Spatial Price Flows for Orphan Legumes: Evidence from Benin

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Working Paper 015-2025

Bringing Rigour and Evidence to Economic Policy Making in Africa

AFRICAN ECONOMIC RESEARCH CONSORTIUM
CONSORTIUM POUR LA RECHERCHE ÉCONOMIQUE EN AFRIQUE

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By

Akem Nina Fabinin

World Bank, Washington DC

&

University of Kiel, Germany

fabininakem@yahoo.com

AERC Working Paper 015-2025

African Economic Research Consortium, Nairobi

November 2025

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Published by: The African Economic Research Consortium
P.O. Box 62882 - City Square
Nairobi 00200, Kenya

Acknowledgements

I would like to express my sincere gratitude to Prof. Morrissey for his support during this process. I am grateful to Prof. Rob Davies for his efforts, as well as to Prof. Oostendorp, for their helpful comments. Additionally, I extend my appreciation to Prof. A. Seck, the resource persons, fellow authors, coauthors, peers, and the administrative staff in Kenya. Reflecting the same gratitude I already expressed, I extend special thanks to my colleagues in Kiel whose unwavering support through our daily in-person and physical presence, mutually friendly and sincere, stayed with me, having no local support system abroad. Also, I am thankful to Mawugnon F.E.S for the data. Finally, I extend my sincere thanks to the African Economic Research Consortium (AERC) for commissioning the study and for providing financial support.

Abstract

Understanding the trends in orphan legume crop markets is of vital importance given propositions for the development of the food system for such landrace crops. Regional distributions for such indigenous crop legumes mean understanding that their markets are crucial for enhancing market linkages for improving market performance and food distribution across regions. The current study descriptively examines monthly producer price data for orphan legume crops. For comparison purposes, a major staple is additionally examined to observe patterns relative to the orphan crops. What patterns exist between orphan crops, and compared to staple commodities? As observed, even within growing areas, differential linkages and inconsistencies may already point to structural challenges rather than market-specific inadequacies such as poor infrastructural amenities and systems. Similar correlated relationships between landrace legume and staple food markets may already point to such structural factors. Reconsidering regional segregation discrepancies into food policy frameworks may be able to contribute to reduced inequalities in food availability across regions. This could take the form of regional food redistributions across affluent and deficit regions.

JEL Classification: Q13, Q18

Keywords: Regional Markets, Producer Price, Legumes, Benin

1. Introduction

Agricultural prices and markets are important for pro-poor development policies in developing countries (Barrett and Mutambatsere, 2008), as strategic policy is crucial for pending development needs (Staatz and Dembélé, 2008). Competitive markets are essential for reinforcing the food system and market actors (IFPRI, 2021a). This is important for low and middle-income markets in developing Sub-Saharan Africa (SSA) economies, where a significant proportion of the agri-food system is made up of smallholder farmers (Staatz and Dembélé, 2008). Notably, pigeon pea (*Cajanus cajan (L) Millsp.*) can be associated with smallholder farmers (Khoury et al., 2015) like other orphan legumes such as Bambara groundnut (*Vigna subterranean),* and others such as the common bean (*Phaseolus vulgaris*) that are going out of production (Akissoé et al., 2022). The diversity of crops is of a key resource for producers, especially with changing markets (FAO, 2022). With interest and propositions for the development of such orphan crops such as pigeon pea in Benin, e.g. through advancement programmes, as it may yet be an under-exploited landrace crop (Dansi et al., 2012; Ayenan et al., 2017a; Fiacre et al., 2018), the current study examines the market dynamics for the production system.

An understanding of the trends in these markets is of importance especially for development policy in this region of SSA where the performance of agri-food markets is vital for development (FAO et al., 2011). Enhancing market performance with distributional considerations and considering local production potential may particularly be important towards food security and development efforts. The current study contributes to literature by descriptively examining the regional producer prices for orphan crops compared with staples in Benin markets. Prices may tend to converge when producers practice free arbitrage (Cachia, 2017). The study makes use of producer prices in the descriptive analyses.

The study examines pricing behaviour between food markets and across spatial inter-regional markets with distinct production and supply capacities as the main objective. Commodities include landrace legumes (pigeon pea, Bambara bean, and white bean) over three year 5-month blocks, and a major staple food (rice) over the period from 2009 to 2017 broadly.

Specifically,

- *Objective 1:* to establish regional market correlations
- *Objective 2:* to examine substitute (legume) commodities and orphan crops

- *Objective 3:* delineate price links in domestic producer food prices in sectoral decentralized market economy

Monthly producer price data measured per kilogramme in five administrative regions for four orphan and staple commodities is used. Pearson's correlation coefficient that shows the existence or absence of a correlation and the degree of correlation is used in the analysis between commodities and regional markets.

2. Institutional Structure of Markets and Production

Given the general characteristics of isolated or unstable food markets considering the link for farmers production and prices in typical Sub-Saharan African countries such as Benin (Barrett and Li, 2002; Fafchamps and Gabre-Madhin, 2006), market liberalization policies took form with limited interventions in food markets (Abdulai, 2000; Fafchamps and Gabre-Madhin, 2006). However, given the long-standing quest for meeting development agendas, such as is a typical case for food security in SSA countries such as Benin, this has meant further promoting nutrient-rich foods such as legumes, and indigenous foods such as pigeon pea and bean, which are high in protein (Katsumata et al., 2007). Such landrace crops are neglected and underutilized despite the potential for upscaling food security efforts (Cavatassi et al., 2006).

Farm producers operate largely on small-scale and constitute 95% of agricultural outcomes in Benin (MDAEP and UNDP, 2015). As markets and prices are central to enhancing agricultural outcomes and productivity and further towards broader and pending development agendas in developing Sub-Saharan Africa countries (Taylor et al., 2009) such as Benin, insights to strengthen their market activities have the potential to support and augment food outcomes competitively, and boost the food system (IFPRI, 2021b).

As a case in point, pigeon pea is prominently grown in the Southern and Central regions (Ayenan et al., 2017a) (regions are based on administrative divisions) of Benin (Katsumata et al., 2007). However, its market for bean extends across other regions of the country.

Pigeon pea producers sell farm output to traders (retailers and wholesalers), whose trade networks are leveraged in the movement of the commodities across regions. These traders are crucial in the movement of commodities across the regions of the country, hence incorporating costs on spatial infrastructure distributions (e.g. transport, loading and offloading, bagging), and information flows. Other costs and trader (retail and wholesale) activities

and related operating and variable cost from the movement of the commodities across markets go beyond the scope of this study and can be found in other detailed studies (e.g. Fafchamps and Gabre-Madhin, 2006).

The comparative summary data for each legume is presented in Table 1 (as in text).

Table 1: Comparative statistics for legumes

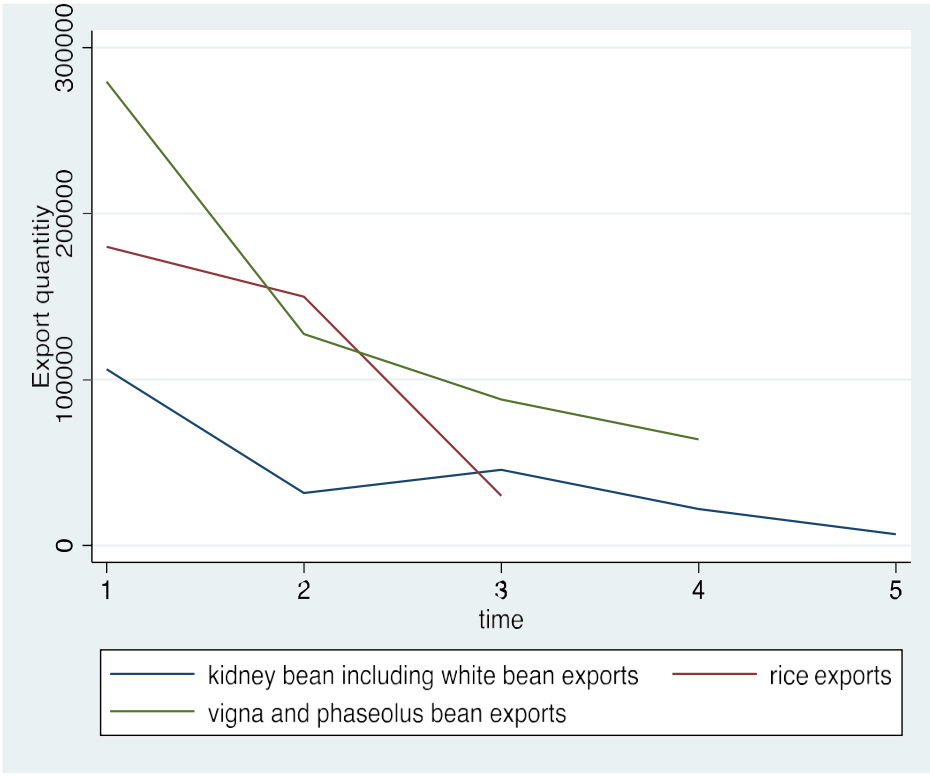
	Main crop producing region	**Prominent Markets**	**Production status**	**Average production yield**	**Nutrient content**
Bambara bean	Northwest Central, Northeast	- White, mottled, red, and black (North) - Red and white (across markets in the country)	2nd most produced legume	- 11,321 tons from an area of about 17,232 hectares (ha) in 2005 yields up to 4000kg/ha - 500kg/ha in households	Pods contain a grain each, constituting 19% proteins, among the major nutrients components
Common bean	Central	Central and Southern Benin[1]	Declines in production	Production declined from 143,625 to 95,794 tons since 2008	Common bean is a notable source of protein; A serving of beans (0.5 cup or about 90 g cooked beans) provides about 7-8g of protein, among other nutrients

[1] White round-grain type seeds

Pigeon pea	Between Central and North	- Market extends across regions of the country - Socio- cultural consumption in specific ethnicities such as Klouekanme with a festival	5th most produced legume	Average annual production of about 4059/ha and 2799 tons of production	Protein content ranges from 21.0%, 18.8%, and 24.6% across green seeds, mature seeds and split seeds with seed coat removed

Sample export statistics from Benin in 2021 are depicted in the chart below.

Figure 1: Sample export statistics



Source: Author's computation from data from the World Integrated Trade Solution

Bambara bean

Bambara bean is the second most produced legume in Benin, mainly produced for home consumption; However, large quantities are sold in local markets (Katsumata et al., 2007; Ayenan et al., 2017b), although there is a variation in its production across different regions in Benin (Katsumata et al., 2007). Three among all regions constitute the major producing areas: the Northwest, Central and Northeast, with an average yield of about 500kg/ha in households (Katsumata et al., 2007). Pods contain a grain each, constituting 19% proteins, 6.5% lipids, and 63% carbohydrates among the major nutrient components (Katsumata et al., 2007). Based on the seedcoat, four varieties based on the seedcoat (white, mottled, red, black) have been notably marketed in the Northern part of Benin. However, the red and white varieties are most common across markets in Benin (Katsumata et al., 2007). Production reached 11,321 tonnes from an area of about 17,232ha in cultivation in 2005, with yields up to 4000kg/ha reported (Katsumata et al., 2007). The crop enhances soil quality as a nitrogen-fixing legume (Hillocks et al., 2012). In Benin, three main regions constitute the primary producing areas. However, production levels vary significantly across these regions. The Northwest region, comprising Atacora-Donga, boasts the largest cultivation area, with 12,142 hectares and a production of 7,192 tons. In contrast, the Northeast region, specifically Borgu-Alibori, has the smallest production area. The Central region, encompassing Zou-Collines, falls in between these two extremes (Katsumata et al., 2007). Prices tend to be highest in August just before harvest, and least after harvest in January (Katsumata et al., 2007). Prices vary across varieties and regions, lower in the North (Atacora and Borgu), and lower for red colored varieties compared to the white (suggested to be associated with higher consumer preference) (Katsumata et al., 2007). Inadequate research(ers) attention on this crop has been a major challenge (Katsumata et al., 2007).

Common bean

Like the Bambara bean whose production is low (Mayes et al., 2019), the diversity of the common bean is threatened, given high declines in production, as evident in prominent growing areas such as in Central Benin (Masangwa et al., 2013; Akissoe et al, 2022). It is notably grown in the Central region of Benin (Loko et al., 2018a). However, since 2008, declines in production were witnessed from 143,625 to 95,794 tonnes (FAO, 2014; Loko et al., 2018b). In marketing, the white round-grain type seeds have notably been sold in Central (Bohicon) and Southern (Cotonou) Benin, observed to attract higher prices compared to other legumes such as cowpea, which is the most produced legume in Benin (Katsumata et al., 2007; Ayenan et al., 2017b). Common bean

is a notable source of protein; A serving of beans (0.5 cup or about 90 g cooked beans) provides about 7-8g of protein, among other nutrients (Messina, 2014). In Benin, the use of young legume pods as vegetables has been promoted for nutritional purposes. Interestingly, despite the sale of common bean seeds in markets, the young pods themselves were not typically sold (Katsumata et al., 2007). In fact, vegetable markets in Benin generally did not offer the pods of pulse crops for sale (Katsumata et al., 2007).

Pigeon pea

In the past decades, pigeon pea crop yield remained far under potential in Africa (Odeny, 2007). Pigeon pea is an important subsistence crop for households in Benin, mainly grown in the Central and Southern regions, with an average annual production of over 4,059 ha (Dansi et al., 2012; INSAE, 2016; Ayenan et al., 2017a). It is the fifth most produced legume in Benin (Ayenan et al., 2017b). Production advantages include the drought-resistant nature of the crop and environmental protection given its hunger alleviation potential, as both young pods and leaves comprise edible food while its foliage is used in green manure or animal feed (Katsumata et al., 2007; Ayenan et al., 2017b). Further, its high nutritional content in proteins and minerals, among others, makes it viable in the fight against malnutrition (Emefiene et al., 2014). Protein content ranges from 21.0%, 18.8%, and 24.6% across green seeds, mature seeds and split seeds with seed coat removed; Fat content ranges from 2.3%, 1.9% and 1.6%, respectively (Saxena, 2010). This is important given the need to meet-up with protein requirements in developing countries that have been deficient, more so where plant-based protein sources are relatively more accessible compared to animal-based protein sources (Saxena, 2010). Production is notable in the dry regions between the Central and North of Benin, a commodity cultivable under rain-fed conditions, with an annual cultivation area of about 4059ha and 2,799 tons of production (Katsumata et al., 2007; Saxena, 2010; INSAE, 2016; Ayenan et al., 2017a). Much of the production is in the hands of smallholder farmers with smaller farm areas, with low annual production averages of about 4436.9 tonnes despite its potential to contribute towards food security (Fiacre et al., 2018; Kinhoégbè et al., 2020) and being a neglected and under-used crop (Ayenan et al., 2017a). Production remains traditional, with little technological inputs despite high (heat) resilient qualities compared to other legume crops (Fiacre and Hubert, 2019). There have been documented production and diversity yield declines for such neglected crops, which can hamper food security (Ayenan et al., 2017a).

Together, pigeon pea, Bambara bean and local bean are among the best-known legumes in Benin (Akissoe et al., 2022). However, these important food legumes and landraces are neglected, under-utilized and under-exploited

(Akissoe et al., 2022; Fiacre et al., 2018; Khan et al., 2021; Mayes et al., 2019) despite their potential towards supporting development challenges such as food insecurity in typical developing economies such as Benin. Their research needs, for diversity and improvement given their crucial roles in food subsistence, medicinal and income uses for households remain enormous (Dansi et al., 2012).

Therefore, the study examines the producer prices as given at given markets, for regional associations between landraces and staples, and across regions. Crop prices are usually set at market price and negotiated sometimes, while 40% of the time are set in advance (Fafchamps and Gabre-Madhin, 2006).

3. Literature Review

Spatial price investigations have taken the form of econometric analyses. Analyses between central and local markets in Sub-Saharan Africa have shown the existence of long-run and short-run effects using econometric methods (Abdulai, 2000; Getnet et al., 2005). In domestic markets in Turkey, Brosig et al. (2011) have shown that the size of the market is a factor that affects the integration of markets. Studies have documented integration in prices and markets (von Cramon-Taubadel, 1999; Loy and Wichern, 2000). Gitau and Meyer (2019) found that price transmission is speedier in the long-run, and for short-run adjustments, under regimes with little or no policy interventions. Policy interventions in Benin have been previously noted to be minimal (Kherallah et al., 2000).

Abdulai (2002) examined the producer-retail price spread for two markets using a threshold cointegration model in the Swiss pork market. Evidence pointed to asymmetric behaviour (further demonstrated by the impulse response functions), with faster passing on of prices for increasing producer prices on the spread compared to decreasing producer prices. This current study uses a model test for asymmetric responses. In this study, regional substitute markets for farm producers are examined.

In terms of methodology, in spatial Kenyan markets, Gitau and Meyer (2019) use a Vector Error Correction Model (VECM) to provide empirical evidence of the effect of policies on the transmission process of prices in spatial markets. Using threshold cointegration and error correction approaches in the maize market in Ghana, Abdulai (2000) showed that different domestic local markets exhibit heterogenous responses to price changes in the central market. Following asymmetric estimations with regard to developing market context, Mofya-Mukuka and Abdulai (2013) using momentum threshold and error correction approaches showed that policy reforms affected price transmission. Using an autoregressive distributed lag model across the

vertical food chain in Ethiopia, Getnet et al. (2005) empirically show that the central market wholesale prices predicted supply prices in the local markets.

The current study, however, makes use of descriptive analysis in examining legume markets. Important questions asked when analyzing these regional linkages include: (1) How are regional market prices within and without predominant crop production areas correlated? (2) Is there a difference with orphan crops compared to staple food commodities? Where the study attempts to contribute to literature.

The current study uses the Pearson's correlation coefficient on the horizontal food chain for regional domestic landrace legume and staple food markets, using producer price data, whereby

$$(x(i)-mean(x))*(y(i)-mean(y)) / ((x(i)-mean(x))2 * (y(i)-mean(y))2$$

Where *x* any *y* are the variables. A coefficient of 1 means a perfect positive association, 0 means no relationship.

4. Data

Sample

Producer price data from the Ministry of Agriculture, Livestock, and Fisheries in Benin is used for the study, across all administrative regions in Benin as shown in Figure 2. Data are given per kilogramme monthly. The data sample for landrace markets is summarized in Table 2a.

Table 2a: Data sample for landrace markets

Administrative division	Administrative region	Market	Period
LANDRACE			
NORTH			
Atacora-Donga	Northwest	Pehunco	Mar-Jul 2013; Mar-Jul 2014; Mar-Jul 2015
Borgu-Alibori	Northeast	Parakou	Mar-Jul 2013; Mar-Jul 2014; Mar-Jul 2015
CENTRAL			
Zou-Collines	Central	Bante	Mar-Jul 2013; Mar-Jul 2014;Mar-Jul 2015
SOUTH			

Mono-Couffo	Southwest	Dogbo	Mar-Jul 2013; Mar-Jul 2014;Mar-Jul 2015
Oueme-Plateau	Southeast	Ketou	Mar-Jul 2013; Mar-Jul 2014;Mar-Jul 2015

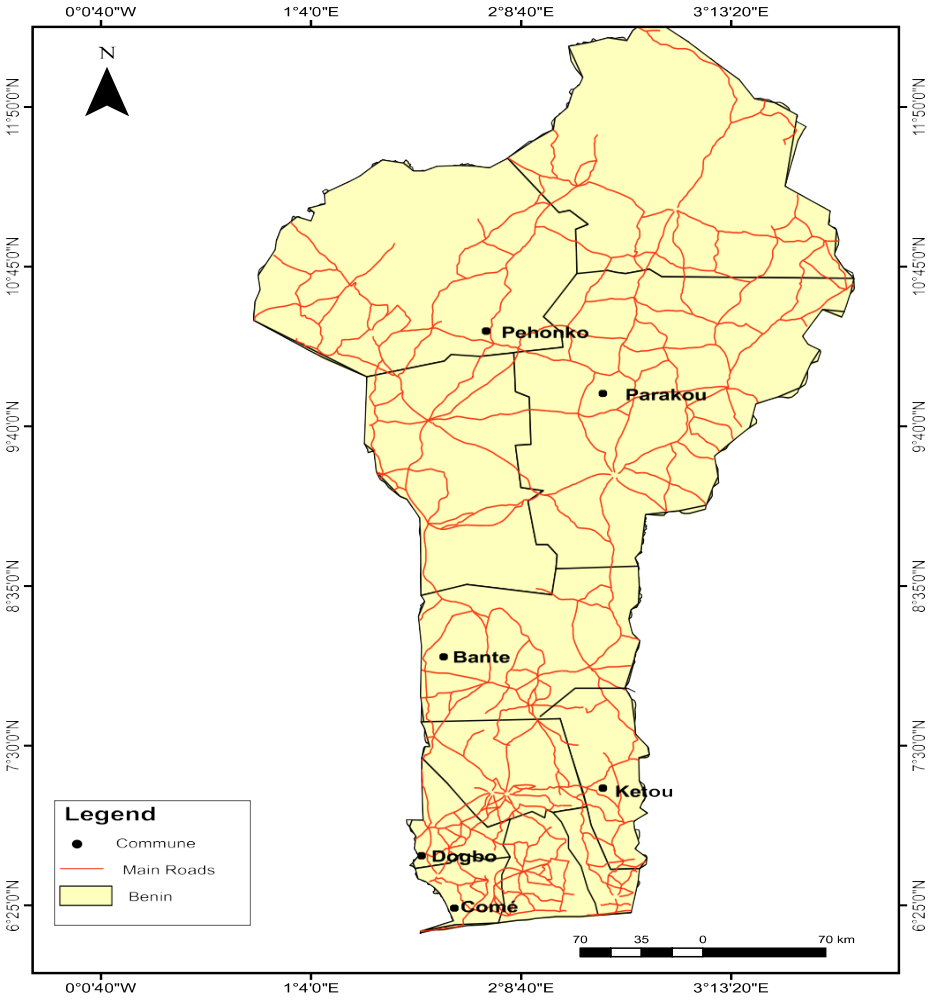
Table (1) presents an overview of the crops across the various administrative regions, including Northwest (NW), Northeast (NE), Southwest (SW), Southeast (SE), and Central regions, and the crops for each market within the designated region, along with the corresponding time periods during which these crops were monitored The data sample for staple markets is summarized in Table 2b.

Table 2b: Data sample for staple food

Administrative division	**Administrative region**	**Market**		**Period**	
STAPLE					
NORTH					
		Local	**Imported**	**Local**	**Imported**
Atacora-Donga	Northwest	Pehunco		Jun2009-January2017*	
Borgu-Alibori	Northeast	Parakou		Jun2009-February2017	
CENTRAL					
Zou-Collines	Central	Bante		October2012-October2015	
SOUTH					
Mono-Couffo	Southwest	Come		October2012-Feb2017***	
Oueme-Plateau	Southeast	Ketou		March2010-January2017	
*Staple plot for Northwest-Northeast (North): June 2009 – January 2017 ***Staple plot for Southwest-Southeast (South): October 2012-January 2017					

The table (2) focuses on staple crops for comparison purposes across regions, across the same administrative regions—NW, NE, SW, SE, and Central. This can provide a foundation for understanding the relationship between local crop production and staple crop cultivation.Market representation is presented in Figure 2. The accompanying map visually represents the geographic locations of the markets covered in the tables. It highlights the specific regions—NW, NE, SW, SE, and Central for the markets.

Figure 2: Map showing sample from all administrative regions

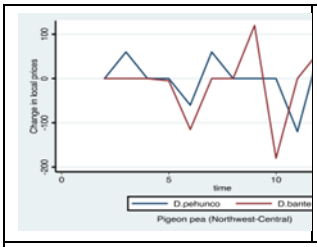


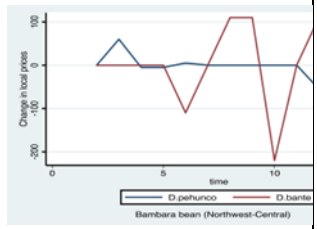
Changes over Time

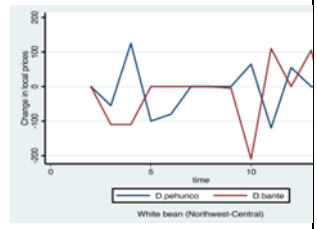
Landrace crop markets

The price changes are presented as a chart in Figure 3, for markets and commodities over time. Aside from white bean in the Southeast market, commodity price changes generally seem to fluctuate with other legume substitutes. The market in the Central region seemingly exhibits the highest degree of variation in price changes. This may already point to distributional implications in food markets. The figure suggests little market integration as indicative with few convergence scenarios.

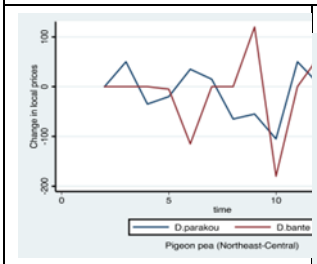
Figure 3: Change in prices over time (Landrace legumes)

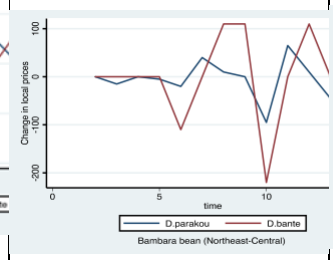


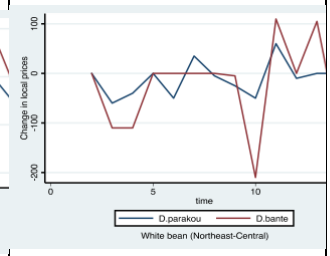




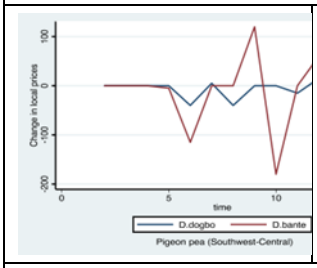
Northwest – Central markets (Pigeon pea, Bambara bean, white bean)

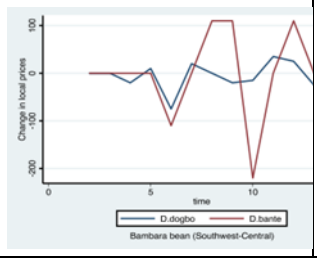


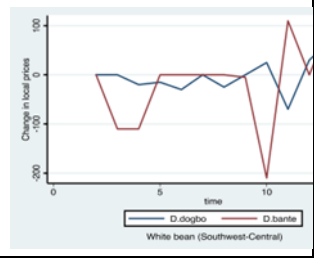




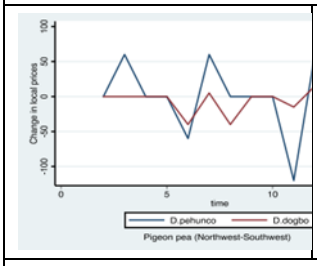
Northeast – Central markets (Pigeon pea, Bambara bean, white bean)

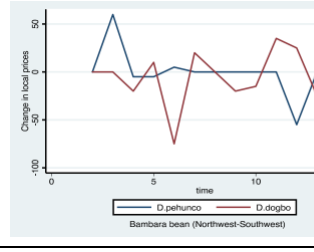


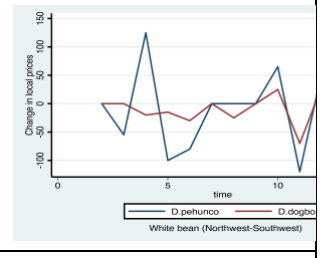




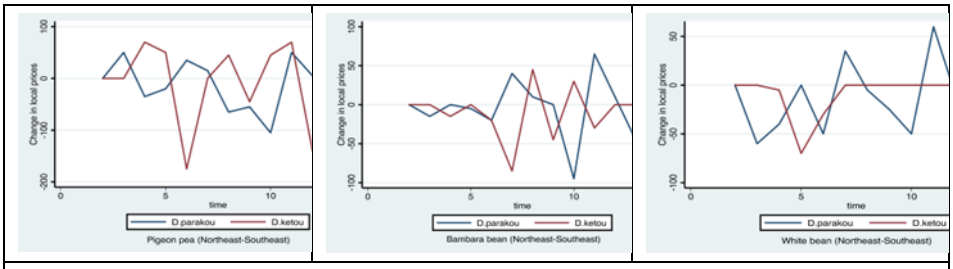
Southwest – Central markets (Pigeon pea, Bambara bean, white bean)



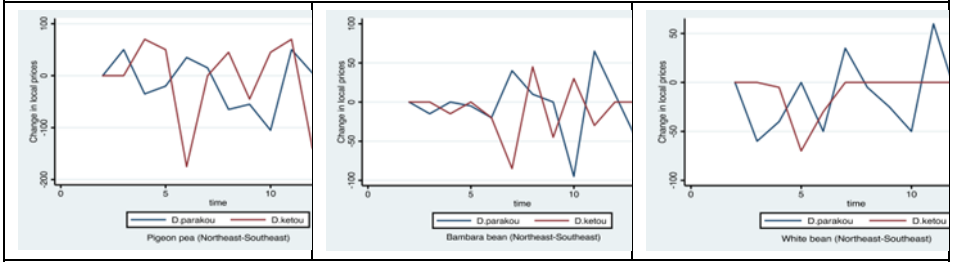




Southeast – Central markets (Pigeon pea, Bambara bean, white bean)



Northwest-Southwest markets (Pigeon pea, Bambara bean, white bean)



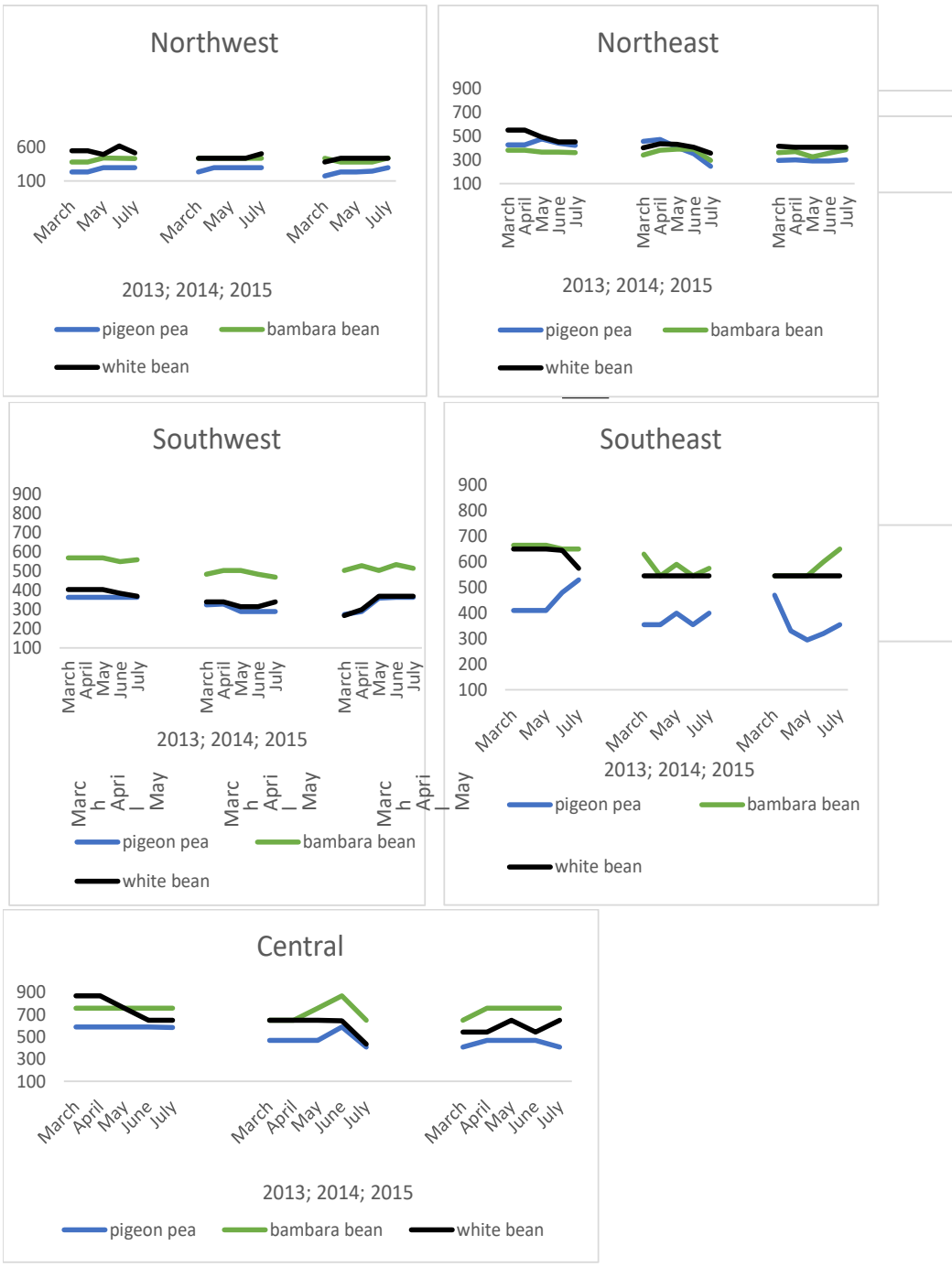
Northeast-Southeast markets (Pigeon pea, Bambara bean, white bean)

Source: *Own computation from producer price data from MAEP, Benin (2023). Prices are in West African CFA Franc per kilogramme (1 CFA is equivalent to about 0.0017 US$)*

Findings in landrace crop markets

Figure 4 presents legume prices in each region over time. In the Northwest, bean (Bambara bean and white bean) prices tend to come closer together over time compared to pigeon pea. This may largely be attributed to reduced white bean prices over time as observed. In the Northeast, there is a similar pattern in the movement of commodity prices when prices are falling. However, Bambara bean exhibits a more varying pattern when pigeon pea and white bean prices become more constant over time. White bean prices are generally observed to be highest in the Northwest and Northeast. It is relatively least for pigeon pea, however, over time in the Northeast, this may vary.

Figure 4: Legume prices across periods in each market

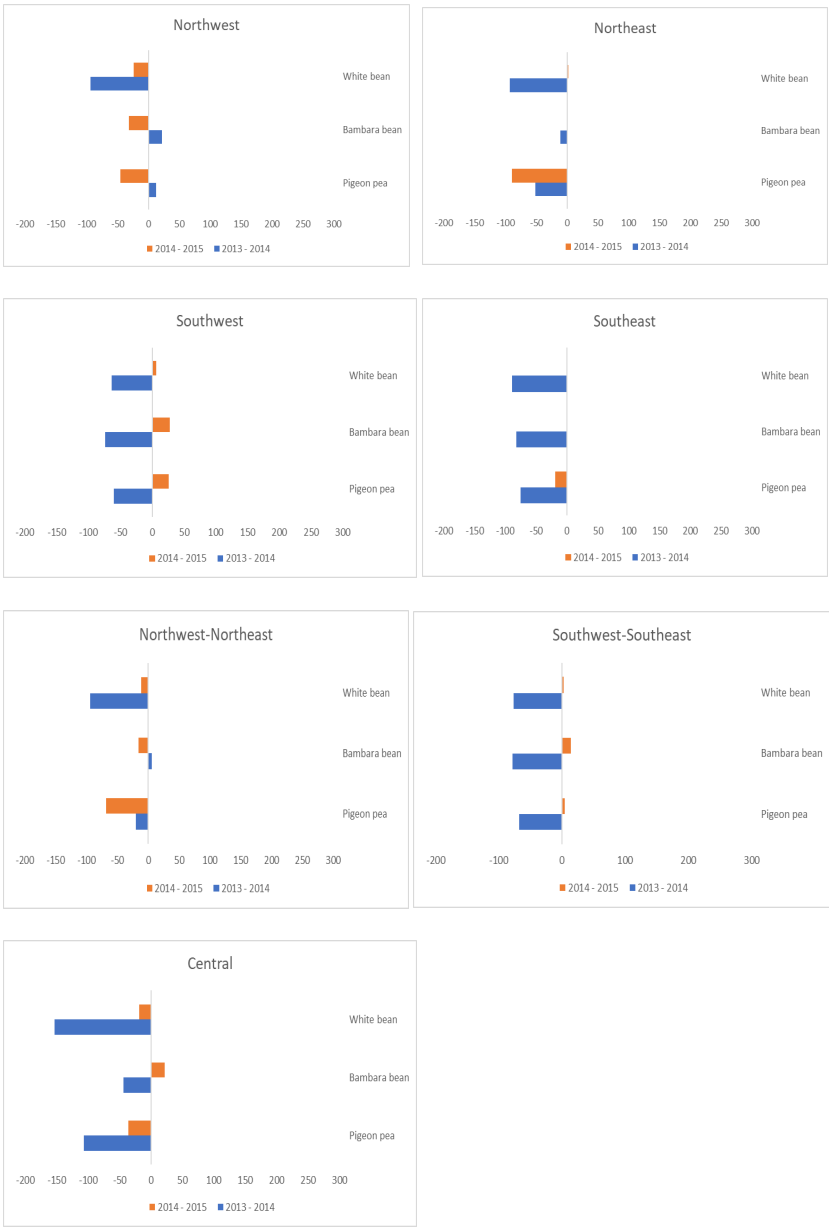


Source: Own computation from producer price data from MAEP, Benin (2023). Prices are in West African CFA Franc per kilogramme (1 CFA is equivalent to about 0.0017 US$)

In the Southwest, pigeon pea and white bean commodity prices move closely together. This is not the case for Bambara bean that is relatively higher. While Bambara prices are still observed relatively higher in the Southeast compared to the other landrace legumes, the prices move more closely together with white bean prices. Pigeon pea prices are distinctly lower, and a similar pattern is observed in the Central region. Over time in the Central region, Bambara prices are relatively higher and the legume commodities do not tend to move closely together or overlap.

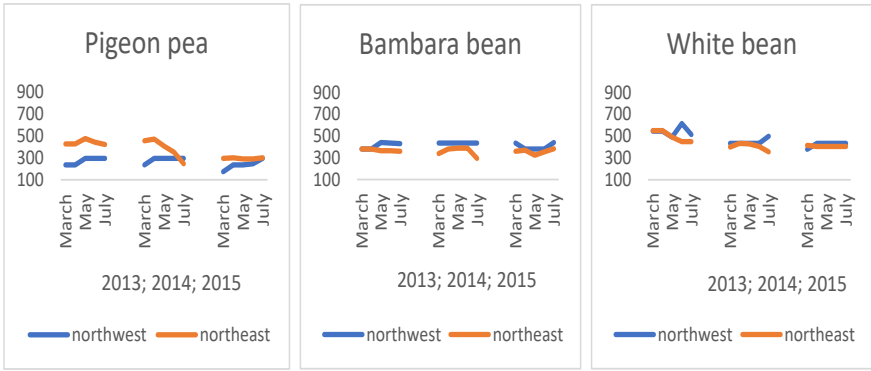
Additional analysis following the price differences within markets is illustrated as shown in Figure 5. Within regions, price differences generally declined over time for legumes in the Northern region, which may point to a plausibility for changing integration.

Figure 5: Legume price differences across periods in each market

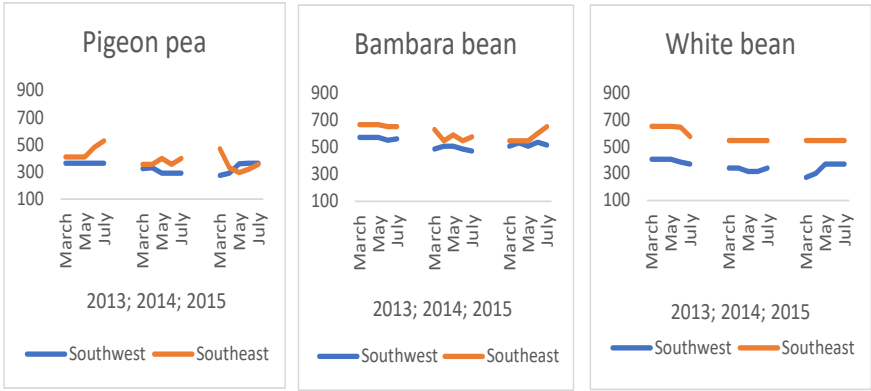


Source: Own computation from producer price data from MAEP, Benin (2023). Prices are in West African CFA Franc per kilogramme (1 CFA is equivalent to about 0.0017 US$)

Figure 6: Legume prices in adjacent markets



Northwest-Northeast



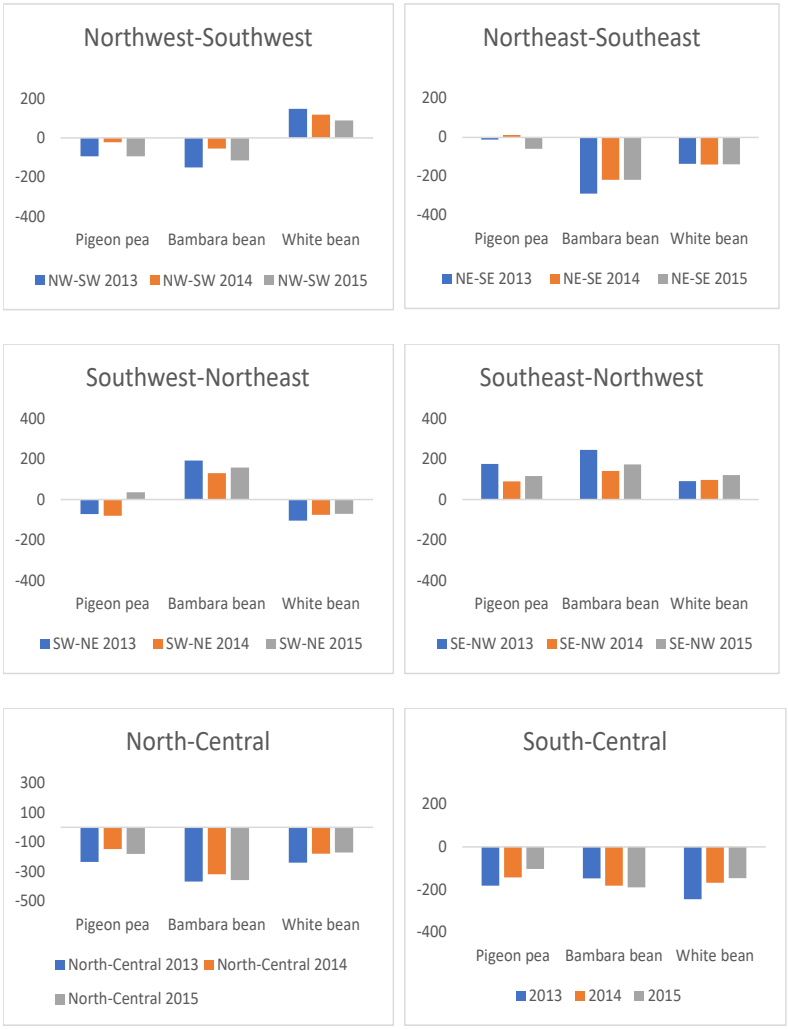
Southwest-Southeast

Source: Own computation from producer price data from MAEP, Benin (2023). Prices are in West African CFA Franc per kilogramme (1 CFA is equivalent to about 0.0017 US$)

In the South, legume prices are typically more affordable in the Southwest compared to the Southeast. This is similar in the North when comparing the Western and Eastern counterparts, but for pigeon pea, which is observed to be generally more affordable in the North, with white bean prices moving closest together in the Northwest and Northeast. In the South, however, white bean prices are the most apart.

Considering the price differences over time in adjacent markets, as shown in Figure 7, except for the spatial links with the Central market, where price differences move in the same direction, there are more varying trends in the commodity price differences between adjacent markets. The pattern of differences is further not systematic to increases or decreases, which may have implications for market integration in relation to the extent of substantial changes, if any.

Figure 7: Legume price differences over time in adjacent markets



Source: Own computation from producer price data from MAEP, Benin (2023). Prices are in West African CFA Franc per kilogramme (1 CFA is equivalent to about 0.0017 US$)

Pearson's correlation is computed for corresponding time periods between market pairs as shown in Table 3. In the Northwest markets, there is an inverse association between Bambara and white bean markets. In the Northeast, Southwest, Southeast and Central markets, spatial associations are all positive.

Table 3a: Correlation within legume and staple markets

	Local Rice	Imported Rice	Pigeon	Bambara	White
NW-SW	0.46	-0.04	0.17	-0.38	0.71
NE-SE	0.48	-0.18	0.35	0.19	0.86
North-Central	0.17	0.14	0.62	0.16	0.76
South-Central	0.03	0.13	0.55	0.25	0.76
SE-NW	0.47	0.35	0.11	0.02	0.82
SW-NE	0.56	0.53	0.37	0.39	0.64

Source: Own computation from producer price data from MAEP, Benin (2023). Prices are in West African CFA Franc per kilogramme (1 CFA is equivalent to about 0.0017 US$)

Between the Northern (Northwest and Northeast) and Southern (Southwest and Southeast) markets, spatial prices are positively associated in landrace. In the North, findings are only significant between pigeon pea and white bean spatial associations (compared to pigeon pea and Bambara bean, and Bambara bean and white bean).[2]

The Pearson's correlation coefficient is presented as shown in Table 3a. In the Northwest markets, there is similarly a positive association between spatial staple markets. In the Northeast, Southwest, Southeast and Central markets, spatial associations are all positive in staple markets. However, in all staple markets between local and imported rice, the findings are insignificant.

Between the Northern (Northwest and Northeast) and Southern (Southwest and Southeast) markets, spatial prices are positively associated in landrace as in staples. In the North, however, compared to landrace legumes, the findings are significant in staple markets for local rice and imported rice. This contrasts with the South where the staple market associations for local rice and imported rice are insignificant, while only the pigeon pea-Bambara bean association is insignificant (compared to Bambara bean and white bean and pigeon pea and white bean) in landrace markets.

[2] Data on production, which is unavailable in the study, could provide more insights on these trends

Table 3b: Correlation between legume and staple markets

	Local-Imported rice	Pea-Bambara	Bambara-White	Pea-white
NW	0.29	0.52	-0.10	0.32
NE	0.48	0.44	0.49	0.63
SW	0.68	0.69	0.69	0.92
SE	0.86	0.44	0.75	0.44
Central	0.18	0.60	0.35	0.70
NW-NE	0.36	0.27	0.03	0.57
SW-SE	0.01	0.07	0.70	0.74

Source: Own computation from producer price data from MAEP, Benin (2023). Prices are in West African CFA Franc per kilogramme (1 CFA is equivalent to about 0.0017 US$)

Between the North and South (Northwest-Southwest and Northeast-Southeast), spatial imported rice price associations are negative compared to positive for local rice in staple markets, while a negative association is only observed for the Western (Northwest-Southwest) market in Bambara bean for landraces. In landraces, findings are all significant between spatial associations but for the Eastern (Northeast-Southeast) market in Bambara bean. This is not the case for staple markets where findings are all significant for spatial associations.

In the Central linkages with the North and South, spatial commodity price associations are all positive in both landrace and staple markets. Findings are, however, only significant in landrace between pigeon pea-Bambara bean and pigeon pea-white bean (but not Bambara bean and white bean).

Price differences are not necessarily further apart in more distant markets as seen in Table 3c when price differences are considered. The differences are more pronounced when there are links to the centre from the North or South. However, the price differences are more pronounced for Bambara bean across the regions compared to the other legumes.

Table 3c: Price difference between legume markets over time

	Period	Pigeon	Bambara	White
NW-SW	2013	-94	-151	148
	2014	-22	-55	118
	2015	-94	-115	88
NE-SE	2013	-11	-289	-136
	2014	12	-218	-140
	2015	-59	-218	-138
North-Central	2013	-235	-368.5	-240
	2014	-148	-319	-179.5
	2015	-180	-357	-171.5
South-Central	2013	-182.5	-148.5	-246
	2014	-143	-182.5	-168.5
	2015	-103.5	-190.5	-146.5
SE-NW	2013	177	246	92
	2014	90	142	97
	2015	117	174	121
SW-NE	2013	-72	194	-104
	2014	-80	131	-75
	2015	36	159	-71

Source: Own computation from producer price data from MAEP, Benin (2023). Prices are in West African CFA Franc per kilogramme (1 CFA is equivalent to about 0.0017 US$)

Within regions as seen in Table 3d, price differences were most pronounced in the Centre over 2013-2014 (Bambara and white bean) with substantial differences across commodities within the same region, such as in the North (NW-NE).

Table 3d: Commodity price differences within legume markets over time

	Period	Pigeon pea	Bambara bean	White bean
NW	2013 - 2014	+12	22	-94
	2014 - 2015	-46	-32	-24
NE	2013 - 2014	-52	-11	-93
	2014 - 2015	-90	0	2
SW	2013 - 2014	-60	-74	-64
	2014 - 2015	26	28	6
SE	2013 - 2014	-75	-82	-89
	2014 - 2015	-19	0	0
Central	2013 - 2014	-107	-44	-154
	2014 - 2015	-36	22	-19
NW-NE	2013 - 2014	-20	5.5	-93.5
	2014 - 2015	-68	-16	-11
SW-SE	2013 - 2014	-67.5	-78	-76.5
	2014 - 2015	3.5	14	3

Source: Own computation from producer price data from MAEP, Benin (2023). Prices are in West African CFA Franc per kilogramme (1 CFA is equivalent to about 0.0017 US$)

Similar to legumes as seen in Table 3c, price differences are not generally larger for more distanced markets (see Table 4a) even for staples.

Table 4a: Commodity price differences between staple markets over time

	Period	Local Rice	Imported Rice
NW-SW	2013	0.83	-57.5
	2014	0.83	-26.25
	2015	-47.92	17.92
	2016	-67.92	-55
NE-SE	2010	-10.56	-25
	2011	-36.25	-29.58
	2012	-56.67	-42.92

	2013	-43.33	-44.58
	2014	-72.5	-67.08
	2015	-74.17	-117.08
	2016	-51.67	-115.83
North-Central	2013	9.58	84.38
	2014	-36.04	66.46
	2015	-45.75	50.5
South-Central	2013	30.83	134.58
	2014	1.46	116.88
	2015	10	94.75
SE-NW	2010	-16.5	24
	2011	6.25	-54.83
	2012	-10.42	-3.33
	2013	-30.83	30
	2014	23.75	30
	2015	55	30
	2016	39.58	52.92
SW-NE	2013	73.33	70.42
	2014	51.25	70.83
	2015	64.58	68.33
	2016	77.5	118.75

Source: Own computation from producer price data from MAEP, Benin (2023). Prices are in West African CFA Franc per kilogramme (1 CFA is equivalent to about 0.0017 US$)

Within staple markets as seen in Table 4b, price differences generally vary over time across commodities.

Table 4b: Commodity price differences within staple markets over time

	Period	Local rice	Imported rice
NW	2009-2010	-21.61	-25.83
	2010-2011	19.17	97.5
	2011-2012	50	-33.33

	2012-2013	20.42	-33.33
	2013-2014	-54.58	0
	2014-2015	-31.25	0
	2015-2016	-4.17	-25
NE	2009-2010	-120.30	-58.10
	2010-2011	5.83	1.25
	2011-2012	18.33	4.58
	2012-2013	12.08	2.92
	2013-2014	-32.5	-31.67
	2014-2015	4.17	-41.67
	2015-2016	2.92	-2.5
SW	2013-2014	-54.58	-31.25
	2014-2015	17.5	-44.17
	2015-2016	15.83	47.92
SE	2010-2011	42.67	25.08
	2011-2012	33.33	17.92
	2012-2013	0	0
	2013-2014	0	0
	2014-2015	0	0
	2015-2016	-19.58	-2.08
Central	2013-2014	2.08	4.17
	2014-2015	-4.75	-30
NW-NE	2009-2010	-70.95	-41.96
	2010-2011	12.5	49.38
	2011-2012	34.17	-14.38
	2012-2013	16.25	-15.21
	2013-2014	-43.54	-15.83
	2014-2015	-13.54	-20.83
	2015-2016	-0.63	-13.75

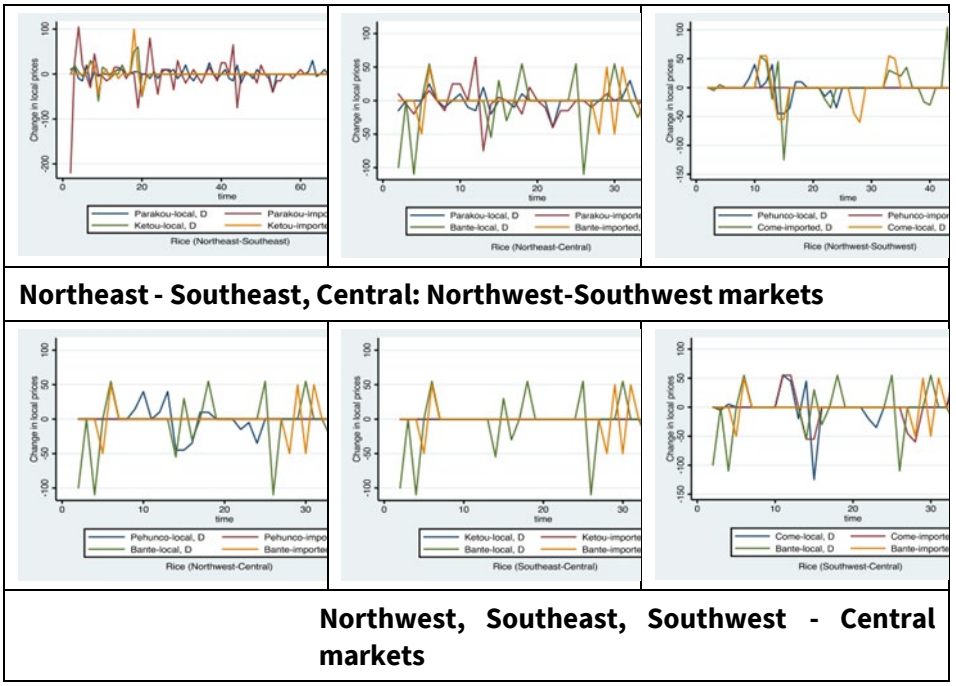
SW-SE	2013-2014	-27.29	-10.83
	2014-2015	8.75	-16.67
	2015-2016	-1.88	-10.42

Source: Own computation from producer price data from MAEP, Benin (2023). Prices are in West African CFA Franc per kilogramme (1 CFA is equivalent to about 0.0017 US$).

5. Staple Food Crop Markets

Staple prices exhibit lesser changes over time compared to landraces as shown in Figure 8. Over the sample period, furthermore, it is observed that imported staple prices show lesser changes over time compared to local staple prices.

Figure 8: Change in prices over time (rice)

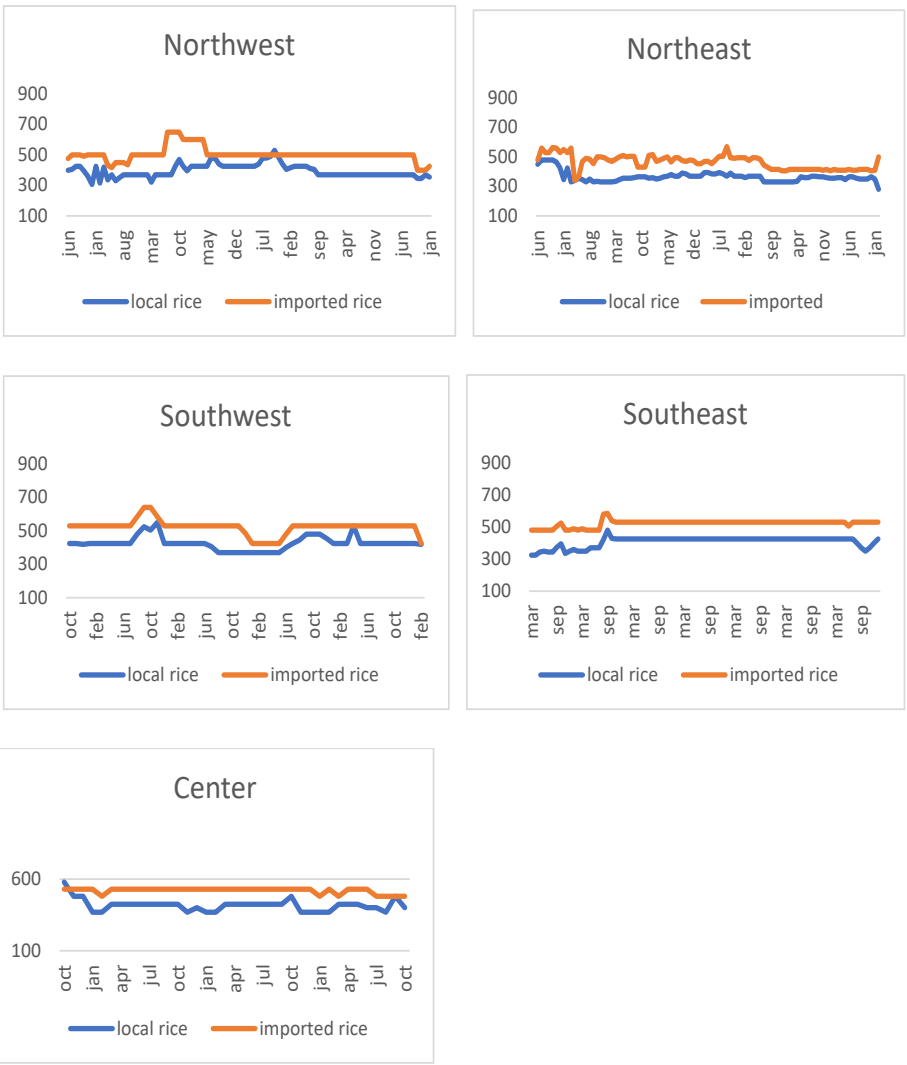


Northeast - Southeast, Central: Northwest-Southwest markets

Northwest, Southeast, Southwest - Central markets

Source: Own computation from producer price data from MAEP, Benin (2023). Prices are in West African CFA franc per kilogramme (1 CFA is equivalent to about 0.0017 US$).

Figure 9: Staple prices (rice) in each market over time



Source: Own computation from producer price data from MAEP, Benin (2023). Prices are in West African

CFA Franc per kilogramme (1 CFA is equivalent to about 0.0017 US$).

In the North, prices are observed to be more volatile in the Eastern counterpart compared to the Western counterpart. This is contrary to the South where prices are observed to be more volatile in the Western counterpart compared to the Eastern. Prices of imported rice are observed to be relatively higher compared to those of locally produced rice. However, in the South, prices of imported rice are observed to be relatively less volatile compared to those of locally produced rice.

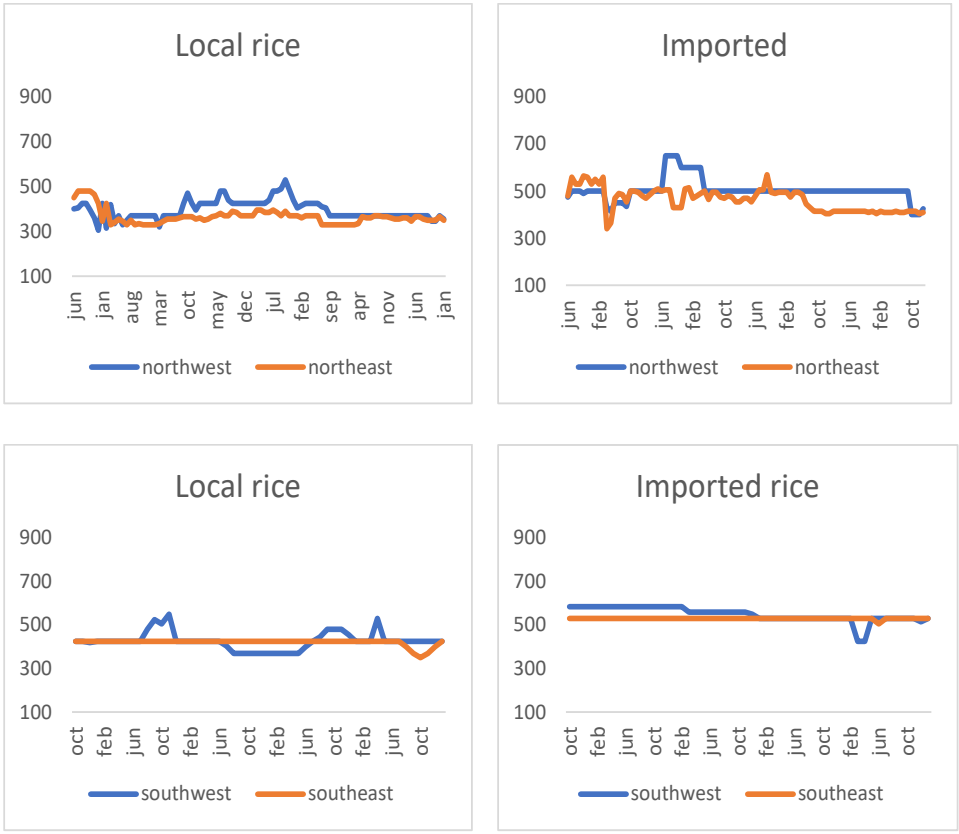
Considering the price differences, dissimilar patterns are observable in staples within regions as shown in Figure 10 (also see Figure 7).

Figure 10: Price differences in each staple market (rice) over time

Source: Own computation from producer price data from MAEP, Benin (2023). Prices are in West African CFA Franc per kilogramme (1 CFA is equivalent to about 0.0017 US$)

Considering each commodity in adjacent markets, this is illustrated as shown in Figure 11.

Figure 11: Staple prices (rice) in adjacent markets

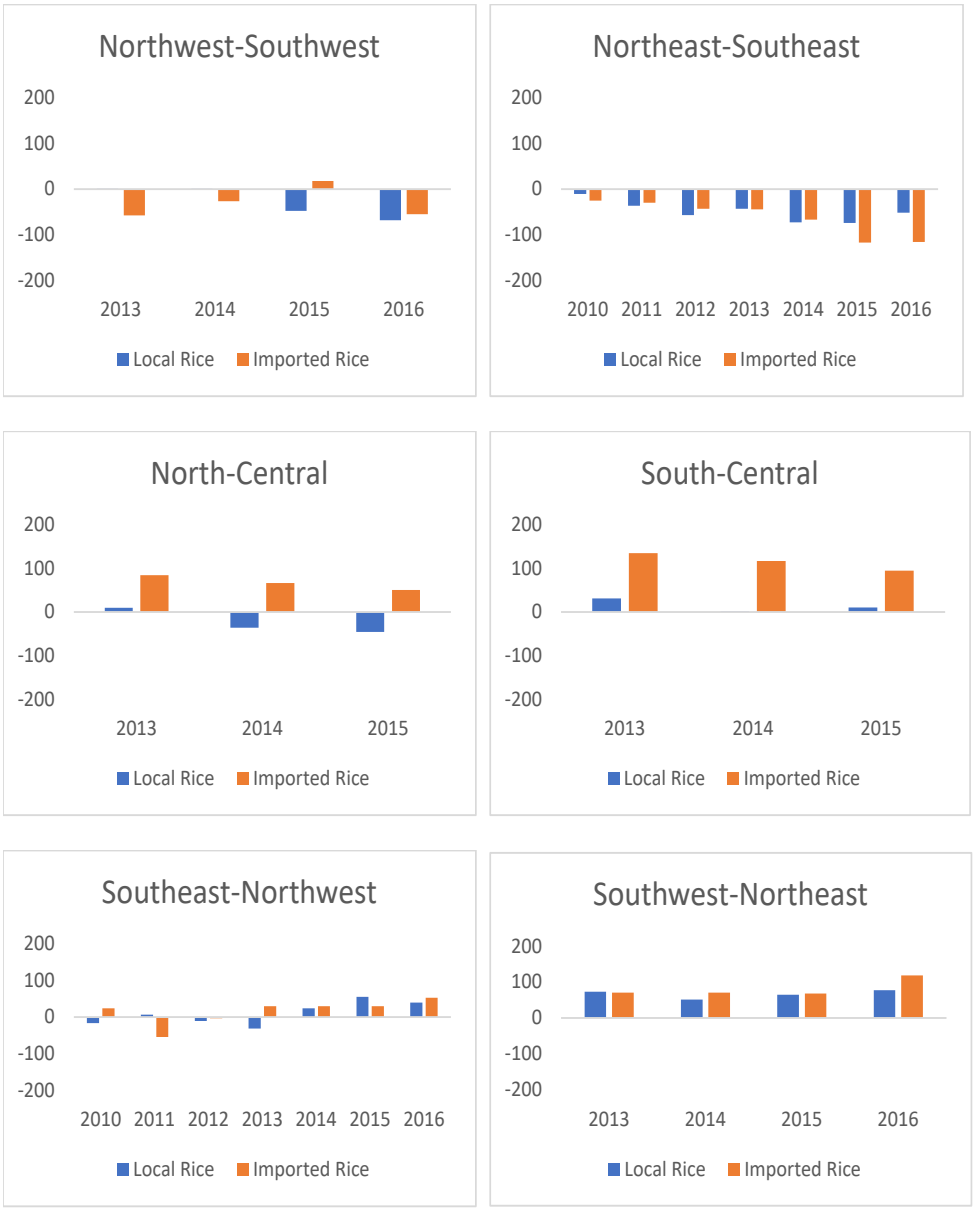


Source: Own computation from producer price data from MAEP, Benin (2023). Prices are in West African CFA Franc per kilogramme (1 CFA is equivalent to about 0.0017 US$)

It can be observed that the prices in the North are relatively higher in the Northwest compared to the Northeast generally, for both imported and locally produced rice. However, in the South, prices are more constant in the Southeast based on the sample data. Moreso, the prices for imported rice are relatively more stable compared to those of locally produced rice.

Increasing price differences over time between the Northeast and Southeast for staples may further suggest implications on the integration of markets, e.g. see the Northeast-Southeast in Figure 12.

Figure 12: Price differences in adjacent staple (rice) markets



Source: Own computation from producer price data from MAEP, Benin (2023). Prices are in West African CFA Franc per kilogramme (1 CFA is equivalent to about 0.0017 US$)

As observed following region distributional differentials, there is need for improving market performance for local indigenous food especially in the face of food security challenges (e.g. see IFPRI, 2021b), and other development-related challenges and efforts that are supported by the production of such legumes, as is the case of conservation and the climate crisis, for boosting general welfare. In such crop producing regions in Benin, strategic drivers for production extend to economic, health-giving, subsistence, commercial, and soil amendment-related motives (Dansi et al., 2012; Ayenan et al., 2017a).

Considering more granular market segregations such as between rural and urban areas, or inland and port regions, opens an avenue for further research, for deeper and broader dynamics, respectively, that could provide insights for broader trade implications.

6. Discussion

As production of Bambara bean is notable in the Northwest in addition to a prominent market, the finding of considerably higher prices in the Central region, and least in the Northern region may be expected. However, for pigeon pea, prices are not observed to be relatively lower in the Central region, which constitutes a major producing area. The prices are observed to be considerably lower in the Northwest. A similar finding is observed for white bean where despite production prominence in the Central region, prices are considerably higher relatively in the region. Over time, based on the data, there has generally been a decline in legume prices.

Price risk in the face of unstable agricultural price patterns typical in SSA impacts farmer production where productivity is less than proportional to growing food needs. This is further exacerbated by the lack of coping mechanisms, for the poor smallholder farmers in typical SSA countries such as Benin, that constitute a significant proportion of farm production and food outcomes. Unstable pricing and signals remain rampant despite non-systematic and inadequately equipped farmer response mechanisms that consequently affect production (see Assouto and Semedo, 2020).

The inflation between the period from 2013 to 2015 in Benin (see AfDB, 2019) that was exceptionally low, at a negative, among WAEMU (West African Economic and Monetary Union) countries could be a potential factor in the price declines over time in this period.

A converge in prices is observed over time for pigeon pea between the Southwest and Southeast (see appendix Fig. 5b for details). A similar finding is observed between the Northwest and Northeast, between pigeon pea and white bean. However, in Bambara bean and white bean markets, between the Southwest and Southeast, prices neither diverged nor converged over time

based on the data. This is again observed for Bambara bean between the Northwest and Northeast.

The averaged constant price differentials over time may suggest limited or no trade for the regions. In contrast, the divergence of Bambara bean prices from pigeon pea and white bean prices over time in the Central region might be indicative of the varying output levels especially when comparing specific commodities across regions as further illustrated on the figures. There was a co-movement in declining prices for pigeon pea and white bean commodities over time in general. Prices co-moved during declines over time in the Northeast and South markets each, across commodities (see appendix Figs. 4b, 5b for details). This could be indicative of trade between markets.

In staples, prices were more volatile in the Northeast compared to the Northwest, and less volatile in the Southeast compared to the Southwest. Rice is cultivated across the country except in the South (Katsumata et al., 2007). This may explain the co-movement of more volatile prices in the North compared to the South. In the white bean market based on the data, prices were relatively quite volatile in the Central region, characterized with production prominence. The domestically produced staple was observed to be cheaper compared to imported staple, as expected.

While prices are expected to be least around January and highest around August for Bambara bean following after-harvest and before-harvest periods, respectively, this was not typically observed as shown on the plots. Such pattern is observed in one of the major producing regions, the Central region, in 2015.

In pigeon pea markets, the Southeast correlation is insignificant despite the Southern region as a major producing area. Correlations are significant in the major producing areas for Bambara bean and white bean. The correlation in the South is also insignificant for the staple, rice, where it is not typically produced. However, there is a mix for significant and insignificant correlations in the rest of the regions where it is generally produced domestically.

7. Conclusion

Recent propositions have been put forward for the development of underexploited crops such as pigeon pea and other orphan legumes in Benin. The gap between what is consumed, and local food production potential is concerning given endeavors for equitable distributions across the population in food availability, affordability, and accessibility for typical developing countries such as Benin with hunger challenges. As prices and markets are critical in food systems, policy approaches that consider neglected and under-

utilized food crops for improving their markets and market performance can strengthen development efforts. The current study descriptively examines regional market dynamics for landrace legume and staple food prices in Benin using producer price data in regional markets. The Pearson's correlation coefficient is used to examine the presence and strength of regional and commodity associations for landrace and staple food. Distributional market differentials could be observed across landrace and staples between different regions. An avenue for further research can consider deeper and broader distributional food implications, such as between urban and rural divides, or port and inland regions. Market policy to strengthen actor participation horizontally and commodity wise inclusively in agri-food markets can enhance coordination and market outcomes such as pricing, for trade development, especially in a developing economy context. A more disaggregated data set representing each region could delve deeper as the current study proxy's individual communes in regions, which constitutes a limitation for the study.

8. Policy Implications

Reconsidering regional segregation discrepancies into food policy frameworks may be able to contribute to reduced inequalities in food availability across regions. This could take the form of food regional redistribution across affluent and deficit regions, and strategic agricultural investments region- and commodity-wise following comparative advantages to boost overall food welfare. Considerations for spatial infrastructure enhancements can propel more efficient price mechanisms for food availability across regions, accessibility, affordability, and better general market functioning for welfare. Even within growing areas, market trend inconsistencies may already point to such poor infrastructural amenities and systems. Given the production and consumption presence locally and among subsistence farmers, from a socio-economic perspective, this could improve commodity market participation especially considering landrace crops, and given efforts and endeavours to promote agricultural diversity in Benin (Nguyen and Dizon, 2017), in a bid towards contributing to minimizing the gap between local food potential with what is consumed, especially in the face of food insecurity challenges. Given the food crisis, this can provide needed support towards welfare and poverty alleviation by tailoring local development efforts to enhance local production and regionally competitive markets, especially through pricing. It has been shown that the degree of concentration of commodities (non-perishable) in agri-food markets could have links with higher asymmetries (Cutts and Kirsten, 2006). Based on focus group discussions, commodities such as the

common bean are out of production and in markets (Akissoé et al., 2022). Distributional differences have implications for policy approaches towards equitable distribution for more efficient food, price, and markets mechanisms towards boosting welfare. Given the essential role of such subsistence local landrace crops for smallholder farm producers of subsistence dependence, which constitute the relevant proportion of total food outcomes, improving the markets and strengthening the performance of such crops across markets competitively and equitably for food access to the population can further contribute to fight hunger, and as a coping mechanism for such hunger vulnerable population with fragile economic performance especially in the face of food crisis.

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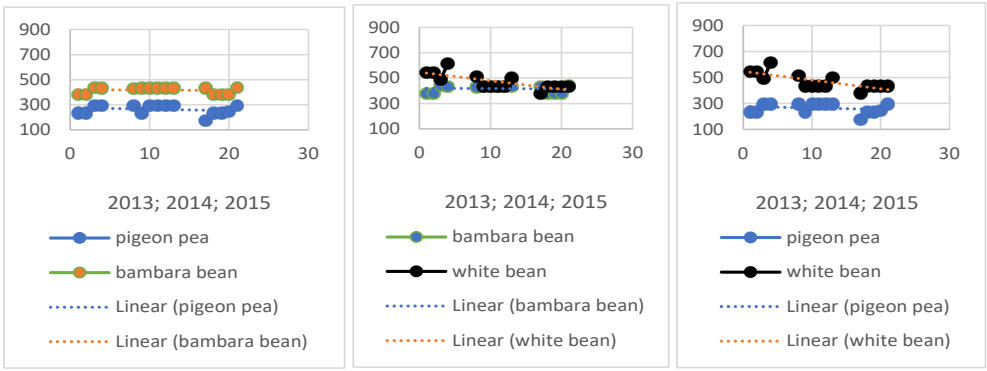
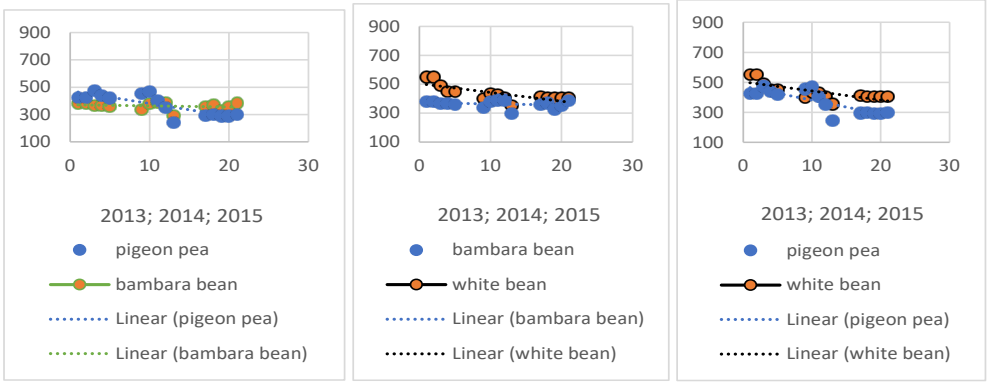
Appendix

When we include linear trend lines to depict pair comparisons, this is illustrated as shown in Figure 4b for each region.

Figure 4b: Legume-pair comparisons in each market



Northwest



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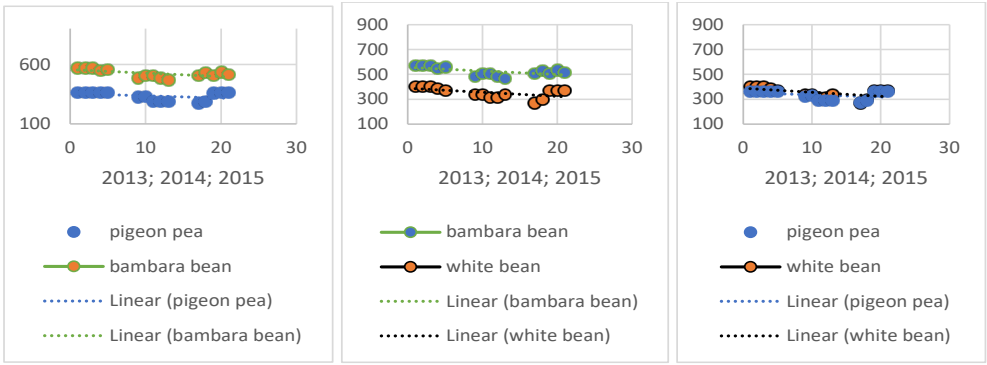
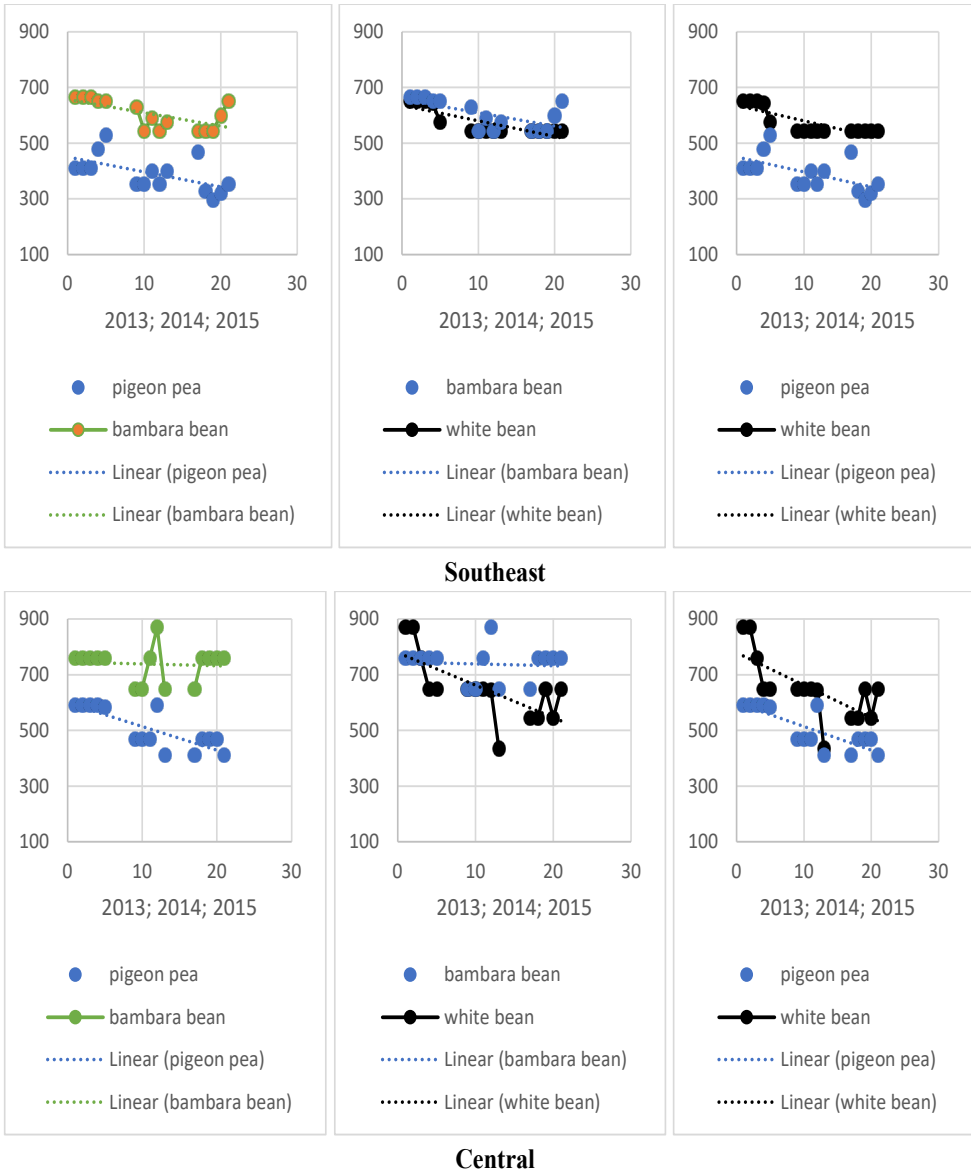


Southwest



Source: Own computation from producer price data from MAEP, Benin (2023). Prices are in West African CFA Franc per kilogramme (1 CFA is equivalent to about 0.0017 US$)

In the Northwest, bean prices tend to come closer together over time. This is similar for pigeon pea and white bean, however, to a lesser extent, but not the case for pigeon pea and Bambara bean. In the Northeast, a similar pattern is observed, with the bean prices observed to move closer together over time. With pigeon pea and other bean prices, a dispersion in the price trend is observable despite falling prices over time. Particularly, for pigeon pea and

white bean, there is an overlap such that Bambara bean prices do not fall over time at a rate comparable to pigeon pea, such that pigeon pea becomes the relatively cheaper commodity over time. In the Southwest and Southeast, there is a general reduction in prices over time across commodities. However, while pigeon pea and white bean prices move closest together in the Southwest, this is rather the case for bean prices (Bambara bean and white bean) in the Southeast, like in the North. In the Central region, prices get dispersed over time as observed based on the sample data, except in the case of pigeon pea and white bean where they slightly come together over time while falling. While pigeon pea and white bean prices fell over time, this was not necessarily the case for Bambara bean. Legume pair comparisons in adjacent markets are done as shown in Figure 5b.

Figure 5b: Legume-pair comparisons in adjacent markets

Source: Own computation from producer price data from MAEP, Benin (2023). Prices are in West African CFA Franc per kilogramme (1 CFA is equivalent to about 0.0017 US$)

Pigeon pea prices are observed to come closer together over time in both the North and the South. White bean prices fell together over time in both the North and the South. A similar pattern is observed for Bambara bean in the South, However, the prices seem relatively more constant in the case of the North.

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