commodity prices remain important for development policy (von Cramon-Taubadel, 2017) especially in developing countries where broad food security, poverty and development agendas could be affected (Barrett, 2008; World Bank, 2008; Varela et al., 2016). Understanding the functioning of the vegetable oil market may be of importance in the face of increasing demand needs and declining production.

These vegetable oils have more or less similar health impacts as heterogenous consumption choices may be more accounted for by differences attributed to other practical purposes (Foster et al., 2009). Hence, this may support the diversification and marketing of these alternate seed oils for improved agri-food market outcomes. Examining these markets can eventually provide development policy insights for improved food and nutrition outcomes in these developing Sub-Saharan Africa (SSA) countries.

The study adds to existing literature in three ways. (1) The study links production and transformation stages of the value chain individually (grain and oil) and combined (grain-oil) for producer prices in spatial (different market locations) and vertical linkages (upstream and downstream market niches). Manero and Grasso (2005) have evidence insights to support separate modelling of the production and distribution stages of the food chain. (2) The study focusses on an important food commodity, vegetable oil, with top trade share of all agricultural commodities, and economic potentials for development especially in developing SSA economies, with its yet a negligible niche in the global market despite the upward trends of demand (USDA, 2018; OECD/FAO, 2019). The study examines six vegetable oil commodities (cashew (*Anacardium occidentale*), soybean (*Glycine max*), peanut (*Arachis hypogaea*), palm oil, palm kernel oil, peanut oil in five West African countries (Benin, Côte d'Ivoire, Ghana,

Senegal, Mali) based on available data. (3) As markets allow for price signals across commodities (homogenous and non-homogenous), the study examines price flows for homogenous grain (cashew, soybean, peanut) and oil (palm oil, palm kernel oil, peanut oil) commodities, as well as differentiated oil forms of the same commodity (palm oil and palm kernel oil). Efforts in strengthening diversification in the agricultural sector of Benin have been noted (Nguyen and Dizon, 2017). Using weekly and monthly panel data sets, the study employs panel techniques with the asymmetric panel Error Correction Model (ECM).

The rest of the paper is organised as follows. The literature and conceptual framework is discussed in section 7.2, the data description and statistics are presented in section 7.3, the empirical strategy is presented in section 7.4, and the results and discussion in section 7.5. Section 7.6 and 7.7 present policy implications and conclude the study with the limitations.

7.2 Existing empirical literature and conceptual framework

Existing literature on price transmission has shown necessity in agri-food markets. Horizontal price linkages and the integration of markets continue to be of importance especially in spatial food markets (Abdulai, 2000; Barrett, 2001; Barrett and Li, 2002; Kouyaté and von Cramon-Taubadel, 2016). Pricing behaviour across spatial markets is important in examining arbitrage in markets in line with the law of one price (LOP) for homogenous products. Understanding spatial market relationships is of importance to the well-functioning of markets and inter-connections across cross-commodity markets and prices (Listorti and Esposti, 2012). Ozturk (2020) examined spatial price relationships in the grain market of Turkey. The author shows that cointegration in markets varies with commodities. Examining spatial market linkages for a homogenous commodity and the effects of volatility, Ganneval (2016) has shown that producer reference prices may be associated with volatility trends.

The expansion of food value chains and the transmission of prices for differentiated and alternate product forms in agri-food markets continue to receive interest (Swinnen and Vandeplass, 2010; Swinnen and Vandeplass, 2014). Analysing the cost pass-through and differentiation of products in the yoghurt market in Germany, Loy and Weiss (2019) found evidence that the pass-through process rates are indeed slower for more differentiated products. In a similar vein, Bittmann et al. (2020) employing an error-correction-distance approach could show that more sluggish speeds of adjustment are associated with the differentiation of products.

Value-added processing may provide better pricing options as well as consumption variety and the expansion of markets for the welfare of market participants. Gizaw et al. (2020) have provided empirical evidence that product differentiation and value-added influences the relationship of price transmission. Similarly, Asche et al. (2014) have shown that price transmission may vary across product forms.

Vertical price relationships in the agri-food chain have been documented in literature. The coordination of markets vertically has implications for upstream and downstream pricing. Louw et al. (2017) investigate vertical price flows using time series techniques. Findings reveal that symmetry in the price transmission process may not be associated with opportunistic behaviour of firms. Emmanouilides and Fousekis (2015) have shown that farm-wholesale movement of prices may be stronger than at the wholesale-retail price spread.

Price flows in commodity markets can be national or across the borders. Extant literature exists on price relationships across domestic, regional and international markets (Abdulai, 2000; Mofya-Mukuka and Abdulai, 2013; Cachia, 2017). These domestic and foreign markets may

tend to converge when producers practice arbitrage freely (Cachia, 2017). Baquedano and Liefert (2014) have empirically revealed sluggish adjustments of domestic consumer prices to long-run equilibrium world prices post shocks. (Abdulai, 2000) has shown that major domestic markets in Ghana are cointegrated.

Market trends across commodities allow for price patterns over time and space. Previous literature has employed time series techniques in modelling price adjustments e.g Lloyd et al. (2001). Even more recently, empirical literature strands have used panel estimation techniques. Zamani et al. (2018) have empirically revealed that prices decrease with lower cost of searching and these lower search costs are associated with higher pass-through rates.

In studying symmetric price adjustments on prices for which shock responses upstream and downstream on the vertical chain or spatially across horizontal markets are identical for upward or downward price movements, asymmetric price transmission modelling considers positive and negative shock impacts that may have varying effects on the other market niche vertically or horizontally, hence the study also considers asymmetric adjustments. Meyer and Cramon-Taubadel (2004) have provided insights on estimations for asymmetric price transmission.

Input and menu costs are among theorised factors that affect asymmetric price transmission and the modelling of asymmetric retail adjustments (Kovenock and Widdows, 1998; Borenstein et al., 1997). Models have been posited for vertical and horizontal asymmetric modelling (Houck, 1977; von Cramon-Taubadel and Loy, 1997; Azam, 1999). Using threshold cointegration techniques, Abdulai (2002) found evidence of asymmetric price transmission on the vertical food chain.

From a developing country context, Cutts and Kirsten (2006) have shown that concentration in agri-markets may be associated with higher asymmetries in price transmission, especially for non-perishable products.

In summary, the existing literature on price transmission has expanded and keeps evolving. The impressive extant literature vertically and horizontally has shown the importance of well-functioning markets. Diverse methodological techniques have underlain the vital role of market efficiency for development and policy. Empirical findings from the existing literature have shown the necessity of market participation on the welfare of market actors and the economy.

7.3 Data and descriptive statistics

The study employed panel data sets for selected vegetable oil prices at the producer level for communes (subnational units in Benin) and departments in the North, Middle East, Central and South of Benin, as well as some selected West African countries. Data for peanut grains and soybean grains constitute monthly panels from January 2010 to February 2017, obtained from the Ministry of Agriculture, Livestock and Fisheries in Benin. Based on data availability and the purpose of spatial analysis, four⁵ departments are considered in the analysis, the North, Middle East, Central and the South. The notable phenomenon of the tale of two regions in Benin distinguishes the Southern and Northern parts of Benin prominently (Nguyen and Dizon, 2017), which are hence generally used as covariates in the study, and in some cases for deeper insights, with another region like the case of palm oil and palm kernel oil, also based on available data. Grain commodities include cashew grains, peanut grains, soybean grains. The data for cashew grains is a two-wave weekly panel respectively in the cashew marketing season in Benin for 2019 and 2020. This period typically runs from February to May (Mensah et al.,

⁵ Representing three out of six regions in Benin (Katsumata et al., 2007)

2012). Data for cashew, obtained from the National Federation of Benin Cashew Nut Producers in Benin covers five countries in West Africa: Benin, Côte d'Ivoire, Ghana, Senegal and Mali. While this provides the plausibility for regional analysis in West Africa, the cashew data for Benin is further divided into domestic markets (North, Middle East and South of Benin) that enables local analysis nationally. A summary of sampled sites under consideration is presented in Table 7.1. Oil data for palm oil, palm kernel oil, and peanut oil obtained from the Ministry of Agriculture, Livestock and Fisheries in Benin covers the period from January 2010 to February 2017 for palm oil and peanut oil, and the period from February 2010 to October 2016 for palm kernel oil. The data covers prices for transformed grains at the processor level. Monthly panels constitute communes in the North, Middle East and South departments of Benin based on available data.

Table 7.1: Data Description

Commodity	Region	Department	Communes	Period
Cashew	Middle East	Borgu	Parakou, Tchaourou, Bembèrèkè, N'dali	Weekly 2019, 2020
	South	Zou	Abomey, Bohicon, Djidja, Zagnanado	
	North	Atacora	Boukoubé, Toucountouna, Kérou, Tanguiéta	
Soybean	Middle East	Borgu	Parakou and Sinendé	Monthly 2010-2017
	South	Zou Plateau	Bohicon Kétou	
	North	Atacora	Natitingou and Cobly	
Peanut	Middle East	Borgu	Parakou and Nikki	Monthly 2010-2017
	South	Zou	Bohicon and Dasso	
	North	Atacora	Natitingou and Péhunco	
Palm oil	North	Atacora	Natitingou and Péhunco	Monthly 2010-2017
	South	Zou	Bohicon and Dasso	
	North-Middle East	Alibori Borgu	Malanville Parakou	
Palm Kernel oil	South-Central	Zou Collines	Bohicon Glazoué	Monthly 2010-2016
	North-Middle East	Atacora Borgu	Péhunco Sinendé	
Peanut oil	North	Atacora	Natitingou and Péhunco	Monthly 2010-2017
	South	Zou	Bohicon and Dasso	

Figure 7.1 presents the map of the study sites.

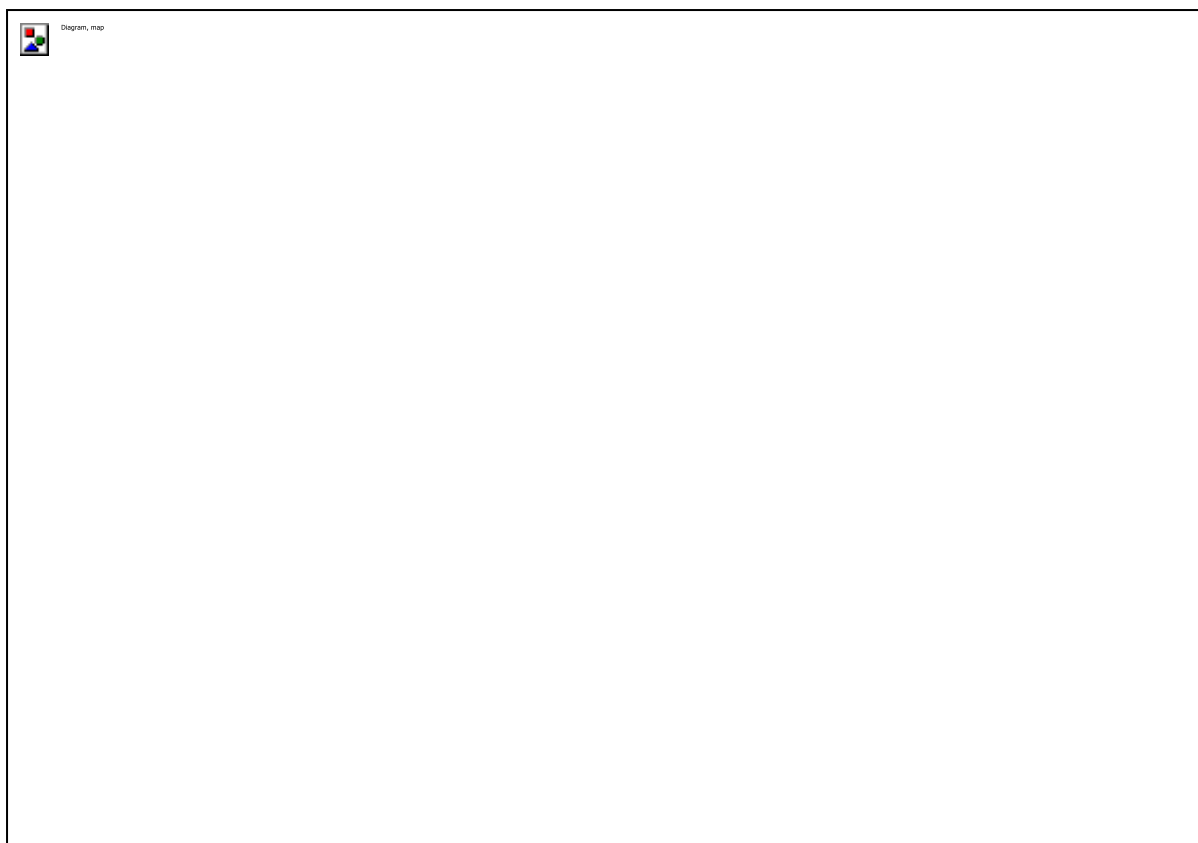


Fig. 7.1 Map of study sites

Descriptive statistics of the data are presented in table 7.2. Based on the data, variations in the prices for cashew in Benin are greater over time (0.301) compared to across departments in Benin (0.038). In the case of regional (Côte d'Ivoire, Ghana, Senegal, Mali) cashew prices, variations are greater over time (0.291) than across individual countries (0.255) similarly, but to a lesser extent. While peanut grains exhibit a different pattern over time and between, this is not the case for its value-added product, peanut oil. In a similar way to peanut oil, palm oil prices are characterised by greater variations over time (0.089) than across individuals (0.024). However, this is not the case for its counterpart palm kernel oil, that shows a greater variation across departments and communes relative to over time. Heterogenous pricing can be noted across commodities (soybean, peanut and cashew) and spatially. Farming activities may be more prominent in the North of Benin and hence production given that about 20 percent of

farms in the North are larger than 5 hectares while only about a quarter of this percentage exists for the South (Soulé et al., 2013). Input (fertiliser) spending is also highest in the Northern areas with just about half of the expenditures in the Southern areas (Nguyen and Dizon, 2017). The share of employment in agriculture is notably lowest in the South areas of Benin and highest in Northern areas (Nguyen and Dizon, 2017). Soybean prices are seemingly low distinctly in the South region.

Table 7.2: Descriptive statistics of Commodities by country

Variable	Description	LIN		LOG	
		Mean	Std. Dev.	Mean	Std. Dev.
Cashew	Price in Benin (Overall)	303.1701	86.0885	5.671	0.303
	Between		8.7759		0.038
	Within		85.7452		0.301
Cashew	Price in other West Africa (Overall)	322.5	106.8206	5.715	0.367
	Between		77.8169		0.255
	Within		82.2946		0.291
Soybean	Price in Benin (Overall)	254.6899	50.2156	5.520	0.207
	Between		1.3978		0.021
	Within		50.2058		0.206
Peanut	Price in Benin (Overall)	566.4302	164.5179	6.293	0.312
	Between		167.7816		0.303
	Within		113.6156		0.227
Palm oil	Price in Benin (Overall)	752.3372	65.4902	6.619	0.091
	Between		18.5109		0.024
	Within		64.1610		0.089
Peanut oil	Price in Benin (Overall)	942.9186	118.6077	6.841	0.130
	Between		32.5845		0.032
	Within		116.3349		0.128
Palm Kernel oil	Price in Benin (Overall)	736.7654	95.819	6.593	0.136
	Between		96.2975		0.134
	Within		67.2003		0.097

Source: Own computation from data from Ministry of Agriculture, Livestock and Fisheries in Benin

Note: Prices are in CFA Franc (West African currency). The CFA Franc is the official currency of West Africa, 1 XOF is equivalent to about 0.00181 USD

The prices for soybean grains are found to be more affordable than the prices for peanut grains in Benin. The Southern and central parts of Benin clearly seem to offer more affordable prices for value-added processed grains (oil). While primary agricultural activities may be more

localised in the Northern areas, the Southern and central part seems more engaged in secondary activities. This may be facilitated by infrastructure availability as it has been noted that the concentration of domestic transport systems in coastal areas of the South in Benin may be relatively more (Nguyen and Dizon, 2017). The South of Benin is coastal and having economic advantage for development as well as favourable agroecological conditions (Nguyen and Dizon, 2017). Also, it possesses strong potentials of economic benefits in its coastlines similarly to Côte d'Ivoire, having unexploited potential for access to international trade and markets (Nguyen and Dizon, 2017). This may imply that the presence of decentralised spatial infrastructural developments may have implications for market outcomes and welfare. Significant spatial spreads of industry and services are notable between the Northern and Southern parts of Benin, with the industrial and service sector together providing more employment than the agricultural sector in the South (Nguyen and Dizon, 2017). This may be associated with the better oil pricing in the South. Sectoral spreads in agriculture, industry and services spatially, may influence value-added agri-markets, and processing.

Oil prices are more affordable for palm oil compared to peanut oil. This may be expected as palm oil is also very widely consumed in West Africa (Ordway et al., 2019). Palm oil is widely consumed as a cooking ingredient in households (Ordway et al., 2019).

To check for correlation across cross-sections, the study uses Pesaran's (2004, 2015) test for cross-sectional dependence and findings suggest the presence of correlation across spatial markets in all but the North-Middle East market covariate in the palm oil market.

Table 7.3: Cross-Section Dependence test

Market	LIN		LOG	
	CD-test	p-value	CD-test	p-value
Cashew (Benin-Middle East)	8.205	0.000	8.165	0.000
Cashew (Benin-South)	7.914	0.000	7.82	0.000
Cashew (Benin-North)	8.241	0.000	8.223	0.000
Cashew (Benin)	8.396	0.000	8.361	0.000
Cashew (Other countries)	6.065	0.000	5.818	0.000
Soybean (Benin-Middle East)	3.214	0.001	2.863	0.004
Soybean (Benin-South)	5.18	0.000	5.427	0.000
Soybean (Benin-North)	2.837	0.005	3.024	0.002
Peanut grain (Benin-Middle East)	7.333	0.000	7.428	0.000
Peanut grain (Benin-South)	2.62	0.009	3.551	0.000
Peanut grain (Benin-North)	6.336	0.000	6.6	0.000
Peanut oil (Benin-North)	6.543	0.000	6.985	0.000
Peanut oil (Benin-South)	3.964	0.000	4.337	0.000
Palm oil (Benin-North)	7.01	0.000	7.415	0.000
Palm oil (Benin-South)	2.918	0.004	3.37	0.001
⁶ Palm oil (Benin-North&Middle East)	-0.587	0.557	-0.249	0.803
Palm kernel oil (Benin-South&Central)	4.513	0.000	5.251	0.000
Palm Kernel oil (Benin-North&Middle East)	4.093	0.000	3.955	0.000

Source: Own computation
CD=Cross-section Dependence

The study employs the Pesaran (2007) panel unit root test in the presence of cross-sectional dependence, and findings suggest failure to reject the null hypothesis of non-stationary prices given that output values from STATA are less than the critical values (see Pesaran, 2003).



⁶ Hadri test

Table 7.4: Unit root test (LIN)

Market	Cashew (Benin- Middle East)	Cashew (Benin- South)	Cashew (Benin- South)	Cashew (Benin)	Cashew (Other countries)	Soybean (Benin- Middle East)	Soybean (Benin- South)	Soybean (Benin- North)	Peanut grain (Benin- Middle East)	Peanut grain (Benin- South)	Peanut grain (Benin- North)	Peanut oil (Benin- North)	Peanut oil (Benin- South)	Palm oil (Benin- North)	Palm oil (Benin- South)	Palm Kernel oil (Benin- South&Central)	Palm oil (Benin- North&Middle East)	Kernel oil (Benin- North&Middle East)
	1%: - 2.03	1%: - 2.03	1%: - 2.03	1%: - 2.03	1%: -2.03	1%: - 1.94	1%: - 1.94	1%: - 1.94	1%: - 1.94	1%: - 1.94	1%: - 1.94	1%: - 1.94	1%: - 1.94	1%: - 1.94	1%: - 1.94	1%: -1.94	1%: -1.94	
Critical values	5%: - 1.74	5%: - 1.74	5%: - 1.74	5%: - 1.74	5%: -1.74	5%: - 1.71	5%: - 1.71	5%: - 1.71	5%: - 1.71	5%: - 1.71	5%: - 1.71	5%: - 1.71	5%: - 1.71	5%: - 1.71	5%: - 1.71	5%: -1.71	5%: -1.71	
	10%: - 1.58	10%: - 1.58	10%: - 1.58	10%: - 1.58	10%: - 1.58	10%: - 1.56	10%: - 1.56	10%: - 1.56	10%: - 1.56	10%: - 1.56	10%: - 1.56	10%: - 1.56	10%: - 1.56	10%: - 1.56	10%: - 1.56	10%: -1.56	10%: -1.56	
(LOG)																		
	1%: - 2.03	1%: - 2.03	1%: - 2.03	1%: - 2.03	1%: -2.03	1%: - 1.94	1%: - 1.94	1%: - 1.94	1%: - 1.94	1%: - 1.94	1%: - 1.94	1%: - 1.94	1%: - 1.94	1%: - 1.94	1%: - 1.94	1%: -1.94	1%: -1.94	
Critical values	5%: - 1.74	5%: - 1.74	5%: - 1.74	5%: - 1.74	5%: -1.74	5%: - 1.71	5%: - 1.71	5%: - 1.71	5%: - 1.71	5%: - 1.71	5%: - 1.71	5%: - 1.71	5%: - 1.71	5%: - 1.71	5%: - 1.71	5%: -1.71	5%: -1.71	
	10%: - 1.58	10%: - 1.58	10%: - 1.58	10%: - 1.58	10%: - 1.58	10%: - 1.56	10%: - 1.56	10%: - 1.56	10%: - 1.56	10%: - 1.56	10%: - 1.56	10%: - 1.56	10%: - 1.56	10%: - 1.56	10%: - 1.56	10%: -1.56	10%: -1.56	

The study also hence employs panel unit root test (Hadri, 2000) for panel random walk in the North-Middle East market covariate for palm oil market. Findings are presented in table 7.5 below.

Table 7.5: Test of unit root

Variable	LIN	LOG
	Hadri test	Hadri test
	25.9928***	26.4403***
	-1.1805	-1.1764

Source: Own computation, ***p<0.01
H0: All panels are stationary

Findings from the Pedroni (1999: 2004) test of cointegration that can be adapted for heterogenous panels, and which employs statistics that are adjusted for serial correlation is employed and suggest that the price series are cointegrated (Newey and West, 1987).

Table 7.6: Cointegration

Test	Statistic	LIN		LOG	
		p-value	Statistic	p-value	
Cashew (Benin-Middle East&South)					
Modified Phillips-Perron t	-1.6428	0.0502	-1.7053	0.0441	
Phillips-Perron t	-8.8846	0.0000	-9.5145	0.0000	
Augmented Dickey-Fuller t	-9.8666	0.0000	-9.7764	0.0000	
Cashew (Benin-Middle East&North)					
Modified Phillips-Perron t	-0.6649	0.2531	-0.8797	0.1895	
Phillips-Perron t	-3.7508	0.0001	-4.2774	0.0000	
Augmented Dickey-Fuller t	-3.9103	0.0000	-4.4228	0.0000	
Cashew (Benin-Other countries)					
Modified Phillips-Perron t	0.2502	0.4012	-0.0471	0.4812	
Phillips-Perron t	-1.3369	0.0906	-1.7612	0.0391	
Augmented Dickey-Fuller t	-1.3377	0.0905	-1.7220	0.0425	
Soybean (Benin-Middle East&South)					
Modified Phillips-Perron t	-5.8067	0.0000	-6.0266	0.0000	
Phillips-Perron t	-3.7011	0.0001	-3.5645	0.0002	
Augmented Dickey-Fuller t	-3.9406	0.0000	-3.7391	0.0001	
Soybean (Benin-Middle East&North)					
Modified Phillips-Perron t	-3.4097	0.0003	-3.2539	0.0006	
Phillips-Perron t	-2.7161	0.0033	-2.4897	0.0064	
Augmented Dickey-Fuller t	-2.9777	0.0015	-2.8179	0.0024	
Peanut grain (Benin-Middle East&South)					
Modified Phillips-Perron t	-3.1814	0.0007	-3.5018	0.0002	
Phillips-Perron t	-2.9132	0.0018	-3.2675	0.0005	
Augmented Dickey-Fuller t	-2.6902	0.0036	-2.7221	0.0032	
Peanut grain (Benin-Middle East&North)					
Modified Phillips-Perron t	-8.3883	0.0000	-9.1536	0.0000	
Phillips-Perron t	-6.0336	0.0000	-6.5411	0.0000	
Augmented Dickey-Fuller t	-5.6817	0.0000	-5.6402	0.0000	
Peanut oil (Benin-North&South)					
Modified Phillips-Perron t	-6.4933	0.0000	-6.3774	0.0000	
Phillips-Perron t	-4.3330	0.0000	-4.2589	0.0000	

Augmented Fuller t	Dickey-	-4.6723	0.0000	-4.5657	0.0000
Palm oil (Benin-North&South)					
Modified Perron t	Phillips-	-3.0898	0.0010	-2.7558	0.0029
Phillips-Perron t		-1.7919	0.0366	-1.2007	0.1149
Augmented Fuller t	Dickey-	-1.9755	0.0241	-1.3474	0.0889
Palm oil (Benin-North&North_Middle east)					
Modified Perron t	Phillips-	-3.2992	0.0005	-2.9234	0.0017
Phillips-Perron t		-1.2876	0.0989	-0.5657	0.2858
Augmented Fuller t	Dickey-	-1.4749	0.0701	-0.7307	0.2325
Palm Kernel oil					
Modified Perron t	Phillips-	-1.3061	0.0958	-1.0382	0.1496
Phillips-Perron t		-1.3106	0.0950	-1.3091	0.0953
Augmented Fuller t	Dickey-	-1.6570	0.0488	-1.6636	0.0481
Cost pass-through					
Peanut grain - oil (North oil-South grain)					
Modified Perron t	Phillips-	-3.4620	0.0003	-3.8284	0.0001
Phillips-Perron t		-2.7889	0.0026	-3.0389	0.0012
Augmented Fuller t	Dickey-	-2.4782	0.0066	-2.4266	0.0076
Peanut grain - oil (North oil-North grain)					
Modified Perron t	Phillips-	-2.7908	0.0026	-3.1963	0.0007
Phillips-Perron t		-2.3311	0.0099	-2.6497	0.0040
Augmented Fuller t	Dickey-	-1.9829	0.0237	-2.0002	0.0227
Peanut grain - oil (South oil-South grain)					
Modified Perron t	Phillips-	-2.1644	0.0152	-3.0976	0.0010
Phillips-Perron t		-2.5142	0.0060	-3.2227	0.0006
Augmented Fuller t	Dickey-	-2.3706	0.0089	-2.3983	0.0082
Peanut grain - oil (South oil-North grain)					
Modified Perron t	Phillips-	-3.3535	0.0004	-3.2562	0.0006
Phillips-Perron t		-3.1621	0.0008	-3.3524	0.0004
Augmented Fuller t	Dickey-	-2.7004	0.0035	-2.5495	0.0054

Source: Own computation

H0: No Cointegration

7.4 Empirical Model

Given cointegration, the asymmetric panel error correction model (ECM) is estimated to validate the existence of any asymmetries in addition to symmetric estimations. For the asymmetric model, the reduced-form long-run relationship and the short-run adjustment specification is specified as follows.

$$p_{b,t} = \alpha + \beta_1 p_{a,t} + \beta_2 \Delta p_{a,t} + v_i + \epsilon_{it} \quad (1)$$

$$p_{b,t} = \alpha + \beta_1 p_{a,t} + \beta_2 \Delta p_{a,t} + \beta_3 \Delta p_{b,t} + \dots + \epsilon_{it} \quad (2)$$

Where $p_{b,t}$ is the price in market b at time t, $p_{a,t}$ is the price in market a at time t, and ϵ_{it} is the random error. Δ denotes a first-difference operator, α is the intercept, β_1 and β_2 are the speed of adjustment coefficients back to long-run equilibrium relationship for positive and negative discrepancies respectively. β_3 and β_4 are the long-run coefficients to be estimated. In line with literature, constant costs are assumed across spatial markets (Goodwin et al., 1990; Dwyer and Wallace, 1992; Alexander and Wyeth, 1994). The first stage estimation outputs an error term that assumes an asymmetric specification in the second stage estimation, that considers price increases and decreases as separate variables hence allowing for possible non-linearities.

β_3 and β_4 are the positive and negative error correction terms from equation (1), given that the transaction cost measure is zero. The symmetric estimation follows such that:

$$p_{b,t} = \alpha + \beta_1 p_{a,t} + \beta_2 \Delta p_{a,t} + \dots + \epsilon_{it} \quad (3)$$

Where ϵ_{it} is the random error. An additional functional form in logs is also estimated for comparisons. The study statistically tests the following null hypothesis:

H1: No difference in the transmission of prices on different niches of the value chain

H2: No difference in spatial cost pass-through rates in the vegetable grain-oil market









H3: No difference in price equilibrium adjustments for the impact of cost shocks on rising and falling prices on the vegetable oil food chain

H4: No difference in the flow of prices for differentiated vegetable oil commodities

7.5 Results and discussion

Estimates of the long-run and short-run random effects model are presented in Table 7.7. Additional symmetric estimates are reported in log form for comparison purposes. The finding is statistically different from zero at one percent level. While the long-run price transmission is statistically different from zero at one percent level for the grain and oil commodities, this is not the case with the Northern covariate in the Soybean market, and the Northern covariate in the Southern peanut oil-grain market. The Northern peanut grain prices are positively associated while insignificant for the latter market, and negatively associated while significant for the Southern counterpart covariate. A factor may be due to the more affordable peanut prices in the North of Benin relative to the South following the descriptive statistics. These findings support the rejection of the first null hypothesis for no difference in the transmission of prices on different niches of the value chain. For the significant long-run price coefficients and considering absolute magnitudes, the least long-run transmission is in the palm kernel oil market, where an increase in the grain price in the Southern and Central is associated with about a 17franc increase in the oil price in the North and Middle East of Benin.

Table 7.7: Long-run and Short-run Estimates

			log 	 +	 -	log  +	log  -		log 
Cashew (Benin)	South	0.960*** (0.025)	1.014*** (0.037)	-1.294*** (0.157)	-1.495*** (0.223)	-0.004*** (0.0007)	-0.006*** (0.0005)	-1.494*** (0.255)	-0.001*** (0.0001)
	North	0.914*** (0.039)	0.843*** (0.075)	-0.060 (0.383)	0.085 (0.326)	0.00002 (0.002)	0.0002 (0.002)	-0.190 (0.114)	-0.0003*** (0.0001)
Cashew (Benin&other countries)	Other countries	0.473*** (0.049)	0.500*** (0.053)	-0.448*** (0.132)	-0.885*** (0.103)	-0.001* (.001)	-0.003*** (0.0003)	-0.337*** (0.037)	-0.001*** (0.0002)
Soybean (Benin)	South	0.597*** (0.063)	0.490*** (0.087)	-0.554*** (0.092)	-0.959*** (0.271)	-0.002*** (2.97e-06)	-0.004*** (0.001)	-0.423* (0.202)	-.001*** (0.0001)
	North	0.221 (0.147)	0.228 (0.123)	-0.445** (0.157)	-0.963*** (0.195)	-0.001** (.001)	-0.004*** (0.001)	-0.385* (0.183)	-0.001*** (.00005)
Peanut grain (Benin)	South	0.503*** (0.107)	0.553*** (0.119)	-0.315*** (0.050)	-0.242*** (0.049)	-0.0005** (0.0001)	-0.0006*** (0.0001)	-0.079*** (0.014)	-0.0001* (0.00005)
	North	0.633*** (0.033)	0.704*** (0.033)	-0.293*** (0.040)	-0.168*** (0.039)	-0.0005*** (0.0002)	-0.0004*** (0.0001)	-0.083*** (0.015)	-0.0001*** (.00004)
Peanut oil (Benin)	South	0.418*** (.043)	0.395*** (0.021)	-0.528*** (0.038)	-0.572*** (0.127)	-0.0005*** (0.00002)	-0.0006*** (0.0001)	-0.169*** (0.050)	-0.0001*** (0.00004)
Palm oil (Benin)	South	0.309*** (0.071)	0.256*** (0.019)	-0.631*** (0.115)	-0.493 (0.321)	-0.0007*** (0.0002)	-0.0006 (0.0004)	-0.152*** (0.046)	-0.0001*** (0.00004)
	North-Middle East	0.220*** (0.029)	0.238*** (0.014)	-0.657*** (0.083)	-0.450* (0.214)	-0.0007*** (0.0001)	-0.0006 (0.0003)	-0.181*** (0.048)	-0.0002*** (0.00003)
Palm Kernel oil	North-Middle East	0.169** (0.065)	0.261*** (0.065)	-0.454*** (0.018)	-0.234** (0.077)	-0.0007*** (0.00006)	-0.0005*** (0.0001)	-0.155*** (0.023)	-0.0003*** (6.86e-06)
Cost pass-through estimates									
Peanut grain - oil (North oil)	South grain	0.360* (0.166)	0.192* (0.089)	-0.570*** (0.041)	-0.607*** (0.057)	-0.0005*** (0.00006)	-0.0006*** (0.00004)	-0.159*** (0.035)	-0.0001*** (0.00001)
	North grain	0.303*** (0.015)	0.185*** (0.009)	-0.535*** (0.054)	-0.582*** (0.028)	-0.0004*** (0)	-0.0006*** (0.00003)	-0.152*** (0.028)	-0.0001*** (0.00003)
Peanut grain - oil (South oil)	South grain	-0.170*** (0.017)	-0.073** (0.024)	-0.461*** (0.072)	-0.299*** (0.008)	-0.0004*** (0.00007)	-0.0004*** (8.55e-06)	-0.193*** (0.039)	-0.0002*** (0.00005)
	North grain	0.084 (0.050)	0.084* (0.040)	-0.458*** (0.074)	-0.270*** (0.017)	-0.0004*** (0.00007)	-0.0004*** (0.00002)	-0.189*** (0.042)	-0.0002*** (0.00005)

Robust standard errors are in parenthesis. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Source: Own computation

In oil markets, the peanut oil market has the largest long-run price transmission for the oil markets under consideration. For the grain-oil markets, the South peanut oil market is significantly associated with the Northern and Southern grain markets despite in opposite directions, as compared to the North peanut oil market that is only significantly associated with the Northern grain market but with positive parameter coefficients for both the Northern and Southern grain markets. No arbitrage for market access has been noted in the South of Benin (Nguyen and Dizon, 2017). Free arbitrage by producers notably encourages the convergence of prices (Cachia, 2017). We reject the second null hypothesis for no difference in the cost pass-through rates in the vegetable grain-oil market. Broadly based on findings, the price transmission for grain commodities maybe higher compared to value-added-oil commodities as seen in the peanut value chain. We reject the first null hypothesis of no difference across niches of the value chain. There is a positive and significant association between grain prices for cashew in Benin, Côte d'Ivoire, Ghana, Senegal and Mali.

In the second stage estimations, symmetric adjustments of disequilibria in prices back to the long-run equilibrium are all negative as expected and statistically different from zero. However, the supply side cost shocks seem to explain very small symmetric adjustments back to the long-run equilibrium from disequilibria when considering an alternate functional form. Symmetric speeds of adjustments are fastest in regional cashew and domestic soybean markets. Robust standard errors are small suggesting a good fit.

Positive and negative changes are broadly significant for adjustments to eliminate positive and negative discrepancies. Except for cost shocks on falling prices in the palm oil market and the Northern cashew markets, asymmetric adjustments are all significantly different from zero in markets for both rising and falling prices. Alternate functional forms may explain the considerably larger magnitude differences for symmetric adjustments. Higher asymmetries in

developing markets maybe associated with concentration in the agri-food markets for non-perishable products (Cutts and Kirsten, 2006). In the South of Benin over 50 percent of those engaged in agriculture are involved in palm oil producing activities (Nguyen and Dizon, 2017) for instance.

Except for peanut oil, oil prices (palm oil and palm kernel oil) seem to have a higher reaction to price increases compared to price reductions. It has been shown according to the rockets and feathers phenomenon that when prices move upward, they do so at a higher speed relative to when they fall (e.g Tappata, 2009). Findings also suggest that differentiated commodities (cooking oil alternatives) can follow the same pattern of price movements. The findings support the rejection of the fourth null hypothesis of no difference in the flow of prices for differentiated vegetable oil commodities. While the peanut grain and cashew grain markets may follow similar patterns of more significant responses to price increases, this maybe not be the same in the soybean grain market. Responses to price increases and decreases may vary for the grain-oil value chain based on the direction of price flows as suggested by findings.

7.6 Policy Implications

Diversification attempts in agri-food markets provide a strategic pathway towards expanding farm value chains. For instance, the government of Benin has highlighted diversification in agriculture and supporting policy reforms towards the welfare and outcomes for the sector. While SSA occupies a negligible proportion of the global vegetable oil market, these diversification efforts in the sector can expand commercialisation initiatives in these markets. Given the importance of vegetable oils especially for consumption uses typically and commonly in households in this region, the availability of alternatives for preferences and functionality can boost welfare for both merchants and consumers. Further, great prospects and

potentials exist considering other uses in industry, biofuels and presents market opportunities for these farmers in these developing countries to be able to access markets on a global scale. Hence development policy reforms that support diversification endeavours while providing variety with food and nutritional benefits can also be key in ensuring the expansion and improved performance of these agri-food markets, with expanded food consumption and nutrition base.

Development policy that promotes the expansion and globalisation of developing SSA vegetable oil markets can stimulate oilseed and vegetable oil output and productivity increases that combine global efforts to ensure better outputs in this sector given diverse uses. Increased production and output can reduce global demand pressures from not only food needs, but industrial, animal feed, and biofuel among others. This can further present market opportunities especially for small scale farmers in SSA to grow their markets and farm resource base from an enabling developing policy environment.

Diversity and expansion of food supply chains may also be a step towards strategic development policy efforts for food security through availability, accessibility and affordability, given more choices. This is especially relevant for SSA where endeavors have been particularly tailored and goals yet pending. More stable and diversified value chains and food options availability can broadly be a step towards enhancing the food base that could mitigate hunger levels and support nutrient options and availability in food.

7.7 Conclusion

The study examines domestic and regional symmetric and asymmetric price behaviour in the vegetable oil and grain market in West Africa. Using six vegetable oil commodities in five

West African countries, analysis is made across the value chain for the grain and consequently processed oil niches, as well as the grain-oil chain simultaneously for the commodities individually and comparatively, as well as for differentiated forms of the same grain commodity. The study employs a recent weekly and monthly panel data set from the Ministry of Agriculture, Livestock and Fisheries in Benin as well as the National Federation of Benin Cashew Nut Producers over the period from 2010 to 2020 generally. The study utilises reduced form price models to obtain findings for first stage and second stage estimations.

Vegetable oil commodities exhibit relevant error correction asymmetries. The peanut market (grain and oil) seems most dynamic. This may be due to consideration of its grain and oil commodities in the study. The South seems to offer more affordable prices for both grains and oil. For the grain-oil markets, the South peanut oil market is significantly associated with the Northern and Southern grain markets despite in opposite directions, as compared to the North peanut oil markets that is only significantly associated with the Northern grain market but with positive parameter coefficients for both the Northern and Southern grain markets, however. Southern peanut grain prices are positively associated while insignificant, and negatively associated while significant. Findings suggest differentiated commodities may follow similar price trends.

While markets are representative of Northern, Middle East, Central and Southern departments in Benin broadly, note should be taken that the representation of the departments is based on selected communes in the particular department based on available data and the sampling of the communes. Note should be taken in comparing symmetric and asymmetric adjustments estimated under different functional forms. The time coverage for each data set may also

influence findings. The relationship for production, prices, trends in the global market for vegetable oils and the link with the environment may provide a caveat for future studies.

Slow speeds of adjustment in these markets may imply the need for tailored market policy for such agricultural trade commodity with potential and significant economic implications, especially in developing countries. Spatial infrastructural allocations may have policy implications for market outcomes, participation and welfare. The vegetable oil market in the face of projected increase in global demand with global population pressures presents an economic opportunity for the African trade sector, internationally in exports and domestically. Interventions in augmenting facilities, infrastructure, services and an enabling policy environment that can support full market participation. This may also improve per capita income levels especially for the most financially vulnerable and those in rural areas (many of whom are usually engaged in agriculture) with more disproportionate income gap effects. Relevant welfare gaps have been found in Benin (Nguyen and Dizon, 2017). Tailored trade policy may also facilitate production increases and mass supply that can ameliorate the potential gap between demand and supply globally.

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Chapter 8

By what difference: Price transmission in the palm oil value chain in Cameroon

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Abstract

The nature of commodities can influence the formation and movements of prices on the agricultural value chain. Using a recent panel data set of monthly observations for prices of fresh fruit bunches of oil palm and wholesale prices of palm oil, we examine the transmission of prices across the palm oil value chain. We further analyse the dynamics of price restorations to market equilibrium using an Error Correction Modelling framework. Markets for value-added and commodity transformed products downstream are correlated with upstream markets. Enhanced market services can boost agricultural market services and the value chain for a food and cash crop like oil palm. Our analysis has implications for development market reforms and market liberalisation policies for improving the market-driven nature of the palm oil sector.

Keywords: Price transmission; Palm oil; Value-chain; Commodity transformation; Cameroon

8.1 Introduction

There is a growing demand for vegetable oils, especially palm oil, for diverse industrial and household uses. The demand and supply of palm oil has been trending upwards for the last two decades (Wiebe et al., 2019; Vijay et al., 2016). To meet the growing demand from the food and pharmaceutical industry, palm oil producers are expanding their operations, and suppliers are expanding their market outreach (Monzon et al., 2021; Quezada, 2019). Palm oil has become one of the most important globally traded goods, with global harvest also being used for energy purposes, generating electric power and heat (Quezada, 2019; Wiebe et al., 2019; Archer et al., 2018). The attraction of palm oil is anchored on its two main sustainable advantages over other vegetable oils. It is a perennial crop with year-round production and having the highest yield of any vegetable oil crop with the highest energy efficiency. An efficient market mechanism is required as effective conduit of the palm oil value chain.

Market transactions generally facilitate the flow of goods and services in the economy. These transactions support the functioning of markets and are dependent on the nature of marketable products. The expansion of global value chains and pricing on added value may influence cost and pricing on the supply chain (Asche et al., 2014). While the costs on commodities are generally marked up in the movement across the supply chain, commodities with product transformation across the chain may be associated with an even extra cost, and the extent of price transmission varies with the changing product forms (Asche et al., 2014). In emergent markets with the prominence of many small to medium scale product transformations, coordinated responses can tailor the improvement and sustainability of the sector (Kvaløy and Tveteraas, 2008).

Trade policies have increasingly supported the dispersion of product lines in several forms for consumer variety. This has increased the participation in product transformations on the value chain. Variation in the pricing of agricultural commodities have been documented (Mundlak and Larson, 1992), and there is resurgent interest to understand the price linkages across the value chain (Asche et al., 2007).

Changing product forms can influence market pricing options with plausibilities for varying actor and participant responses (Larsen and Asche, 2011). As value is added to the transformation of product forms, transmission of costs are incurred in the movement of these products along the chain. Price changes on the final product at each stage of the value chain are transmitted as the product changes in time, form and space (Landazuri-Tveteraas et al., 2018). The price responses across the value chain can exhibit non-linear behaviour especially at the retail level for consumers (Kinnucan and Forker, 1987; Chavas and Mehta, 2004).

As consumers seek to optimise product satisfaction and consumption, increasing demand for alternate product forms and variety can generate supply pressures that risk gouging prices and depreciate welfare if cost-price movements are not characterised and understood in food markets (Jaffry, 2004; Kvaløy and Tveteras, 2008; Bittmann et al., 2020; Gizaw et al., 2021). Understanding how the cost of product transformation and value-addition influences the transmission of prices across the supply chain may be of utmost importance in coordinating the functioning of product markets. Such coordination roles are relevant for policy enforcements in a bid to ensure more efficient and informed market structures. This can stimulate the continuous flow of the market chains and the potential for sustained growth. Prices can be stabilised to curb market failures and strengthen the development of these emergent markets.

Marketing nodes and product quality make up a significant factor in influencing price changes across market margins, and the direction of trade flows (Gardner, 1975; Lloyd et al., 2001; Goetz and von Cramon-Taubadel, 2008). Value addition on products promotes diversification and consumer choices. Trade theories of consumer choices and preferences have associated models that underlie the preference of variety by consumers (Hotelling, 1929; Lancaster, 1966; Dixit and Stiglitz, 1977). Different consumers would prefer different product or commodity forms. This is even more the case for a commodity like oil palm (*Elaeis guineensis*) with different levels of product differentiation where the marketing strategies for each of the product forms can be hypothesised to be different. For instance, while a less processed variant like the direct fresh fruit bunches (FFB) may attract a lower price and be directly sold at the farm, producers may prefer to directly process and attract a higher price. Recent evidence by Ordway et al. (2017) point to this insight where only about 20% of oil palm farm households decide to sell FFBs to an industrial mill. This clearly suggests the strong incentive of producers to process palm oil at their lower capacity mills and preferably sell value-added palm oil at different market structures.

In this paper, we examine the cost pass-through for an important value chain food and cash crop, oil palm. We assess both the directly harvested FFBs and the ensuing processed palm oil to establish the vertical pass-through mechanism. While the FFBs represent an unprocessed oil palm product, palm oil is most likely the most used processed product of oil palm in the study region. It is not only used as a source of food for the rural population, but it is also exported both nationally and internationally for food and other by-products. To the best of our knowledge, we are one of the first to understand the cost pass-through for an important cash and food crop like oil palm. Bergmann et al. (2016) provide an early attempt to understand

cross-commodity price transmission between palm oil prices and butter. As both commodities are sources of fat, price transmission was found to be driven by the substitutability of palm oil and butter. Thus, an increase in palm oil prices may increase the demand for butter, which in turn may increase butter prices. While these insights are important for developmental and pricing policy, they largely speak to the concept of horizontal price transmission (market integration), ignoring the concept of vertical pass-through of cost. This is the gap we fill in this analysis.

Unlike previous literature, this study examines the pass-through of prices for a supply chain with a form changing product through value-added processing. Value addition may require additional cost and strategies that influence marketing processes and hence price movements and the flow of transactions (Swinnen and Vandeplass, 2014). Modern processing may affect the functioning of markets and expand developing market opportunities (Swinnen and Vandeplass, 2010).

Being an important source for continental and global supply of palm oil (Ordway et al., 2019; Feintrenie, 2012; Hoyle and Levang, 2012), Cameroon presents an important laboratory to test and understand the cost pass-through of palm oil for a plethora of reasons. First, Cameroon ranks third in the production of palm oil in the greater sub-Saharan Africa region with a significant amount of forest cover still available (Ordway et al., 2017). Second, oil palm production in Cameroon takes place in a variety of scales, ranging mainly from smallholder plantations to large scale industrial plantations and to a lesser extent, wild harvesting. Third, given that palm oil contributes to almost 80% of edible oil demand in Cameroon, of which about 30% is obtained from small scale non-industrial mills (Frank et al., 2011), there exists large potentials for addressing food security and food household level demands through

ensuring stable pricing and marketing policies. As highlighted by the World Bank (2017), both household consumption and industrial demands of palm oil has increased since 2000 at an annual rate of 21%, arguably due to population growth.

The study employs a panel data set (2016-2019) of oil palm producers in the Southwest region of Cameroon that covers farm prices for unprocessed FFBs and the corresponding wholesale prices after the product is transformed to palm oil. The Southwest region with humid tropical climatic conditions is the established production basin in Cameroon for oil palm production and processing (Ordway et al., 2019; Feintrenie, 2012; Hoyle and Levang, 2012). This case study is aptly instructive to better gauge the market performance of a bio-economically important vegetable oil. We employ a reduced form cost pass-through model for the long-run estimation, and an Error Correction Model (ECM) for the dynamics of short-term disequilibria. We run both fixed effects and random effects to provide robust estimates both at the long run and in the short run. A battery of diagnostic tests are also performed to ensure little or no biases in the estimates.

Our contribution to the literature on pass-through and price transmission is threefold. (1) We add to the burgeoning literature evidencing pass-through of cost in the value chain of food commodities consumed by households. Our insight here stems from establishing vertical price linkages between an unprocessed product and its processed form. (2) We focus on an important food and cash crop with critical effects on global land use change and one of the biggest drivers of deforestation (Ordway et al., 2019) and (3) We provide empirical evidence from a developing country context, Cameroon which has been described as ‘Africa in miniature’ and largely representative of oil palm production in Sub-Saharan Africa. As edible palm oil consumption is expected to triple by 2050 (Ordway et al., 2019), understanding how cost is

passed-through matters for the value chain especially and is relevant for agricultural and development policy plans.

The rest of the article is organised as follows. Section 8.2 provides some background and literature review on the pass-through of cost and price transmission in general. The data and descriptive results from the data is presented in section 8.3. Section 8.4 contains the empirical model, strategy and the empirical results. The results are discussed in section 8.5 while the article ends in section 8.6 with a conclusion, policy insights and limitations of the study.

8.2 Background and literature review

In recent years, price transmission and marketing margins continue to be an important research area for agricultural product markets especially in vertically related food markets. While studies on horizontal price transmission have explored price linkages across different market places and commodities, studies on vertical price transmission have looked at price linkages along the value chain of commodities (Acosta and Valdes, 2014; Gizaw et al., 2021). Understanding such price changes at different levels of a product is not only important in the growing face of product differentiation (see for instance Loy and Weiss, 2019), but even more relevant for price determination processes such that different product sub-markets have different price determination mechanisms. Horizontal price transmission has been generally referred to as market integration since it looks at price linkages at different marketplaces and includes both cross-commodity and spatial price transmission. Cross-commodity price transmission hinges on the (potential) substitutability and complementarity between different commodities while spatial price transmission is based on the conventional spatial arbitrage and the law of one price (LOP) (Singh et al., 2015), or at a more aggregated level the concept of purchasing power parity.

The extant literature on vertical price linkages has taken a slightly different step to dwell more on the links between the farm price, the wholesale price, and the retail price. In many recent studies, vertical price transmission relationships have taken fore stage since commodity markets are becoming increasingly concentrated at both individual levels as well as integrated across the individual levels (Mai et al., 2018). Important questions asked when analysing vertical price transmission include, e.g., What happens to wholesale prices when a shock hits the primary commodity market at the farm level? It could also take the opposite direction as what will be the effect of farm level prices following a shock on wholesale prices. In summary, the primary focus of vertical price transmission is on four key characteristics: the magnitude or extent of adjustments, the timing (speed) of the adjustment, the nature (asymmetry) of the adjustment in response to the shock and the direction of the adjustment. Examining the price transmission across the various product nodes of a commodity offers profound insights on market efficiency, and the ensuing welfare of both the consumer and the producer (Meyer and von Cramon-Taubadel, 2004). Furthermore, asymmetric movement of prices can influence market failures across distribution channels on the vertical chain in markets. Several studies have provided empirical evidence on the transmission of prices across the food (processing) sectors and intermediary distribution channels (Abdulai, 2000; Wohlgenant, 2001, Wang et al., 2006; Bonnet and Réquillart, 2013).

Analysing asymmetries in retail to import price transmission across the seafood value chain in Germany, Ankamah-Yeboah and Bronnmann (2017) find evidence that supports both a price transmission relationship and equilibrium adjustments asymmetries. This implies that market agents only respond to shocks based on the size of the deviation from equilibrium. In this case, the response is when the deviation is above or below a given threshold value and retail outlets

practice market leadership with some level of adjustments. More recently, Gizaw et al. (2021) also reported asymmetric adjustments for the fresh and smoked salmon value chain in both the Norwegian export market and the retail markets in France and Spain. While the fresh salmon is unprocessed, the smoked salmon is a more processed variant. Their analysis indicates the presence of price transmission in the fresh salmon value chain in both markets but fails to establish any transmission along the smoked salmon chain in any of the markets. In both markets, there was some level of asymmetric adjustments for the unprocessed fresh salmon value chain.

Given that markets generally allow for different price signals to be transmitted both vertically and horizontally, Conforti (2004) provides detailed dynamics of market relationships for comparative models using a comprehensive data set across several countries (Argentina, Brazil, Chile, Costa Rica, Egypt, Ethiopia, Ghana, India, Indonesia, Mexico, Pakistan, Senegal, Thailand, Turkey, Uganda, and Uruguay) and emerging agricultural markets. Findings showed relative lower and (sometimes) incomplete transmission of prices for African markets as compared to Asian and Latin American markets. Examining the transmission of prices between world food prices and consumer food price indices in an emergent market, Vavra and Goodwin (2005) provide profound insights on the processes and mechanisms of asymmetric price transmission both from an empirical and a theoretical perspective. The authors, however, are keen not to draw any conclusions from their review or offer any policy implications.

As local or domestic prices can either be transmitted or not irrespective of international prices, Barahona and Chulaphan (2017) examine the extent and degree to which world food price indices are transmitted to consumer price indices which in a way describes the food expenditure incurred by different classes on consumers in Thailand. They show that while there exists a

cointegration relationship between these prices, the deviations from the long-run price-cost equilibrium are generally independent of the consumer price indices and similar across models. Further analysing price transmission from the international wheat market to the domestic wheat market for Indonesia, Varela and Taniguchi (2014) employ an Error Correction Model and find suggestive evidence in support of the existence of price transmission with causal effects that can be associated with the presence of market concentration. They report a faster upward adjustment of the domestic price of wheat as opposed to downward adjustments, especially when the deviation is from the long-run equilibrium. Their findings are not only robust to the addition of other exogenous variables like input prices but also to the use of disaggregated data.

8.3 Data and descriptive statistics

We utilise a panel data set of domestic price series at the farm level for fresh fruit bunches (FFBs) of oil palm, and the wholesale prices of the consequently transformed oil palm (palm oil). The data used represents price data for the FFBs and transformed palm oil prices from these FFBs at the wholesale level. The data at the farm level represents price data for FFBs harvested. Wholesale prices are deduced prices per litre of palm oil from typical aggregate sales made at that level. Prices are obtained from the agricultural post of Mondoni and cover the period from January 2016 to December 2019, a monthly price series of quoted prices from the traders at the specific nodes of this value chain. The prices were obtained over 20 observations within the period. Data were obtained through a multistage sampling procedure, first purposely sampled for the oil palm producing villages in the area, and consequently, two randomly selected farming areas from these villages each. Of the 32 traders that make up the survey rounds, the final panel constituted a panel of 20 traders due to inconsistencies in the other 12 observations.

Table 8.1 presents the price characteristics of the data over the years. The wholesale price demonstrates the most considerable average price variation. This could be accounted for by the fact that bargaining power at this node of the chain is usually more flexible for discounts due to purchases that are associated with economies of scale. According to the respondents, due to high labour demand and the energy demanding nature of the various tasks involved in the oil palm cultivation activities, most of the activities at oil palm cultivation level are coordinated by males. As highlighted by Nkongho et al. (2014), labour availability remains a serious constraint in both the non-industrial and the agro-industrial oil palm sector. Most of the youths who are expected to engage in the sector are uninterested and rather prefer to move to cities in search of non-farm jobs. Labour unavailability is even more felt as mechanisation is still away from most smallholder farmers. In this regard, there is the reliance of hired labour which is to a large extent scarce or missing.

Furthermore, as a result of customary tenure systems that still dominate the area, male dominance in the sector is somewhat expected. In most of these rural communities, women lack access to land and are more involved in short cycle crop-related activities while the males are more involved in longer cycle perennials such as palm oil due to increased access to land and other productive resources as well as existing power relations that play a role in the system. Most females are only involved in the palm oil sector post-harvest; to aid in the transformation of the FFBs to palm oil and the marketing activities that ensue. The issue of land ownership is quite a complex one in Cameroon in need of further research (Ordway et al., 2017). While it is not clear whether ownership is based on clearing and using virgin land, Ordway et al. (2017) found that about 87% of oil palm farmers claimed ownership of the land they cultivated but only 5% had a state land titles. Most of these are large farms that practice improved and commercialised forms of oil palm production and are usually owned by elites (Nkongho et al.,

2014). In this regard, improving the contextual institutional setting with regards to access may attract the younger and more energetic segment of the population to be more involved in the activities with prospects for improved efficiency, which may take the form of better yields. Improved and stable yields of FFBs may have significant bearings on the formation, flow and stability of prices.

Table 8.1.: Descriptive Statistics of Data

Variable		2016		2017		2018		2019	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD
FFB price($P_{i,t}^F$)	Overall	263.5 4	33.52	263.5 4	33.52	263.5 4	33.52	265.6 3	33.23
	Between		18.23		18.23		14.17		10.89
	Within		28.40		28.40		30.53		31.48
Wholesale price($P_{i,t}^W$)	Overall	441.6 7	54.35	442.0 6	55.00	442.4 3	55.69	442.7 1	56.41
	Between		43.13		43.84		44.49		18.73
	Within		34.35		34.52		34.82		53.36

Source: Own computation from market and price data, 2020 using STATA. Note: N=960. Prices are in FCFA (Central African currency) per kilogram of palm oil sales. The CFA franc is the official currency of Cameroon, 1 CFA is equivalent to about 0.00166395 USD. The within variation represents the variation across time, the between variation represents the variation across individuals, the overall represents the pooled variation.

As is standard with data that covers a time period, we check for the presence of unit root and ensure stationarity of the series to allow for the reliability of estimates. A difference stationary process may be necessary to reject the null hypothesis of a unit root. On the assumption of cross-sectional independence and considering the heterogeneity of individuals in the panels, the Hadri (2000) first-generation unit root test for strongly balanced panels is employed. This test is based on the null hypothesis of stationarity. Findings are presented in Table 8.2 below.

Table 8.2: Test of unit root

Variable	Hadri test
Fresh Fruit Bunch price ($P_{i,t}^F$)	10.388***
First difference Fresh Fruit Bunch price ($dP_{i,t}^F$)	-4.474
Wholesale price ($P_{i,t}^W$)	24.977***
First difference wholesale price ($dP_{i,t}^W$)	-4.353

Source: Own computation from market and price data, 2020 using STATA

Note: The values are significantly different from zero at *** $p < 0.01$

Null Hypothesis: All panels are stationary

To examine the long-run dynamics between the FFBs (oil palm) and wholesale prices for palm oil along this chain, it is vital to ascertain the existence of a long-run relationship between the variables. If the variables are non-stationary at this level but move together in the long-run, a linear combination of their integrated values is stationary, then our variables are established as cointegrated, and the presence of the long-run relationship is established. The variables then converge together in the long run. Pedroni (1999, 2004) under the null hypothesis of no cointegration allows for heterogeneity across panels testing for cointegration across the cross-sections by varying the cointegration vector. Results of the Pedroni test of cointegration are presented in Table 8.3 below. Findings are statistically different from zero at one percent significance level. For both the Phillips-Perron and Augmented Dickey-Fuller test, the null hypothesis of no cointegration is rejected, hence the existence of a cointegrating relationship between the variables and the plausibility of a long-run relationship.

Table 8.3: Cointegration test

Test	Statistic
Modified Phillips-Perron	-12.845***
Phillips-Perron	-19.610***
Augmented Dickey-Fuller	-24.855***

Source: Own computation from market and price data, 2020 using STATA

Note: The values are significantly different from zero at *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Null Hypothesis: No Cointegration.

To model the long-run and short-run estimations based on our panel data set, there exist two estimation methods, the fixed effect (FE) model and the random effect (RE) model. While the FE model is usually regarded as the work horse for linear models as it controls for individual specific effects (unobserved heterogeneity), the RE model is a fairly restrictive model but also controls for individual specific effects when it is constant over time. Unlike the FE model, the RE model assumes no correlation between the individual-specific effects and the covariates. To make an informed choice on the best model to use for the analysis, we performed a Hausman test. As shown in table 8.4, the Hausman test fails to reject the use of the RE model over the FE model. We thus employed the RE model to establish the long-run and short-run relationship for our covariates. That notwithstanding, we also reported the results from the FE model both for comparison and robustness purposes.

Table 8.4: Hausman test

	Coefficient		Difference	S.E
	Fixed Effect	Random Effect		
FFB price ($P_{i,t}^F$)	0.332	0.337	-0.005	0.004

Source: Own computation from market and price data, 2020 using STATA

FE = consistent under the null hypothesis and alternative hypothesis

RE = inconsistent under the alternative hypothesis, efficient under the null hypothesis

chi2(3) = 2.40

Prob>chi2 = 0.4944

8.4 Empirical model

Establishing the long-run relationship for our variables, we apply the following reduced-form cost pass-through model.

$$P_{i,t}^W = \alpha_1 + \alpha_2 P_{i,t}^F + c_i + \epsilon_{i,t} \quad (1)$$

$P_{i,t}^W$, our dependent variable is the wholesale price for palm oil, α_1 is the constant term, α_2 estimates the relationship between the wholesale price of palm oil and the price of oil palm (FFBs). The average price per FFB is used. The assumption of the random effects model that the error correction term is uncorrelated with the covariates is in the representation of c_i . $\epsilon_{i,t}$ is the error term representation. Neglecting sunk cost of processing and other transaction costs, in a perfectly competitive market we may expect $\forall \in (0,1)$ for symmetric price movements *ceteris paribus*, where \forall is the cost advantage of repeated suppliers (Swinnen and Vandeplass, 2014).

Differences that arise from product differentiation and the derivation of secondary products from primary commodities may influence consumer perceptions and consequent purchase choices. Hence information flow to manage bargaining power is vital for asymmetric price flows to be curbed in the directions of trade (Stiglitz, 1989). These may distort the long-run equilibrium.

We use an Error Correction model (ECM) as it allows us to capture the distortion in trade flows for price transmission rates based on the adjustments from the price-cost equilibrium in the long-run. While the ECM is advantaged over the plausibility to capture the cointegration trends

among price series as well as integration between markets, it will also allow validating the existence in the long-run of causality from the covariates to our outcome variable.

Assuming the presence of a long-run equilibrium relationship between our variables, however, there could be a divergence from the long-run equilibrium in the short-run. A deviation from the long-run equilibrium would be corrected by short-run adjustments for the restoration of the long-run equilibrium relationship. These deviations from the long-run price-cost equilibrium can be verified with the specification of an ECM that allows for the dynamics of the speed of adjustment back to the long-run equilibrium from short-run disequilibria to be quantified. This allows us to establish the extent of disequilibrium from stationary characteristics. The ECM incorporates the error correction term that measures the speed of adjustment of such disequilibria back to the long-run equilibrium, as presented in equation 2;

$$dP_{i,t}^w = \gamma_1 + \gamma_2 \epsilon_{i,t-1} + \dots + \mu_{i,t} \quad (2)$$

where d represents a first-difference operator, $\epsilon_{i,t-1}$ is the error correction term from equation (1). γ_2 is the speed of adjustment back to equilibrium, given that the transaction cost measure is zero. The study hence statistically tests the null hypothesis that there is no significant difference in price linkages between primary and secondary markets (Rapsomanikis et al., 2003).

8.5 Empirical results and discussion

Findings from the long-run cost pass-through model are presented in table 8.5. Based on the data, an increase in the price of FFBS is associated with increasing prices at the wholesale level for a product that has changed form. The sign of the coefficient for FFBS is positive. The upstream (FFBS) and downstream (wholesale) prices for palm oil, are associated in a positive

relationship. Following the random effects model, an increase in the price of FFBs increases the wholesale price for palm oil by about 33franc. Marginal cost has been associated with higher mark-ups (Loy and Weiss, 2019). Earlier findings have found evidence that price transmission may be relatively faster for less processed than more processed commodities (Landazuri-Tveteraas et al., 2018). The average mark-up is about 353franc, the constant c.p.

Table 8.5: Long-run Estimates

X_{it}	Y_{it}	
	$P_{i,t}^w$	$P_{i,t}^w$
	Random Effects	Fixed Effects
FFB price($P_{i,t}^F$)	0.337*** (0.094)	0.332*** (0.094)
Intercept	353.122*** (24.899)	354.559*** (24.732)
R ² Overall (within) (between)	0.06(0.05)(0.17)	0.06(0.05)(0.17)
Wald $\chi^2(DF)\pm (F)$	12.81***	12.56***

Robust standard errors are in parenthesis. ***p<0.01, **p<0.05, *p<0.1. Source: Author's computation from market and price data, 2020 using STATA

Our error correction term is negative as expected. Deviations from the long-run equilibrium are corrected for by about 10.6% per cent in the following month. Findings are significantly different from zero at one percent level. According to Acosta (2012), faster restoration from disequilibria back to the long-term can be incentivised by increasing prices in African markets. Similar insights have been offered by Bashir et al. (2018) who found a speed of adjustment of about 31% for agricultural value added in an emerging market in Indonesia. Zamani et al., (2018) found a similar correction of about 30% for disequilibria in the Iranian poultry market. The relatively lesser speed of adjustment may be in line with lower price transmission rates for more processed commodities (Gizaw et al., 2021).

Table 8.6: Short-run Estimates

X_{it}	Y_{it}	
	$dP_{i,t}^w$	$dP_{i,t}^w$
	Random Effects	Fixed Effects
Error-Correction Term ECT_{it-1}	-0.106*** (0.016)	-0.058 (0.142)
First difference FFB price ($dP_{i,t}^F$)	0.276*** (0.075)	0.279*** (0.077)

First difference wholesale price ($dP_{i,t}^w$)	-0.388*** (.092)	-0.439** (0.180)

Intercept	-0.088 (0.340)	-0.087 (0.090)
R ² Overall (within) (between)	0.84(0.84)(0.66)	0.84(0.84)(0.05)

Robust standard errors are in parenthesis. ***p<0.01, **p<0.05, *p<0.1. Source: Author's computation from market and price data, 2020 using STATA

Findings are statistically different from zero at one percent level of probability. However, the constant is not significant in the short term.

8.6 Conclusion

In this paper, we analysed the transmission between FFBs, and wholesale prices for palm oil in Cameroon using a high frequency monthly collected price data between 2016 and 2019. We employ a panel error correction model for our analysis. From the descriptive analysis of the data, land rights still affect livelihood commercialisation activities, the welfare of livelihoods will be boosted if the tenurial system can be improved such that women have access and use rights. They make up a relevant part of the population and their enforced input will yield welfare. Raw materials or untransformed products are correlated with their counterpart final products that are transformed. The provision of advanced market services may not only meet up to infrastructural drawbacks and the lacking labour sometimes left in the hands of the older and less energetic, but also help in connecting these local markets globally through expansion.

From an empirical point of view, transformed products in upstream markets are correlated with the downstream final product price. Cost and discount advantages exist for repeated buyers and this affects prices and their consequent flow based on bargaining power. Bargaining power plays an important role in the formation and consequent movement of prices. This is also accounted for by the lack of structurally organised markets. More organised markets can enhance the stability of prices and eliminate unfair price distribution mechanisms.

Our study has important implications for both market liberalisation and agricultural development plans. To the extent that the palm oil value chain shows slow adjustment rates of price flow trends, there remains an underlying need to explore the market opportunities of these supply chains for boosted value creation and welfare of added value. We therefore lend support to the development of interventions that target each node in the value chain separately. If this is not the case, any market liberalisation policy would over-estimate the potential benefits to consumers at the end of the chain since farm prices may not be fully transmitted to them. Some caution should be exercised when making generalisations from our results given that context matters. However, the market and pricing realities may not be different in other developing countries where price determination and marketing policies are both triggered and hampered by similar socio-economic and socio-political situations. In this regard, our analysis may be interpreted and generalised to representing an emerging market situation which is prevalent in many developing nations.

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Chapter 9

Spatial Price Flows in Domestic Markets: Panel evidence from the Soybean market in Benin

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Abstract

Coordination across emerging markets is increasingly needed to guide the movement of prices and trade flows efficiently in every direction of the supply chain to boost market performance. Understanding how commodity price changes in various (domestic) markets are transmitted to consumers is crucial in examining household vulnerability to price shocks. We employ a panel data set from Benin to examine horizontal relationships within the soybean market from 2010 – 2017. An augmented panel error correction model is used to assess the short-term dynamics for producer prices across the country. Findings reveal the direction of trade flows affect the movement of prices. Domestic markets are integrated. Findings suggest that the North-South soybean markets for Benin are positively coordinated while the North-North markets are negatively associated. The magnitude of trade transactions may directly influence the flow and movement of prices in different directions within these markets. Tailored policy interventions in perspective of the direction and magnitude of trade transactions within markets have the potential to provide a balance that ensures market efficiency. Furthermore, augmenting market services underlie a boost to the functioning and performance of these markets.

Keywords: Price transmission; Error correction model; Soybean markets; Market performance; Market efficiency; Benin

9.1 Introduction

Trade is increasingly needed in Sub-Saharan African (SSA) economies to boost the emerging nature of their markets. Small businesses comprise several supply chains that make up a significant proportion of the markets. Markets that are segmented spatially isolate economic agents across space and limit the transmission of price incentives and the associated positive welfare impact as a result of lower prices and increased productivity. The messy character of market relationships (Barrett and Li, 2002) cannot be fully addressed in the presence of imperfect market integration where trade takes place in the absence of price transmission, and segmented equilibrium in the possibility that price transmission occurs in the absence of trade. Price adjustment and signals are particularly not instantaneous in food markets (Barahona and Chulaphan, 2017).

Thus far, spatial pricing behaviour in most domestic markets has been used as an indicator or better still yardstick of marketing performance in many countries (Abdulai, 2000). In this regard, market strategies that improve the access and signals for better coordinating supply chains spatially and vertically can boost the functioning and performance of markets. In the last decades, many nations in SSA have initiated several market liberalisation measures like reducing/halting price and wage controls, privatisation of state-owned and controlled sectors as well as deregulation (Abdulai, 2000). Such measures are all in line with economic theory, which suggests that the proper functioning of marketing systems and channels is necessary for the optimal allocation and distribution of resources.

Policy makers have in the recent past also shown considerable interest in price transmission. This interest arises from the world food price crises in 2007-2008 and 2010-2011 where food prices dramatically increased, pushing associated increases in commodity prices like oil. This was accompanied with economic and political instability as well as social unrest in many poor

and developing nations. This has since been a critical subject of debate for most governments and developing agencies who seek to avert and prevent any such global crisis as it has deleterious effects on the numerous efforts put so far in reducing poverty and ensuring food security. Understanding how to react to price increases for staple food commodities like soybean is important for protecting or preventing vulnerable households from falling or remaining into poverty. Policy measures in such circumstances will vary depending if markets are integrated or not. In the case where markets are integrated, social protection measures like cash transfers may be more appropriate than food aid (Tankari and Goundan, 2018). Since price signals and information flow is guaranteed between different markets, there are more efficient trade flows between food affluent and food deficit regions which reduces and stabilises regional differences. In this light, one can argue market reforms are a viable policy option for in stabilising prices for food commodities. However, the success of such policy measures hinges on the strength of the price transmission signals between markets, which are spatially separated.

It is in this light that we examine spatial price transmission for the soybean market in Benin. Specifically, we assess the relationship between horizontal markets in the Northern region of Benin, in comparison to the relationship between spatial markets in the North and South for the same commodity. We also examine the functional relationship between the flow of producer prices spatially for a homogenous commodity over space and time. Summarily, our study examines the food price transmission across departments in Benin considered relatively homogenous concerning the characteristics of their respective agricultural markets (Cachia, 2017). Food consumption patterns, especially in staples, are similar across SSA with similar growth rates recorded in West, East, and South Africa influencing growth in food consumption

(von Braun and Paulino, 1990). This makes it possible to generalize empirical findings, enabling comparability in policy insights across the entire region.

Our analysis is akin to Cachia (2017) and Abdulai (2000) who used international regional consumer prices and domestic wholesale prices for different regions of the world and across domestic markets in Ghana respectively to offer insights on the estimates of price spatial price transmission. The two studies make use of threshold cointegration and an asymmetric error correction model on some time-series data. Our analysis is however different from theirs as we employ a panel data set to provide proper insights on the dynamics of the price linkages and adjustments across space and time. We employ an augmented panel error correction model that accounts for the heterogeneous impacts of unobserved factors across panel means to obtain mean group estimates of the first and second stage estimations. We use a monthly data set of soybean prices at the producer level for regions in the North and South of Benin which allows the possibility to capture shocks. The panel data set covers the period from January 2010 to February 2017 across four departments of Benin, two in the North (Atakora and Borgou) and two in the South (Zou and Plateau).

Our focus is on soybean (*Glycine max*) which is a multipurpose legume and like other legumes can be described as pro-poor and environmentally friendly since it is a cheap source of protein for many rural households in lieu of other protein sources like meat and fish. It is thus relevant for food and nutrition security (Ayenan et al., 2017). It is environmentally friendly because, as a legume, it aids in the synthesis of atmospheric nitrogen, improving soil fertility and reducing the use of synthetic fertilisers. Soybean is also used as a raw material in producing vegetable oil and has high demand in feed milling, increasing its economic value and making it a market-oriented crop (ibid). Though Africa remains a minor player in terms of global soybean production, African soybean production in Africa still lacks in the global market, and Benin is

among the major producers (Cornelius and Goldsmith, 2019). In the period from 2008-2015, soybean production in Benin greatly increased from 31,111 to 139,909 tons (MAEP, 2016). Given that it is rainfed, production and price fluctuations are expected especially on a seasonal basis. As a staple, which is both produced and consumed locally, soybean can be described as a non-traded or locally traded food crop with a significant role in food security. Being non-traded would imply the absence of long-term relationships between domestic and international food prices, making them more volatile than the internationally traded commodities.

We add to the existing literature in three main ways. First, we link domestic regional producer food prices in sectoral decentralised market economy, for the long-term dynamics and symmetric short-run adjustments of the price transmission signals. Second, since we analyse spatial price flows between domestic markets in the North and South of Benin, we attempt to provide novel evidence on the difference between a price shock emanating from inter-regional markets with distinct production and supply capacities. As noted by Katsumata et al., (2007), soybean production reportedly took turns in Benin post the cotton crisis. Production activities for soybean rapidly expanded in the South including the Zou department in the late 1990s (Katsumata et al., 2007). However, the Northern regions including Atakora and Borgu notably boosted their production rapidly in the early 2000s (Katsumata et al., 2007). Third, we establish the dynamics of the domestic horizontal market interdependence relationships for producer prices. Producer prices provide an underlying point of understanding for subsequent price movements across the nodes of the supply chain. Studies have focused more on understanding the evolution and transmission of prices across all stages of the supply chain and between the world market and domestic markets. The outcome from earlier market segments and the flow and linkage of price signals at this stage provides an underlying foundation of how the prices arrive down to the finished goods price. The level of cointegration between these markets can

also facilitate the understanding of the evolution towards the overall functioning of these markets. Understanding the functional network of these chains can provide important insights into the flow of trade and prices for implications on the overall functioning of the market.

The rest of the article is organised as follows. We discuss the background of price transmission and market integration in section 9.2 and delve into a review of the empirical literature. In section 9.3, we provide the data used in the analysis and some descriptive results. The empirical strategy is then presented in section 9.4, which is closely followed by the results and discussion in section 9.5. The article ends with some conclusions, policy implications, and limitations in section 9.6.

9.2 Existing empirical literature and conceptual framework

The literature on price transmission is burgeoning and largely points to the important role of price transmission in the overall welfare of producers and consumers, through the accruing of full benefits from declining prices both across the product chain and within different markets. Price transmission can either be horizontal or vertical. While vertical price transmission relates to price linkages along the various nodes in the supply/value chain of a product, horizontal price transmission refers to price linkages within different markets and different commodities. Horizontal price transmission is also referred to as market integration and can be defined as the walrasian transfer of physical commodities or the transmission of price shocks between different markets. Closely related is the price-based concept of market efficiency, which more or less refers to how responsive different market systems are to equilibrium after being hit by shocks (Gitau and Meyer, 2019).

Well-functioning and integrated markets are usually key when it comes to the design and implementation of effective price stabilisation policies. For instance, well-functioning markets

would enable price signals act as both effective and efficient allocators of scarce resources, which may lead to price stability (Gitau and Meyer, 2019). Pricing behaviour in both space and time continues to be a central theme in economic theory, making price transmission and market integration very important for policy prescription and development (von Cramon-Taubadel, 2017).

Horizontal price transmission is broadly divided into spatial price transmission and cross-commodity price transmission. The theoretical underpinnings of the cross-commodity price transmission is the substitutability and complementarity between different commodities over space. For spatial price transmission, the theoretical foundation is based on spatial arbitrage and the Law of One Price (LOP). Linking this to a basic partial equilibrium model for two markets, it is possible to show that relative prices are stable if the effect of supply or demand shocks in a single price space are investigated (Asche et al., 2007), implying that the LOP holds. When producers are allowed to practice arbitrage by freely selling their products on both home (domestic market) and abroad (regional or international market), the home and abroad prices will tend to converge (Cachia, 2017). Our focus in this analysis is on spatial price transmission in different domestic markets in Benin. Worthy of mention is the fact that previous literature has largely centered around the Law of One Price (LOP) which is more plausible for homogenous products (Baffes, 1991; Barrett, 2001; Yang et al., 2006; Conforti, 2004; Hossain and Verbeke, 2010).

Extant literature exists on the spatial dynamics of trade flows and integration between markets. Market reforms, the magnitude of physical trade movements, incapacitated infrastructural services have been found to affect integration across markets (Ivan et al., 2018). Ivan et al., (2018) found that lower state-dependent markets can be more strongly integrated with

international markets especially in the absence of export restrictions, trade barriers or price support policies. Several studies have found evidence of integration across prices and markets (von Cramon-Taubadel, 1999; Abdulai, 2000; Loy and Wichern, 2000; Barret and Li, 2002; Galay, 2019). Also, these studies stress that such integrated markets adjust rapidly. In a way, this is also indicative that most agricultural commodity markets are well-functioning.

Tinta et al., (2018) employed panel estimations and examined comparative strategies between regional and international trade in some emergent markets in West Africa. They found that augmented regional trade better provides tailored solutions in enhancing market performance for these West African states. Employing a single equation error correction model on paired data for some developing country economies, Baquedano and Liefert (2014) showed that prices in the consumer markets are cointegrated with the prices of the world agricultural commodity markets. Domestic and regional markets in open economies have been found to exhibit stronger market integration relationships relative to their market integration links with international markets (Fossati et al., 2007).

In a very recent strand of the literature, empirical studies have examined the pass-through of cost in non-homogenous markets. Findings have shown that in such differentiated product markets, the pass-through of cost is inversely related for more differentiated products, and product quality diversity is associated with more sluggish speeds of adjustment back to the long-run equilibrium (Loy and Weiss, 2019; Bittmann et al., 2020). In an emergent market context, Zamani et al. (2018) have found that elasticities of associated pass-through of cost are heterogeneous and directly affected by the seasons of demand.

In terms of methodology, different empirical methods and specifications have been used to prefer evidenced based insights. In examining the price transmission between world prices and consumer prices, Barahona and Chulaphan (2017) transform the error correction model into an autoregressive distributed lag model allowing for the flexibility of changing lag dynamics and ascertain the potential of determining welfare dynamics using consumer price indices. They showed that the world and domestic price series were cointegrated with similar speed of adjustment rates across all price series. In a similar vein, Weinand and Auer (2019) employ a multistage weighted country-product-dummy method to study regional price differentials with micro price data on the consumer index for only identical products. They find evidence of spatially autocorrelated price levels. In a bid to improve the modelling of price transmission, Acosta et al. (2019) have proposed considering the market's institutional context in addition to the mainstream econometric methods to support evidence-based policy and decision making. They suggest a structured empirical toolkit that combines the simultaneous use of econometric and market structure methods to model price transmission

From the literature review, we surmise that the study of price transmission is both relevant from a scientific and a developmental policy viewpoint. While different empirical techniques and methodologies have been used to offer insights into spatial price linkages, most of the studies have pointed at the important role price linkages play in the market economy with positive bearings on both producer and consumer welfare. It is also considered an important indicator of market performance.

9.3 Data and descriptive statistics

The study uses a monthly data set of soybean prices at the producer level for regions in the North and South of Benin. Data is obtained from the Ministry of Agriculture in Benin. The panel data set covers the period from January 2010 to February 2017 across four departments

of Benin, two in the North (Atakora and Borgou) and two in the South (Zou and Plateau). The monthly data set allows the possibility to capture shocks. Based on the available data, there are four markets. Two departments in the North make up the markets in the North (Atakora and Borgou) and two departments in the South make up the markets in the South (Zou and Plateau). In each of the Northern markets, two communes were randomly sampled within the departments, making up the markets for each of the departments; Cobly and Natitingou are the communal markets sampled in Atakora, while Sinende and Parakou are the communal markets sampled in Borgou. The Southern markets however, based on available data have just one commune sampled within each of their departments. Bohicon is the communal market for Zou, and Ketou is the communal market for Plateau. Hence the analysis considers two departmental markets in the North and two departmental markets in the South of Benin. The departmental markets were randomly sampled within the Northern and Southern regions of Benin. The Northern and Southern markets were purposely sampled for their notable prominence in soybean cultivation in Benin (Katsumata et al., 2007). Figure 9.1 presents the map of the area indicating the sampled areas.

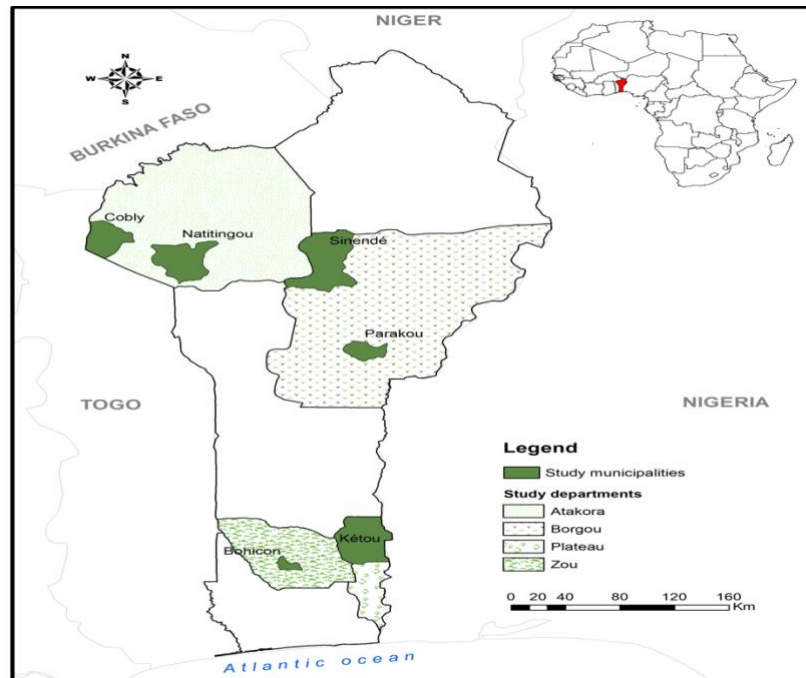


Figure 9.1: Map of Benin showing sampled areas

In Aakora, the markets include the communes Natitingou and Cobly. In Borgou, the markets include the communes Parakou and Sinende. In the Southern, the markets include the communes Bohicon in Zou, and the commune Ketou, in Plateau. Due to data availability constraints, data could not provide two commune markets each for the departments in the South, like the case for the North markets. For the more available data in the South, we hence examine South-South price linkages in addition to South-North price linkages. Two departments were represented for the Southern market. In Zou department, the represented commune is Bohicon. In Plateau department, the represented commune is Ketou. The data consist of 86 months over above 6 years. Summary statistics of the evolution of these prices in the years are provided in table 9.1 below.

Table 9.1: Descriptive statistics of Soybean prices over the period from 2010–2017

Variable	Description	Mean	Std. Dev.	Min.	Max
$P_{i,t}^a$	Logarithm of Producer price				
	in Borgu	5.569	0.240	4.745	6.215
	Overall		0.040	5.541	5.598
	Between		0.239	4.716	6.186
	Within				
$P_{i,t}^b$	Logarithm of Producer price				
	in the South	5.337	0.297	4.654	6.075
	Overall		0.112	5.257	5.416
	Between		0.287	4.575	5.996
	Within				
$P_{i,t}^c$	Logarithm of Producer price				
	in Atakora	5.584	0.301	4.828	6.142
	Overall		0.209	5.436	5.731
	Between		0.262	4.976	6.290
	Within				

Source: Own computation from data from the Ministry of Agriculture in Benin

Note: Prices are in CFA Franc (West African currency) per kilogramme of soybean. The CFA Franc is the official currency of Benin, 1 CFA is equivalent to about 0.00182022 USD. N = 172;

Prices in the South (Zou and Plateau) of Benin are averagely lower, compared to the prices in the North for soybean over the period. This suggests greater soybean availability in the South of Benin compared to the North. Producer prices for soybean were notably least in the Southern region of Benin based on the data. There was a considerable variation over time (within) and individuals (between) for soybean prices in the period.

Panel data could be associated with spatial effects between or within cross-sections of some unobserved factors that could lead to interdependency from the correlation between cross-sections. This could bias estimates if not accounted for. Utilising Pesaran's (2004, 2015) test

of cross-sectional dependence, findings suggest evidence of the presence of cross-sectional dependence among spatial markets in Benin (Table 9.2).

Table 9.2: Test of Cross-Sectional Dependence

Variable	Pesaran's CD test
Producer price in Borgu ($P_{i,t}^a$)	2.863***
Producer price in the South ($P_{i,t}^b$)	5.427***
Producer price in Atakora ($P_{i,t}^c$)	3.024***

Source. Own computation from data from the Ministry of Agriculture in Benin

H0: Cross-section independence. *** $p < 0.01$.

In the presence of cross-sectional dependency, we test for unit roots based on the mean individual t-statistics across cross-sections that accounts for cross-section dependency by augmenting the Dickey-Fuller statistics of the regression (Pesaran, 2007). Our critical values (-1.94, -1.71, -1.56 for the cross-sectionally augmented DF (ADF) at 1%, 5%, and 10% levels of significance respectively) are smaller than the critical values (-3.23, -2.58, -2.24 at 1%, 5%, and 10% significant levels respectively) and hence we fail to reject the null hypothesis of non-stationarity. Testing for the unobserved factors of the data and the presence of unit root as well as cointegration, findings are also robust to the Bai and Ng (2004) second generation panel unit root test. We adopt a test for the cross-section dependence of the errors. The null hypothesis is rejected; however, this is not robust to spatial linkages and correlation (Moscone and Tosetti, 2009).

Plots of the price series are shown in figure 9.2. As is characteristic of data that covers space and time, the movement of the prices over time exhibits changes and variances. However, the

prices tend to follow a common trend. The presence of unit root may affect the predictability of outcomes and expand forecast error.

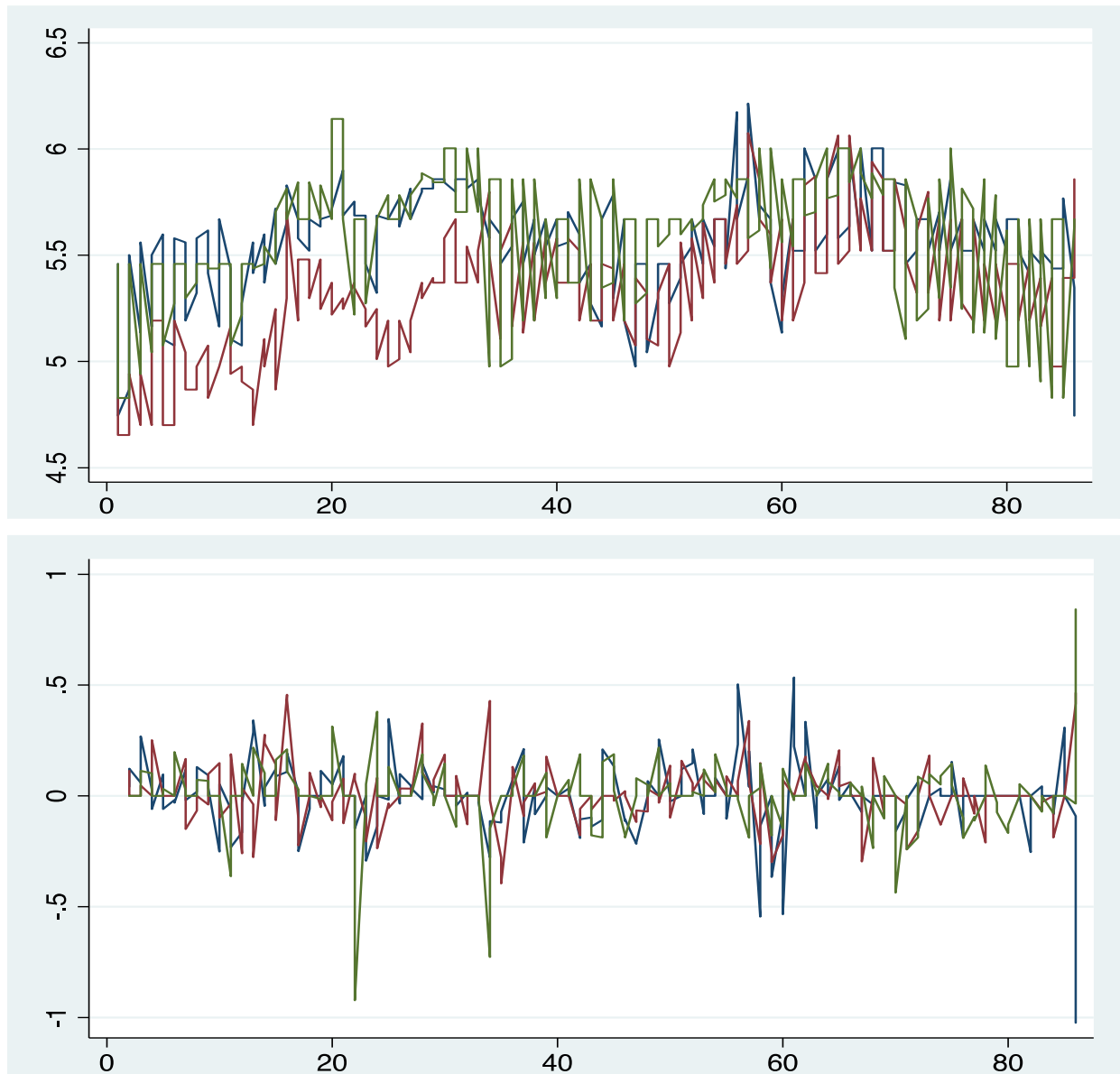


Figure 9.2: Unit Root on price series (Source: Own computation from data from the Ministry of Agriculture in Benin)

Price series may exhibit variant statistical properties over time. Hence a plausibility of spurious regressions or biased estimates. The presence of unit root in our price series may imply non-stationarity. Hence the necessity to validate the absence of unit root in our price data for plausible forecast results and estimates. Figure 9.2 shows that our price data demonstrate the presence of unit root at levels. First differencing our variables stationarises the price series. We

further employ the Hadri (2000) residual Lagrange multiplier test to investigate the presence of unit root in the price series data. Findings are presented in Table 9.3.

Table 9.3: Unit-root test

Variables	Hadri test
Producer price at Borgu ($P_{i,t}^a$)	15.827***
First difference of producer price at Borgu ($dP_{i,t}^a$)	0.191
Producer price in the South (Bohicon and Ketou) ($P_{i,t}^b$)	41.434***
First difference producer price in the South (Bohicon and Ketou) ($dP_{i,t}^b$)	-1.137
Producer price at Atakora ($P_{i,t}^c$)	9.255***
First difference producer price at Atakora ($dP_{i,t}^c$)	-0.926

Source. Own Computation from data from the Ministry of Agriculture in Benin,

H0: All panels are stationary,

*** $p < 0.01$.

The variables of our price series process are integrated of order I(1) in first differences following the Hadri (2000) Lagrange multiplier test. Hence our price series are all stationary at first difference. Our stationary price series allow us to investigate cointegration among our variables. Ascertaining the existence of a cointegrating relationship among our variables establishes the plausibility for the presence of a long-run relationship between our variables. Based on our data series, we employ the Westerlund (2007) panel cointegration test that adopts an approach that is more robust to serial correlation and cross-section dependency of panel test that is error based. Findings empirically reveal that our price series are cointegrated as shown in table 9.4.

Table 9.4: Panel cointegration tests of producer price series based on Westerlund (2007)

Statistic	Value	Z-value	P-value
Group mean tests			
G_t	-4.078	-3.138	0.00
G_a	-38.484	-6.620	0.00
Panel tests			
P_t	-5.561	-3.039	0.00
P_a	-32.325	-6.692	0.00

Source. Own computation from data from the Ministry of Agriculture in Benin

H0: No cointegration.

The Westerlund panel cointegration test strongly rejects the null hypothesis of no cointegration for the group mean test and the panel test. We find evidence that soybean markets in Benin are integrated. These results complement previous works in agricultural commodities in West African nations (Abdulai, 2000). The market integrated nature of the Benin market may be suggestive of a well-functioning agricultural commodity market triggered by liberalisation policies.

Variables might exhibit causal relationships that can be uni-directional in one way or bi-directional both ways for the independent and dependent variables. We examine the correlation between variables and the direction of causality in a bid to ensure the reliability of our estimates. Findings suggest evidence of uni-directional causality in line with earlier studies and we proceed with modelling our variables.

9.4 Empirical specification

Based on evidence for our cross-sectional dependent panel price data series as shown above, our long-run estimation is such that;

$$\log P_{i,t}^a = \beta_0 + \beta_1 \log P_{i,t}^b + \varepsilon_{i,t} \quad (1)$$

$$\log P_{i,t}^a = \alpha_0 + \alpha_1 \log P_{i,t}^c + \varepsilon_{i,t} \quad (2)$$

Where $\log P_{i,t}^a$ is the logarithm of the price of region *a* at time *t*, $\log P_{i,t}^b$ is the logarithm of the price of region *b* at time *t*, $\log P_{i,t}^c$ is the logarithm of the price of region *c* at time *t*, in line with earlier studies (see Zamani et al., 2018). $\varepsilon_{i,t}$ is the error correction term. Region *a* is a major market in the Northern region of Benin (Borgu department with two communes, Coby and Natitingou), Region *b* is a market in the Southern region of Benin (with two communes, Bohicon and Ketou in Zou and Plateau departments respectively), and Region *c* is another major market in the North Region of Benin (Atakora department with two communes, Sinende and Parakou). The Southern Regional market consists of two departmental markets (Zou and plateau). Our price series are considered exogenous in line with the findings of the Granger non-causality test. This is in line with earlier studies (Zamani et al., 2018). The type of market in perfect and imperfect settings can affect the completeness of price transmission and coordination of prices. Spatial price movements and linkages across markets of developing economies can coordinate the flow of information among market participants and enhance the functioning of these markets (Fackler and Goodwin, 2001).

The adjustment of prices from disequilibria for cointegrated markets can be modelled by employing error correction models (Ravallion, 1986). We employ an augmented panel error correction model that accounts for the heterogeneous impacts of unobserved factors across panel means to obtain mean group estimates of the first and second stage estimations (Nagel, 2017). The coefficient of the Error Correction term is expected to lie between 0 and 1, that is, $0 \leq \epsilon \leq 1$ (Engle and Granger, 1987). We test the null hypothesis that there is no difference in the flow of prices for different directions of trade flows across domestic regional markets.

Meyer and Cramon-Taubadel (2004) have shown that magnitude and direction are factors that can account for price transmission.

9.5 Results and discussion

Results of the long-run relationship are presented in Table 9.5. The pass-through of prices across producer markets is highly significant at one percent level. A percentage change in the producer prices in the South is positively associated with a change in the producer price in the North by about one percent. However, this is not the case for spatial North-North markets of soybean in Benin. There exists an inverse relationship between the prices that a percentage increase in Borgu producer prices is associated with a 51.8 percent decline in Atakora prices based on findings. This may suggest an existing difference in the coordination between Northern and Southern spatial prices in the soybean markets in Benin. The flow of prices between the South market and the North market exhibits a positive relationship while the flow of prices between two North markets (Atakora and Borgu) exhibits a negative relationship. We hence reject a null hypothesis of no difference in the flow of prices across different directions of spatial markets.

Table 9.5: Long-run Average Estimates

X_{it}	Coefficient
Producer price in the South ($P_{i,t}^b$)	.121*** (5.55e-07)
Producer price in Atakora ($P_{i,t}^c$)	-.518*** (5.00e-07)

N=168; Robust standard errors are in parenthesis. ***p<0.01, **p<0.05, *p<0.1. Source: Own computation from data from the Ministry of Agriculture in Benin.

Contemporary investment initiatives in the Benin soybean market may have stimulated its market expansion. The venture into soybean exports might mean more trade flows across the

country North-South in larger volumes to the ports. Hence, this could ensure better and more tailored coordination of the market in this direction. Evidence may not favour an alignment with the Law of One Price as prices may not be identical in the North and South c.p. The finding is in line with Bakucs et al. (2015). The value of the root mean square error (0.0643 and 0.0664) also provides evidence to suggest that our empirical model is robust in resolving for cross-sectional dependencies.

Table 9.6: Short-run Estimates

X_{it}	Coefficient
Error-Correction Term (ECT_{it-1}) ⁷	-.475*** (-4.775)
Error-Correction Term (ECT_{it-1}) ⁸	-0.408*** (-3.991)
First difference South price ($dP_{i,t}^b$)	-.014*** (1.12e-07)
First difference Borgu price ($dP_{i,t}^c$)	-.198*** (5.79e-08)

N=168; Robust standard errors are in parenthesis. ***p<0.01, **p<0.05, *p<0.1. Source: Own computation from data from the Ministry of Agriculture in Benin.

Findings from the mean-group error correction estimation are presented in Table 9.6. There is evidence of convergence of short-term disequilibria to the long-run equilibrium. Further, findings suggest significant responses to exogenous shocks by producer prices in both Northern and Southern soybean markets. Deviations from the long-run equilibrium are corrected for by atleast 40 and about 48 (upper interval) percent in the following month. Earlier findings have documented evidence of much lower speeds of adjustment in emerging markets (Abdulai, 2000; Zamani et al., 2018).

⁷ Model 1 (t-bar statistic in parenthesis)

⁸ Model 2 (t-bar statistic in parenthesis)

A full representation of the error correction estimates is presented in figure 9.3.

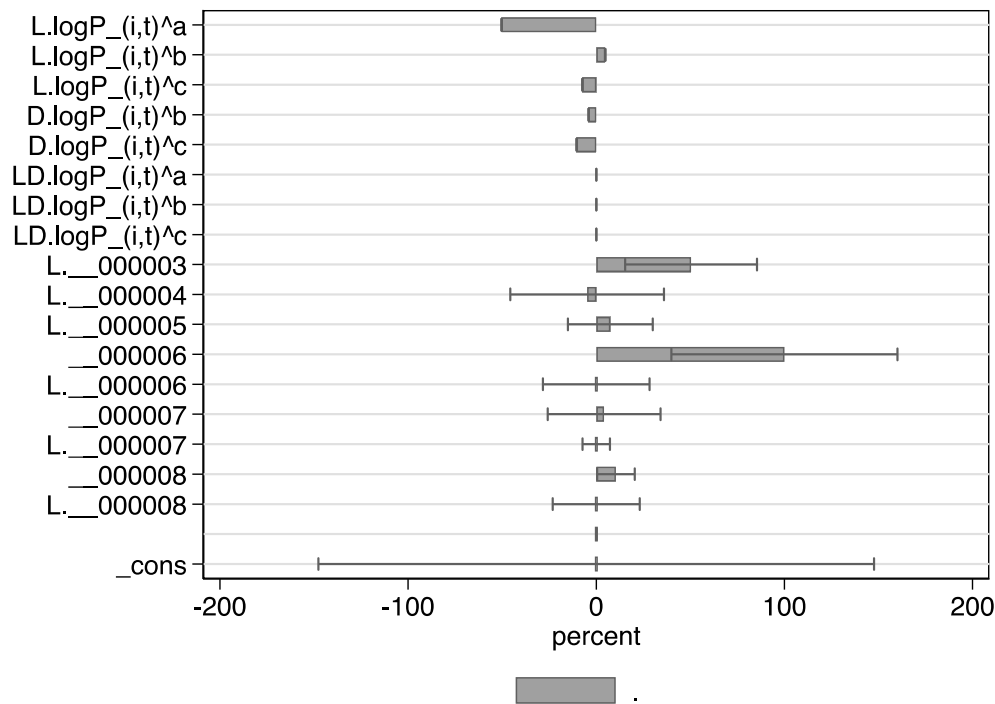


Figure 9.3: Rescaled Error Correction Estimates with cross-sectional averages (Source: Own computation from data from the Ministry of Agriculture in Benin)

Except for the lag value of producer prices in the south, all lag values for producer prices and the first difference of the producer prices in all regions are negative and also statistically different from zero at the one percent level of probability. Cross-sectional averages are also seen to have higher magnitudes. These findings may suggest that while previous prices in the South are positively associated with the subsequent price changes in Atakora, this is not the case for Borgu.

9.6 Conclusion

Price responses vary by the direction of flows. Understanding the coordination of price movements in the different directions of flows can provide policy insights on the functioning of markets and guide reforms for better market performance. This study uses a multi-wave monthly panel data set to examine the relationship between the movements of producer prices

in the Benin soybean market in the framework of spatial price flows across some domestic markets in Benin. An augmented panel error correction model examines the short-term dynamics of disequilibria. Empirical insights largely point to the fact that agricultural commodity markets are integrated in Benin. Our results support earlier findings for staple commodities like maize in Ghana and other West African countries. While North-South markets are found to be positively associated in the relationship of their price flows, this is not the case with the North-North markets. The symmetric error correction model suggests significant convergence back to the long-run equilibrium of producer prices.

It is important for both development and pricing policy to augment market services and facilities that can symmetrically ensure better coordination across domestic regional markets. This may take the form of improving both rural and urban market infrastructures. More efforts may also be directed to guide the functioning of horizontal markets trade flows that can boost market performance.

Since the domestic soybean market in Benin is integrated, our analysis supports the design, targeting, and implementation of unique market-based price policies which are usually cost minimising. Such policies have the potential of being effective based on our study findings. To maintain the current status quo, it is important to strategically invest in both rural and market infrastructures and create enabling conditions to ease spatial price flows between regions. Critical attention should be meted to price signals in the various markets to further ease the design of price monitoring policies.

Despite the clearly relevant policy-oriented insights from this analysis, we end by highlighting some limitations of the study and offer directions for future research. To begin with, due to

data limitations and constraints, we did not adequately compare the domestic markets in Benin. While two departmental markets were represented in the South, only a single departmental market was captured in the North. Granted that our interests is just in establishing evidence of spatial price flows in the different markets, this is not a valid limitation in itself but it may have implications on the generalisability of the findings. We thus guide the understanding of this analysis using this caveat. That notwithstanding, as most agricultural markets are similar in developing nations and faced with similar shocks, our analysis may be understood and generalised in any developing country context specially for emergent markets. In this regard, other empirical analyses are warranted to profer and support these findings of spatial price flows in domestic markets for agricultural commodities. Future research may want to examine further the consistency of these findings in the light of asymmetric price flows and convergence of short-term disequilibria in these markets.

ⁱ Mondoni is an oil palm producing area in the Southwest Region of Cameroon. It is one of the seven palm oil zones selected as a production basin to supply FFB to major industrial companies under the Fonds National du Développement Agricole (FONADER)-sponsored smallholder scheme. FONADER was a government agency (acting like a rural development bank) set up around 1977 to control and supervise the donation of improved planting materials, quality seedlings, technical and agronomic advice as well as extension trainings to smallholder farmers with funds from the World Bank. Mondoni is home to one of the largest CDC (Cameroon Development Corporation) mills in the Southwest region of Cameroon.

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Chapter 10

Conclusion

The dissertation consists of eight contributions that lend support to empirically examine price transmission and cost pass-through on agri-food supply chains and value chains in West and Central Africa. To the extent that these studies not only contribute to the extant research, but they also focus to establish and contribute to the development implications for African countries and provide recommendations for policy and the welfare of market actors and participation. Given the individual research questions and objectives for each study, a final inference is made individually for the chapters as presented below.

Pulse, Export and Staple Convenience Food: Market Analysis in West Africa

Following an asymmetric vector error correction estimation for individual spatial commodity markets for cowpea, cashew, cassava, and its value-added products, producer prices are employed for analysis. As price transmission increases with value addition, this can better market performance. Price transmission between differentiated value-added commodities varies. Previous studies showed that the price transmission can be faster for less processed commodities compared to more processed commodities (Landazuri-Tveteraas et al., 2018). As price transmission varies through domestic and regional markets, tailored market policy interventions are recommended for individual market scales in a bid to foster efficient markets.

Earlier studies have documented differences in price transmission rates across regions and countries (Mofya-Mukuka and Abdulai, 2013; Cachia, 2017). Further, boosting value addition through a more enabling policy environment and better institutional and technical facilities. However, given differences in the scope of data coverage, this provides a limitation for broad interpretation of findings and the need for caution to this end.

Food Markets and Price Responses: Panel Evidence from a developing Economy market

Using monthly producer prices, a panel error correction framework is utilised in the markets of root and tubers, cereals, meat and fish, and other food staples. Given spatial data, with the rejection of the null hypothesis of cross-section dependency and failure to reject the null hypothesis alternative stationary test is applied for each case. Price transmission is fastest on a root and tuber value chain (dried yam flour-ordinary yam). This finding supports value addition as a means for improving market efficiency. Hence the need for a policy that promotes value-addition in agri-food markets. Asche et al. (2014) similarly showed that price transmission is influenced by changing product forms. Cross-commodity price transmission for differentiated markets (Snail-freshwater fish and Snail-sea water fish) and differentiated value chain (Wheat flour-white cereal and Wheat flour-red cereal) are in different directions for each of the markets and significant. Hence a relationship across differentiated products that could be substitutable. This is similar for imported rice and local rice commodity price transmission. A policy that enhances the growth of agri-food markets through availability of substitutes and value addition is increasingly necessary especially given the hunger situation of developing countries. This can provide more food options through the growth of these markets hence the need for market reforms that can expand these markets. The findings of the study may however have bearings for the developing economy perspective.

Functional Food Markets: Panel Evidence from Benin

Through a panel error correction model using monthly producer prices for the fruit and vegetable market, the study empirically finds positive associations across the markets for fruit and leafy vegetables but not consistently in the markets for fruit vegetables. Given the prominence of fruit vegetables like tomato in household diets (Katsumata et al., 2007), it may not be very surprising that the cross-commodity price transmission in its market is highest. However, the price adjustments are also lowest in the fruit vegetable markets. As it has been shown that policy is a factor for the transmission of prices in developing countries (Abdulai, 2000), the underlying need to augment support policy for these markets and pricing that can boost the price flows is increasingly important.

Mobile Money and Vertical Price Transmission: Panel Evidence from Cameroon

Utilising a reduced form model for monthly panel price data at the wholesale and retail level, the measure of Mobile Money as an alternative use of cash payments is captured as the relative effect such that $D_{i,t} = \frac{Mobile}{Mobile+Cash}$. Considerable variations in time are more noticeable, than in space between individuals, which could be attributed to unreliable power supplies that affect the service. Time and space price dispersions have been noticeable for Mobile Money coverage in SSA (Aker and Fafchamps, 2015). As first differenced variables are stationary and parameter variables cointegrated, retail prices are assumed exogenous as well as wholesale prices.

Wholesale price increases are found to be associated with retail price increases of 0.66 as price transmission is incomplete when no Mobile Money is used. However, when half of the transactions are done using Mobile Money, price transmission increases to 0.74, closer to the absolute value 1. When all payments are done using Mobile Money, the simulated model prediction finds the average mark-up to be lowest for wholesale prices increases.

Disequilibrium adjustments are roughly two times faster when half of the transactions are done using Mobile Money. Stylised adjustments path shows that when all payments are done using Mobile Money, simulated disequilibrium after five months is 10 francs compared to 30 francs when all payments are done using cash, and corrections for disequilibria at 10 months compared to 16 months when half of the payments are done using cash and half done using Mobile Money. amani et al. (2018) similarly found that mobile internet is associated with faster speeds of adjustment back to the long-run equilibrium.

Hence as findings speak in favour of digital payment solutions in developing markets, policy investments in functional network infrastructures can support techno-development for the markets and economy, as well as financial inclusion in the economy that can especially benefit the rural population and promote equity. However, a limitation to the study is that the market dynamics were not examined for non-linearities.

Mobile Money and Asymmetric Price Transmission: Panel Evidence from Cameroon

We extend the earlier study on Mobile Money and price transmission to account for non-linearities. Using monthly wholesale and retail price data, Mobile Money is measured as the alternative use of cash in days per month. Utilising an asymmetric panel error correction approach, we empirically show that the speed of adjustment is speedier for falling prices compared to rising prices. Price adjustment paths favour the retailer with more Mobile Money use compared to the wholesaler. Hence policy investments that adopt the use of new information and technology on a broad scale are especially important to boost market performance in developing countries and enhance market participation. This is important to

especially include access to financial services for the less wealthy segments of the population in this region (Suri, 2017).

Cost pass-through in the oil and oilseed market: Panel Evidence from West Arica

Using weekly and monthly price data for oilseed crops and oil commodities in agri-food markets, the panel error correction framework is utilised five countries in West Africa (Benin, Côte d'Ivoire, Ghana, Senegal, Mali). The study empirically finds that the transmission of prices for nuts/cereals is broadly higher compared to oil downstream. Observing from findings, supply side cost shocks seem to explain very small symmetric adjustments. Given alternate functional forms, non-linear adjustments exhibit considerably larger magnitude differences compared to symmetric adjustments. Larger asymmetries in developing markets maybe associated with concentration in the markets for non-perishable commodities in agri-food markets (Cutts and Kirsten, 2006). Concentration of agrarian palm oil activities is notable in the South of Benin (Nguyen and Dizon, 2017) for instance. Given the differences across spatial market flows, and the overall price transmission rates, the need for tailored market policy for individual product markets as well as augmenting spatial infrastructural allocations can support pricing behavior for better performance in these markets, more so as relevant welfare gaps have been found in Benin (Nguyen and Dizon, 2017). As sampled communal markets are represented for regional departments, this might have a limitation for generalisability of findings.

By what difference: Price transmission in the palm oil value chain in Cameroon

Utilising panel domestic prices at farm level (Fresh Fruit Bunches-FFBs) and wholesale for the palm oil value chain in a reduced form cost pass-through model, we empirically find that transformed products (palm oil) are correlated with the resource input prices (FFB). Following descriptive statistics of the data, bargaining power can play a role in the formation and movement of prices and this can also point to structurally unorganised markets. Customary tenure systems are observed to also dominate based on the descriptive data as most women were found to be involved in post-harvest activities as primary farm activities for longer-cycled crops such as palm oil can mean land-right engagements, given gender related land-right issues in Cameroon (Ordway et al., 2019).

Our empirical findings can lend support for trade development interventions targeting each node of the value chain individually. Otherwise, possible policy on market liberalisation could over-estimate the potential benefits to consumers at the end of the chain given that farm prices may not be fully transmitted to them. Some caution should be exercised generalising findings given context. Hence, findings may inference for an emerging market situation prevalent in developing economies.

Spatial Price Flows in Domestic Markets: Panel evidence from the Soybean market in Benin

Using recently monthly soybean producer prices in the North and South regions of Benin, the data covers four departments of Benin, two in the North (Atakora and Borgou) and two in the South (Zou and Plateau). We empirically find with a panel error correction model that the direction of trade flows have implications for price transmission (in line with Bakucs et al., 2015), and thus it is of importance that development pricing policy augments rural and urban services in ways that can facilitate symmetrical coordination in markets, targeting the design of price policies that are cost minimising. The root mean square value also supports the model

in resolving for cross-sectional dependency. Due to limitations and constraints on data availability that pointed towards inadequate domestic market comparisons, this could limit generalisability of findings.

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Declaration of co-authorship

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If a dissertation is based on already published or submitted co-authored articles, a declaration from each of the authors regarding the part of the work done by the doctoral candidate must be enclosed when submitting the dissertation.

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Mobile Money and Vertical Price Transmission: Panel Evidence from Cameroon


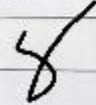
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
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Planning: Planning of experiments/analyses and formulation of investigative methodology, including choice of method and independent methodological development, in such a way that the scientific questions asked can be expected to be answered	C
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
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