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THE RESILIENCE OF AGRICULTURAL TRADE NETWORKS IN WEST AFRICA

MAY 2025, NO.50

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Lacey Harris-Coble and Olivier J. Walther

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UF Sahel Research Group
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https://doi.org/10.1787/24142026.

Please cite this work as:
Harris-Coble, L. and O. J. Walther (2025), "The Resilience of agricultural trade networks in West Africa", Sahel and West Africa Club, *West African Papers*, No. 50, OECD Publishing, Paris.

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https://doi.org/10.1787/24142026

Abstract:
Trade networks for agricultural products play an important role in agricultural development and regional integration in West Africa. However, mapping these networks is challenging due to the lack of a comprehensive analytical framework that supports evidence-based policymaking. This note represents a first attempt to integrate the spatial, social and temporal aspects that influence trade patterns in the region. The paper begins by examining how external shocks, such as border closures and pandemics, affect agricultural trade networks in West Africa and how these networks respond to such shocks. The paper then uses data on livestock movements, collected from 2013 to 2017 by the Permanent Interstate Committee for Drought Control in the Sahel (CILSS), to illustrate the benefits of spatialising trade networks over time. The paper argues that a more network-based approach to regional trade could help to identify specific places, routes and key actors that are particularly vulnerable to external shocks, and design place-based policies that would strengthen their resilience.

Keywords: Trade, networks, resilience, agriculture, West Africa, Sahel
JEL Codes: N77, O24, Q17

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Acknowledgements:
The authors thank Valerie Valerio and Abdul Zanya Salifu.

Note to readers:
This note is published as part of the partnership between OECD/SWAC and the Sahel Research Group of the University of Florida. The collaboration aims to: 1) Reinforce ties between research and policies for sustainable development that can help better anticipate changes within the Sahel and West Africa region; and 2) Promote West African expertise by reinforcing links with African researchers and research centres through the Sahel Research Group network.

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ACRONYMS AND ABBREVIATIONS

CILSS	Permanent Interstate Committee for Drought Control in the Sahel
ECOWAS	Economic Community of West African States
IOM	International Organization for Migration
SCDi	Spatial Conflict Dynamics indicator
SNA	Social network analysis
WTO	World Trade Organization

EXECUTIVE SUMMARY

In West Africa, trade in agricultural goods is crucial for both livelihoods and food security. Trade networks play a crucial role in supplying a fast-growing population with locally produced goods as well as agricultural products imported from global markets. Yet, despite their regional importance, agricultural trade networks are subject to disruptions, such as political crises, extreme weather events, currency devaluation, or epidemics, all of which can significantly impact food security and economic development.

A recent example of such external shock is the border closure between Economic Community of West African States (ECOWAS) members and Niger following the military coup in Niamey in July 2023. This shock had major consequences on the Nigerien economy, which heavily depends on access to the Gulf of Guinea, as well as for the livelihoods of urban populations in coastal countries, who increasingly rely on agricultural products produced in the Sahel.

Against this background, this note represents a first attempt to integrate the spatial, social and temporal aspects influencing trade patterns in West Africa into a broader framework that can support policymakers to design policies that enhance the resilience of the region. The paper addresses two fundamental questions:

(1) How do external shocks affect agricultural trade networks in West Africa?
(2) How do West African agricultural trade networks respond to external shocks?

The paper begins by discussing the multiple tariff and non-tariff barriers that contribute to making Africa one of the most expensive regions in the world for conducting business. It then explores how trade networks can be mapped in West Africa, by incorporating social actors such as traders and geographical features such as borders, markets and road infrastructure. Using a relational perspective, the paper argues that external shocks affect both the social structure and spatial patterns of agricultural trade networks. In other words, these shocks impact specific trade routes and locations, such as border markets, in different ways.

The paper then draws trade data collected by the Permanent Interstate Committee for Drought Control in the Sahel (CILSS) from 2013 to 2017 to demonstrate the importance of considering the structure of trade networks, their geography and temporal changes. It suggests that network data can be used to allocate flows along transportation routes to better understand how shocks will affect cities, markets, specific road segments, or entire regions. Spatialising trade flows at the regional scale could also help integrate trade data collected at the regional level with border trade surveys conducted at the national level.

Mapping the social structure of trade networks could also better inform market information systems and disease surveillance, both of which rely heavily on the movement of goods, people, livestock and capital across the region. Finally, more attention should be paid to the temporal evolution of trade networks, given their ability to quickly adapt to changes in consumer preferences, national bans on certain products, regulatory differences and political unrest.

Together, these examples highlight the utility of applying a spatial and social network approach to agricultural trade data. Such an approach can enhance policymaking to promote agricultural development, regional integration and resiliency.

INTRODUCTION

In West Africa, trade in agricultural goods is crucial for both livelihoods and food security. Trade networks play a crucial role in supplying a fast-growing population with locally produced goods, such as millet, yams, or maize, as well as agricultural products imported from the global markets. Trade in this region relies heavily on the transportation network and market infrastructures developed between the landlocked countries of the Sahel and the Gulf of Guinea. These roads and markets facilitate the circulation of agricultural commodities and ensure that both Sahelian and coastal countries benefit from the complementarities that exist between ecological zones. Agricultural trade also depends on the skills and social networks developed by local traders, who have adapted to the changes brought by the liberalisation of agricultural markets since the 1980s and developed extensive trade diasporas across the region.

Agricultural trade networks may be subject to environmental, economic and political disruptions that can significantly impact food security and regional integration. A recent example of such external shock is the border closure between ECOWAS members and Niger following the military coup in Niamey on 26 July 2023. The sanctions imposed by ECOWAS have had major consequences for the Nigerien economy, which depends on its neighbours for most of its imports and exports, particularly among vulnerable populations (ICG, 2023). The political crisis has also had unexpected consequences for coastal countries such as Ghana and Benin, where urban populations increasingly depend on agricultural products produced elsewhere in the region. In Accra, for example, the price of imported Nigerien onions has skyrocketed following the border closure with Niger (Al Jazeera, 2023).

Regional policies lack a conceptual framework to assess the impact of external shocks on the geographic organisation of agricultural trade. The paper aims to contribute to filling this gap by addressing two fundamental questions:

(1) How do external shocks affect agricultural trade networks in West Africa?
(2) How do West African agricultural trade networks respond to external shocks?

Using a relational perspective, the paper assumes that external shocks will affect both the social structure and spatial patterns of agricultural trade networks. In other words, these shocks should affect certain segments of the trade network and certain places, such as transport corridors or border markets, differently.

The paper begins by examining the multiple tariff and non-tariff barriers that contribute to making Africa one of the most expensive regions in the world for conducting business. It then explores how trade networks can be mapped in West Africa by incorporating social actors, such as traders, and geographical features, such as borders, markets, and road infrastructure. The fourth section uses trade data collected by the Permanent Interstate Committee for Drought Control in the Sahel (CILSS) to illustrate the importance of considering the structure of trade networks, their geography and temporal changes. The last section examines the policy implications of this work.

TRADE BARRIERS AND SHOCKS IN WEST AFRICA

Regional trade agreements have been implemented in sub-Saharan Africa to promote the free movement of people and goods. Within regional blocs such as ECOWAS, there are no tariffs on products traded between countries, which should, in theory, promote economic integration between countries. However, non-tariff barriers remain high across the continent. These include high transportation costs, currency exchange fees, administrative inefficiencies, linguistic differences, road harassment and illegal bribes (Lamarque and Nugent, 2022).

Transport costs in sub-Saharan Africa are notably among the highest in the world, which, in turn, increases the price paid by consumers on the local markets (FAO, 2021). Doubling transport distance increases costs by four to five times more in Nigeria compared to the United States for example (Bernard and Moxnes, 2018). In addition to high transportation costs, border delays and *tracasseries* lengthen the time required to move goods. For example, numerous checkpoints along West African roads slow the average speed of travel in the region (OECD/SWAC, 2019). Recent studies suggest that accessibility could improve by up to one-third along certain road corridors if border waiting times were eliminated in West Africa (Walther et al., 2020). While roadblocks may be set up by law enforcement, officers may extract illegal payments, which significantly impact local traders and their customers.

High transport costs and delays are particularly detrimental to the trade of agricultural products, which are perishable. While non-tariff trade costs across the African continent are estimated at an ad valorem equivalent of around 283%, these costs are significantly higher for agricultural products, estimated at over 300% ad valorem equivalent, compared to more than 100% for non-agricultural manufacturing products (OECD/FAO, 2022). Another measure of the impact of trade barriers on agricultural products show that each day in transit is equivalent to an ad-valorem tariff of 3% for agricultural products (Bouët et al., 2017). Additionally, agricultural products are more likely to be traded illegally due to the time sensitivity involved in their trade (Bensassi et al., 2016).

Reduced trade in agricultural goods has implications for both producers and consumers in the region. Sub-Saharan Africa is increasingly a net food importer, a trend which is expected to continue in the future due to the projected demographic growth and urbanisation of the continent(FAO, 2021). Agricultural products are particularly impacted by both transportation costs and delays, which decreases the competitiveness of agricultural products from within the region compared to imported goods (Williams et al., 2006). Thus, high transport costs may impede farmers from accessing growing markets that could drive economic growth in the region, while also increasing prices for consumers by reducing supply.

As the importance of trade increases, the potential cost of disruptions to trade has also become increasingly important. Factors that can disrupt agricultural trade are either sudden or gradual. Sudden shocks include border closures, extreme weather events and currency devaluation, while gradual shocks include exchange rate volatility, climate change and epidemics (Torreggiani et al., 2018, see Table 1). Armed conflicts can produce sudden or gradual shocks depending on the type of belligerents involved. For example, Russia's war of aggression against Ukraine was a sudden shock that led to major disruptions to global agricultural supply chains, particularly for countries heavily dependent on wheat and maize imports (Jafari et al., 2022). In contrast, the impact of the Boko Haram insurgency has been much more gradual, decreasing market activities around the Lake Chad region over a period of several years (Van Den Hoek, 2017).

Table 1.
Types of external shocks affecting agricultural trade networks

Sudden Shocks		Gradual Shocks	
Type	**Examples**	**Type**	**Examples**
Armed conflict (inter-state)	Invasion of Ukraine by Russia on 22 February 2022.	Armed conflict (insurgency)	Between 2009 and 2013, 255 violent attacks were carried out by Boko Haram within 1 km of Maiduguri, decreasing market functioning.
Border closures	On 20 August 2019, Nigeria closed its land borders with Benin, Cameroon, Chad and Niger to fight smuggling. Nigeria and Benin closed their land borders after the 26 July 2023 coup in Niger. Niger shut off oil exports to Benin in June 2024.	Climate change	In 2015, late rains and limited pasture for a second consecutive year triggered higher than usual animal sales in northern Burkina Faso.
Currency devaluation	On 13 January 1994, the CFA franc was devalued by 50 percent within UEMOA countries.	Exchange rate volatility	The CFA franc achieved an unprecedented peak against the naira, reaching 2.4 naira per franc in May 2024 against 0.8 in June 2023.
Extreme weather events	On 1 September 2009, extreme flooding affected Ouagadougou in Burkina Faso.	Epidemics	During the Covid-19 epidemic, border closures between Mali and Niger left large concentrations of herders stranded at borders without feed for livestock.

In the long term, climate change is projected to negatively impact global agricultural yields. Between 2011 and 2050, averaged across all crops, yields are projected to decline by 1.1% globally (FAO, 2021). The strongest declines are predicted to occur in developing countries and will impact staple crop production. Yields are projected to decline by double digits for wheat, sorghum and millet, and by 5% for maize. Climate change is also expected to contribute to increased agricultural imports across all regions of Africa except East Africa, with West Africa projected to be the region most affected (Knox et al., 2012; FAO, 2018). In West Africa, where agricultural systems rely predominately on extensive production systems dependent on natural grazing, there is a risk of extreme weather events such as droughts. These events could result in large-scale livestock losses as risk of such events increase due to climate change (OECD/FAO, 2022).

Although climate-related shocks have impacted local food production, conflict-driven crises are currently the primary cause of severe food insecurity (FAO, 2021). Areas afflicted by conflict face high levels of food insecurity and internally displaced persons (FEWS NET, 2023). Conflict negatively impacts food security, both in the short and long term, through the disruption of crop production and trade networks (Adelaja and George, 2019; Jedwab et al., 2021). Unfortunately, conflict has been increasing in West Africa due to a combination of insurgencies, rebellions and military coups. While Nigeria is the epicentre of violence in the region, Mali and Burkina Faso are also heavily impacted (OECD/SWAC, 2023). A strong correspondence is observed between food and political insecurity in West Africa since the late 2000s, particularly in the Liptako-Gourma region, around Lake Chad, and in northern Burkina Faso. Recent studies combining conflict and food security data suggest that the most acute food insecurity often corresponds to the most geographically concentrated violence. In other words, regions where violence is repeatedly expressed in specific places are most likely to face severe food insecurity (Walther, 2024).

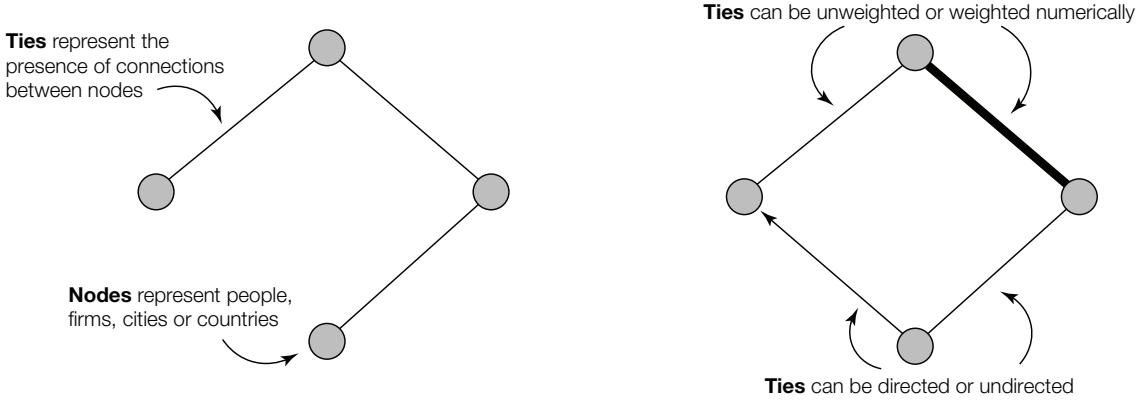
For agricultural markets, increasing conflict results in higher crop prices across markets in Africa (Raleigh et al., 2015). In conflict regions, farmers are no longer able to cultivate their fields or are subjected to heavy taxes by armed groups, while traders tend to avoid regions where their cattle could be raided. In Nigeria, markets were targeted in attacks by Boko Haram, and the intensity of the conflict was associated with decreased market functioning (Van Den Hoek, 2017). Conflict in urban areas and key markets in Nigeria was found to have negative economic impacts on border towns in Niger, Chad and Cameroon due to decreased trade activity (Jedwab et al., 2021). The disruption of markets can result in economic spillovers in other areas through higher prices or reduced economic growth. Thus, examining patterns of violent events in relation to trade and markets could help in understanding how different types or intensities of conflict shocks impact the wider trade network.

MAPPING TRADE NETWORKS

Trade and social networks

Relational approaches, such as social network analysis (SNA) are increasingly used to study the structure of trade in Africa (OECD/SWAC, 2019; Valerio et al., 2020). Networks are an abstract graphical representation of phenomena or systems composed of two elements: nodes and ties. Nodes and ties can represent a wide range of system components and their connections. As indicated in Figure 1, nodes in networks may represent places such as markets, countries, and firms, or people, such as traders. The presence of a tie connecting two nodes can represent an exchange of goods (Barigozzi et al., 2011). Trade lends itself to a network representation due to its relational nature and the creation of connections between places or people through exchange. Ties can represent either the binary presence or absence of trade between two nodes or a weighted connection based on a quantitative aspect, such as the quantity or monetary value of goods traded. Ties can be either directed, when the direction of trade is known—from an exporter to an importer—or undirected otherwise.

Figure 1.
Nodes and ties in a network



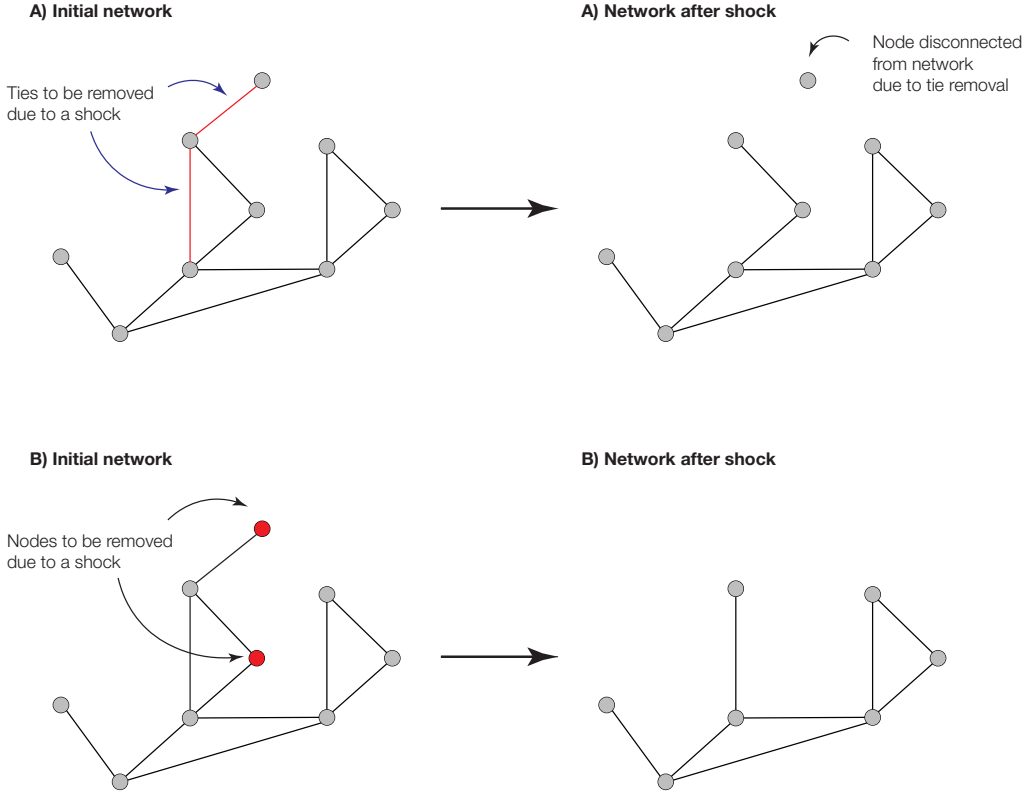
By representing activities such as trade in the form of a set of nodes and ties, network analysis can describe the properties of the network and its elements, such as which nodes are the most important or central, the overall density of the ties between nodes, or whether the actors are segmented by age, nationality, gender, or any other variable. In a large region divided into 16 countries, such as West Africa, informal trade often crosses international boundaries to benefit from agro-pastoral complementarities, differences in tariff regimes, currency variations and growing demand from urban areas (Walther, 2015). The large number of actors involved in these trade networks makes international studies particularly challenging, unless a network approach that maps how traders are connected across countries is adopted (Kuépié et al., 2016).

Gender is another dimension of trade that could benefit from a more network-oriented approach. In a study of the business connections of men and women rice traders in West Africa, for example, consistent gender inequalities were observed in both the number and importance of business connections, despite the active participation of women in trade networks (OECD/SWAC, 2019). A network approach can also be applied to identify communities that share similar interests or are connected through specific value chains, both at the national (Dong et al., 2022) and subnational levels (Walther, 2015).

How networks respond to shocks

In addition to describing a network, network analysis can examine the resilience of network connectivity to external shocks. Shocks to a network can change the number, location, or capacity of nodes and/or ties (Fair et al., 2017; Cerqueti et al., 2019). For example, flooding may make a road connecting two cities impassable and result in the functional removal of that tie in the transportation infrastructure (Testa et al., 2015). The impact of removing ties due to a shock such as flooding is illustrated in the upper part of Figure 2. Following the disruption, the resulting network has only nine ties, and one node is disconnected from the network. Alternatively, extreme events such as a natural disaster may prevent goods from entering or leaving a market, which can be simulated as the removal of a node in the network (Davis et al., 2021). The lower part of Figure 2 illustrates the impact of the removal of nodes in a simplified network. Note that the removal of nodes also entails the removal of the ties that connect the nodes to the rest of the network.

Figure 2.
Removing nodes and ties from a network



Disruptions to the structure of a network can be simulated in two ways. The first method involves randomly removing nodes or ties from the network and then assessing how the removal impacts the structure based on quantitative measures of the network's properties. For example, police forces may want to disrupt drug trafficking activities by arresting all actors selling or buying drugs in a neighbourhood. The second approach selectively targets the most important nodes and assess how their removal affects the network. In a drug trafficking network, this approach would involve targeting wholesalers or specialists who maintain the supply chain (Duijn et al., 2014).

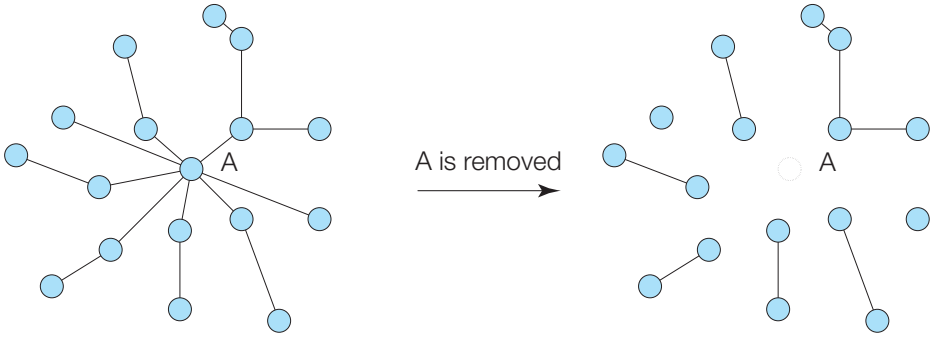
These techniques, initially developed to study criminal, 'dark', or terrorist networks, have also been applied to existing or simulated agricultural trade networks. For example, Fair et al. (2017) showed that the resilience of the global wheat trade network was reduced by targeted shocks, while the long-term effects of random shocks were minimal. More recently, Jafari et al. (2022) found that COVID-19 had only short-term effects on agricultural trade, primarily on the total number of trading partners rather than the volume or intensity of trade. For simulated shocks, Ercsey-Ravasv et al. (2012) found that a core group of seven countries was connected to 77% of the world's countries through agricultural trade. Thus, changes to these nodes would have the greatest impact on the performance of the network.

Studies focusing on the resilience of networks suggest that their structure is key to determining whether a country or a region will adjust to external shocks (Acemoglu et al., 2015; Karakoc and Konar, 2021). Resilient networks are able to maintain cohesion despite disruptions and are able to quickly return to functioning following a disruption. Different network structures may be more resilient to certain types of disruptions (Gutiérrez-Moya et al., 2021). For example, networks with a centralised structure, such as a star network in which every node is connected to a central actor, are more vulnerable to targeted network disruptions while they are resilient to disruptions that occur randomly (Fair et al., 2017). In contrast, decentralised networks are much more difficult to disrupt, as they are composed of many redundant ties that can be used to keep the overall structure functioning, as indicated on Figure 3.

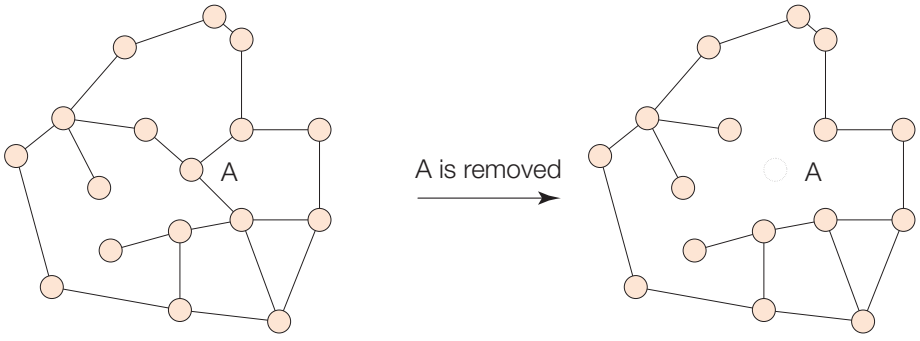
Studies of the global agricultural trade network have used this approach to highlight the increasing number of trade linkages between countries over time, following the liberalisation of trade in the 1980s (Jafari et al., 2023). Similarly, network techniques have shown that nodes with a similar number of ties are less likely to be connected, as most international agricultural trade is concentrated among a small number of countries, such as the United States and China. Finally, as countries become more economically integrated, the distance within the network is decreasing, leading to a small-world effect, in which most countries can be reached through a small number of ties (Zhang and Batinge, 2021).

Figure 3.
How centralised and decentralised networks can be disrupted

Centralised networks are easily disrupted because they rely on a few key nodes. Removing node A breaks the network into several disconnected components



Decentralised networks are hard to disrupt because they contain many redundant ties. The network remains cohesive even after node A is removed.



Source: OECD/SWAC (2025).

Trade and spatial networks

In the last couple of years, growing attention has been paid to the spatiality of social networks, which is now recognised as a key component that can affect their resilience (Andris and Sarkar, 2022). In addition to connecting traders and firms, trade networks bring different markets, regions and countries together. External shocks are likely to create great disruption to the geography of such networks, by affecting the physical infrastructure upon which trade activities develop, such as transport corridors, major markets and areas of production. In West Africa, for example, border closures are likely to affect border markets, whose economic activities depend on the ability of local traders to exchange goods with neighbouring countries.

The geography of social networks can be examined using gravity models, which provide an estimate of the volume of trade flows between two locations, depending on their demographic or economic importance and the distance between them. These models consistently find that the attributes of the nodes, such as their population or gross domestic product (GDP), as well as the social or geographic distance between them influence trade flows. For example, Aker et al. (2014) found that shared social characteristics such as language or ethnicity, reduced trade costs for cowpea in West Africa, while Euclidean distance consistently had a negative influence on trade flows (Chaney, 2018). Bailey et al. (2021) found that controlling for social connectedness between countries reduced the impact of distance on trade flows in a gravity model.

Studies of trade networks also find that social and geographic distance influence trade patterns, meaning that countries located near each other tend to exchange more goods and services than distant ones. For example, geographic distance is negatively associated with global trade in the trade network of meat products (Chung et al., 2019) and in the wheat trade network (Gutiérrez-Moya et al., 2021). Torreggiani et al. (2018) found that geographic proximity and trade agreement membership had a stronger influence on community structure in the agricultural trade network than a country's economic size or income. Conversely, increasing tariff and non-tariff barriers between countries can be seen as equivalent to adding an extra distance between them, leading to a decline in international trade (Bernard and Moxnes, 2018).

Most of the studies using gravity models and geographic distance in Africa focus on trade connections between countries. For example, Zhang and Batinge (2021) find that closer economic, geographic and cultural distance increased the likelihood of trade network connections. Each national economy is a node connected to many others, and the demographic size of each node reflects its economic importance. However, this approach is difficult to apply in West Africa, where much of agricultural trade is largely unrecorded. In addition, the size of West African markets can rarely be used as a proxy for their economic importance, as is typically the case in gravity models. This is because West African trade relies much more than trade in other regions on small markets where trade diasporas involved in regional trade are located (Walther et al., 2015). Unlike other markets that owe their importance to the size and qualifications of their population, border markets rely on the opportunities offered by their strategic location. For example, much of the agricultural trade between Niger and Nigeria relies on more than a dozen border markets that exploit variations in currency exchange rates, price of manufactured goods, import taxes, and bans of imports and exports (OECD/SWAC, 2017).

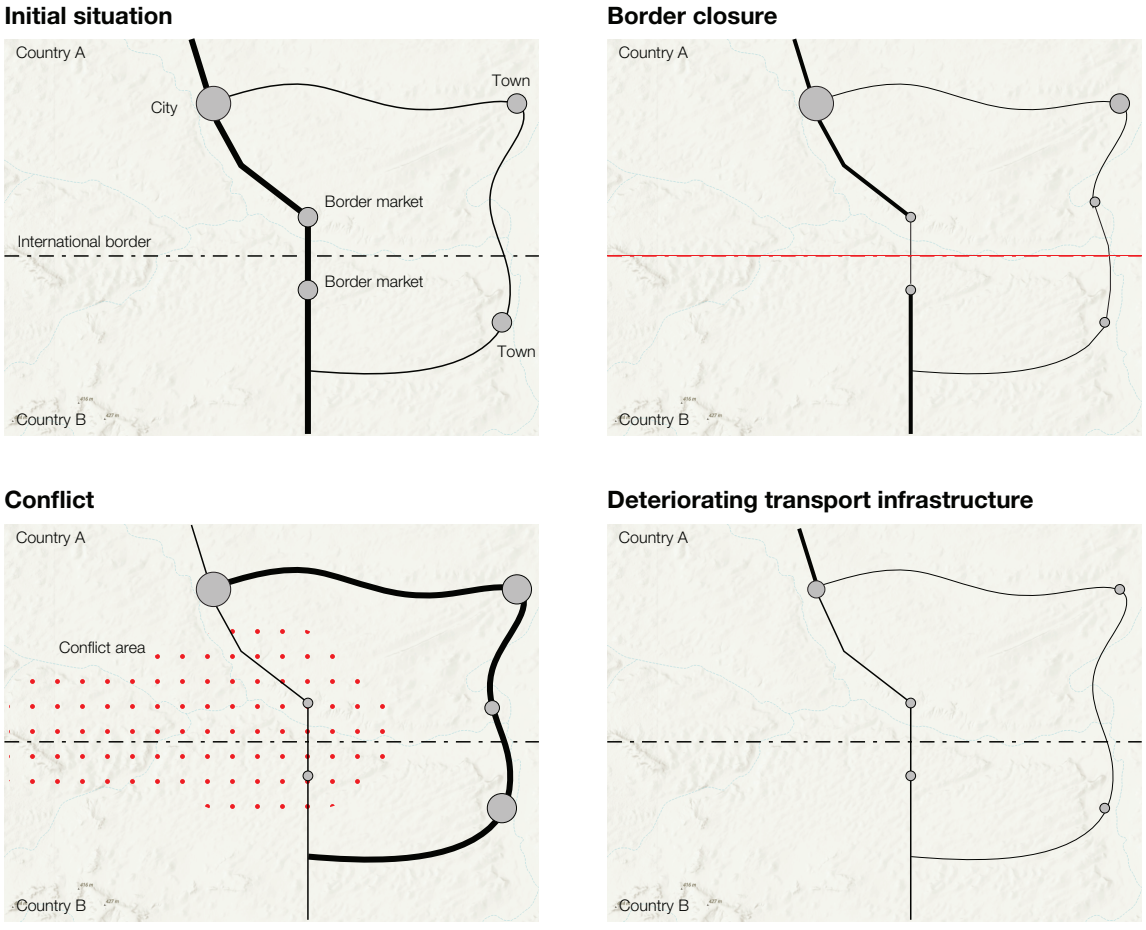
Thus far, only a handful of studies have examined the geography of trade networks in West Africa at the subnational level. At the regional level, Walther (2015) found that trade networks were more affected by international borders when trade was relatively recent and local traders were not native to the area as in the trinational region of the Dendi in southern Niger, compared to areas where trade had pre-colonial roots such as the Hausaland. Studies conducted by the OECD/SWAC (2019) in the same region have also found that the geography of trade networks was heavily constrained by the demand from neighbouring countries, irrespective of the import bans imposed by West African states. Much of the rice produced along the Niger River is exported to the markets of northern Nigeria, for example, thanks to a dense network of local traders that connect production areas to the large urban markets of the Sokoto region.

Aspects of both distance and place can be incorporated through a spatial network approach. Spatial networks, where nodes and ties are located through geographic co-ordinates, differ from aspatial networks, which do not embed nodes and ties in geographic space. Additionally, spatial networks are characterised by restrictions on the formation of ties based on distance or prohibitions against ties crossing each other in space (Andris and O'Sullivan, 2021). The embedding of nodes in geographic space constrains the number and orientation of potential connections in the network. Projecting networks onto geographical space also helps understand how people relate to their natural and political environment. For example, mapping livestock movements can highlight why some regions face overgrazing, how national borders should be monitored to prevent the spread of diseases, and how to best prevent potential conflicts with farmers (Jahel et al. 2020).

How spatial networks are affected by shocks

A spatial network approach that integrates both the spatial embedding of nodes and factors influencing the interaction range is illustrated in Figure 4. Three of the most fundamental features of geographical space are represented: areas, represented by national territories and their borders; places, represented by markets and cities; and connections, represented by roads. In this simplified representation of a West African region, cities located near international borders have developed into border markets. Traded goods move along different categories of roads, which provide the physical connections between border markets and other cities of the region.

Figure 4.
How shocks can affect a spatial network



External shocks are likely to affect different parts of this border region. Border closures would drastically reduce the amount of formal trade between border markets and potentially lead to an increase in informal trade through alternative channels. This was precisely observed on the markets of Malanville and Gaya recently, following the closure of the border with Benin and Nigeria. While hundreds of trucks were stranded on both sides of the border, informal trade developed considerably across the Niger River (De Bruijne and Gehrling, 2024).

The emergence of conflict zones generally results in the decline of local markets and the transfer of trade flows to alternative roads. This occurred in many markets in the Lake Chad region after Boko Haram expanded its activities in rural areas in the 2010s (Van den Hoek, 2017). The persistent activity of militant groups around Lake Chad led to the destruction of rural and urban markets and to the development of new trade corridors that avoided the most affected areas. Further west, the recent development of jihadist groups in northern Benin and Togo has also led transporters to seek alternative trade routes to reach the Gulf of Guinea, such as via northern Ghana.

Finally, gradual shocks can lead to a slow decline in trade activities, for example when transport infrastructure is no longer properly maintained. Poor road conditions, in particular, tend to slow and divert trade to other regions, causing border markets to shrink in size and activity (OECD/SWAC, 2025). If the situation persists for many years, the lack of road accessibility can lead the local economy to be dominated by illegal activities based on a vast array of informal roads, as in the extreme north of Mali.

AN APPLICATION TO WEST AFRICAN TRADE

Given the importance of the social, spatial and temporal aspects of networks, an approach is needed that combines all three elements together to better understand the resilience of West African trade. Such an approach would allow for the integration of the spatial basis of the network with information on temporal events, such as conflict or market shocks, as well as information on how traders are connected. This section illustrates the benefits of developing such as integrated approach, using livestock data collected by CILSS on ten trade corridors in West Africa since 2013. In this context, corridors are defined as geographic routes with sufficient volume and value that are important for food security. Along each corridor, CILSS enumerators collect information on trade flows and trade barriers. CILSS does not use a sampling framework; rather, it aims to capture all trade along the key corridors. Its data is particularly well suited for analysis of agricultural trade at the regional level, as it incorporates both formal and informal trade, which is prevalent throughout the region.

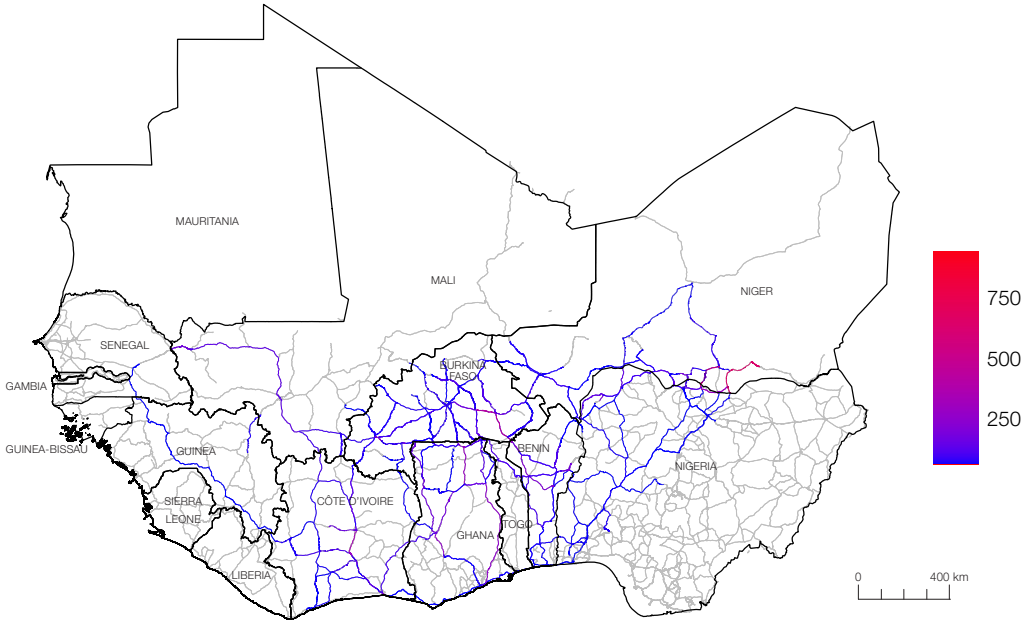
Space

Spatial networks are heavily constrained by the physical infrastructure used by people, goods and animals. In regions where the road network is very sparse, such as West Africa, economic exchanges tend to follow certain transport corridors, and traders have fewer opportunities to develop long-distance trade compared to regions where roads are more widespread. The topological structure and quality of the physical infrastructure impose transaction costs in economic exchanges that increase with distance, the number of border crossings, or the existence of different national standards.

Livestock trade exemplifies this, as since most recorded movements cross national borders along long-distance trade routes (Valerio et al., 2020). On the one hand, long-distance trade routes are economically essential, facilitating the movement of animals between sparsely populated semi-arid areas used for extensive livestock production and densely populated cities in humid coastal zones where they are consumed. Without ranching, livestock mobility has long been a strategy to take advantage of such agro-ecological complementarities between the Sahel and the Gulf of Guinea (Walther and Retaillé, 2021). However, this long-distance trade occurs in a region where trade costs are among the highest in the world, due to its division into more than 15 countries and non-tariff barriers that impose informal taxes and delays to traders. The structure of the livestock network reflects these constraints: it has a low density, traders have only a handful of business partners, and they tend to connect to other traders with dissimilar properties (Valerio et al., 2020).

One of the most effective ways to integrate space into the analysis of trade networks is by allocating trade flows along the region's transport routes as in Figure 5, which represents the number of cattle heads observed by CILSS between 2013 and 2017. This spatialisation of trade networks is vital to understand how economic activities may respond to external shocks such as border closures. For instance, if the border post of Gaya-Malanville, between Niger and Benin were to close, which alternative trade routes would traders use to supply Cotonou? Anecdotal evidence suggests that West African traders adjust very rapidly to changing conditions in the regional network. Before the security crisis in the Sahel, Nigerien onion produced in Galmi was exported to Accra in Ghana via Niamey, Kantchari, and Bittou in Burkina Faso. Today, traders use a longer route that connects Galmi to Jega and Kamba in Nigeria, Kara in Togo, and Yendi in Ghana (Salifu, personal communication, 2024).

Map 1.
Cattle trade flows allocated across major transport corridors, 2013-17



Source: Authors based on CILSS data.

Changes in trade routes do not only affect the road infrastructure; they also have a major impact on the nodes of the physical network itself. Due to their small size and relative specialisation on certain products, border markets are particularly sensitive to changes in the intensity and direction of trade patterns. Shift in regional flows, rather than changes in local production, explains why some markets boom while others decline. These disparities reflect one of the paradoxes of border markets: only a few of them are located on strategic routes that enable them to benefit from the advantages of international trade. Such strategic advantages, which are often local in nature, fluctuate with changes in tax and customs regulations, exchange rates and import policies between West African countries. Consequently, the demographic evolution of border markets is often erratic (OECD, 2019). Along with transport corridors used by traders, these essential places of commerce should be integrated into a more spatial approach to livestock trade in the region.

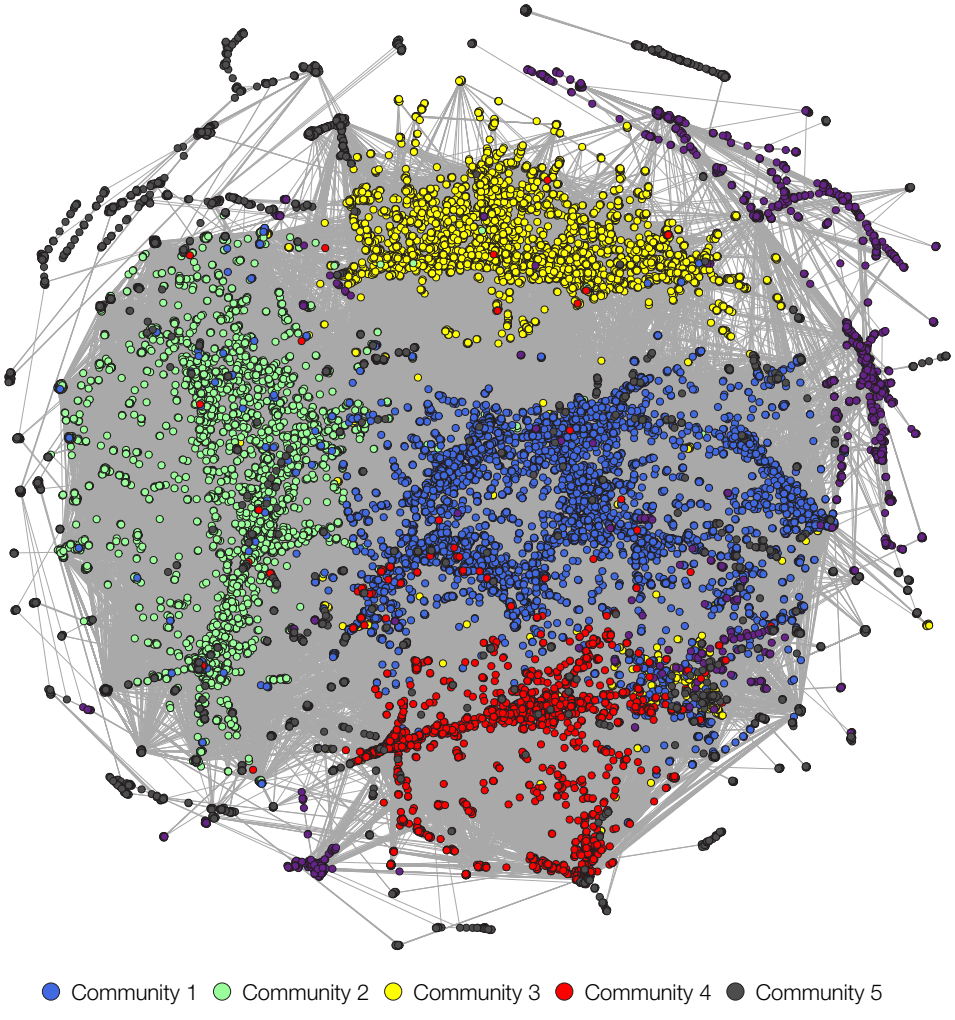
Networks

In the absence of strong formal institutions, traders routinely rely on personal relationships to co-ordinate trade and enforce contracts over long distances in West Africa. These networks are the backbone of informal trade. Between Niger and Nigeria, for example, informal trade relies on a handful of brokers who supply large urban centres in manufactured goods, textile, second-hand cars, and gasoline (Walther, 2015). Such trade networks help reduce trade frictions and maintain competitive prices for agricultural products like millet and cowpeas, especially when traders share the same ethnic background, as seen in the Hausa communities (Aker et al., 2014).

The social structure of livestock trade networks is similar, with small traders selling to larger wholesalers, a few of which have the capital to transport livestock across borders to destination markets (Williams et al., 2006). These traders selling or buying livestock tend to occupy specific markets and form tightly knit groups, called 'communities' in the network jargon, as indicated on Figure 6. These communities can span over several countries, making them difficult to identify through traditional surveys. While the physical infrastructure of a region creates a range of opportunities for local traders, trade ultimately relies on the people involved in economic activities. Understanding the social structure of these networks has important implications for projects related to market information systems, where information must be transmitted throughout the network.

Thus far, however, little is known about how these traders are informally connected. Most studies on informal trade in the region have adopted a qualitative approach and were published decades ago (see Grégoire, 2002; Quarles Van Ufford, 1999; Koné, 2015). The need to better document the social structure of West African trade networks is also justified by their importance in the spread of animal diseases. Community detection methods can identify sub-groups within the network that can be targeted for dissemination through specific markets. Additionally, focusing on hubs in the network may offer an efficient way to strengthen disease surveillance efforts (Motta et al., 2017).

Figure 5.
Largest communities in the West African livestock trade network, 2013-17



Note: The graph shows five 'communities' of traders involved in livestock trade in West Africa. A 'community' is a group of traders between which business interactions are particularly frequent.

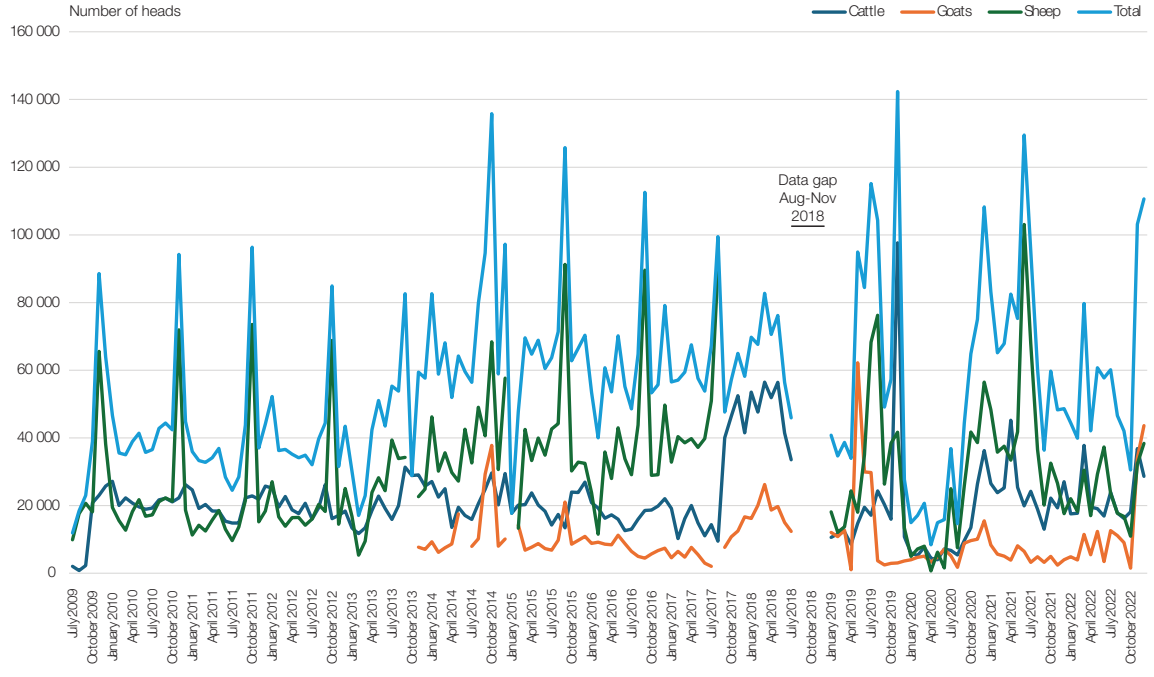
Source: Valerio (2024), reproduced with permission.

Time

The livestock trade network in West Africa is not static, but rather influenced by both intra-annual and inter-annual variability. Given the dynamic nature of the environment, seasonal movements have long been a strategy used to adapt to and exploit natural resources (Walther and Retaillé, 2021). In much of the Sahel, seasonal changes in the proportion of small ruminant versus cattle sales are driven by Tabaski celebrations, an Islamic holiday that requires a sacrificial sheep (Figure 7). Inter-annual variability can also be observed in livestock trade patterns, due to climatic shocks such as drought that affect pasture areas. Temporary shocks such as border closures, pandemics and political crises can also impact the livestock trade network. Border closures following the recent coup in Niger resulted in the disruption of cargo flows to and from coastal ports, leading to higher food prices. During the COVID-19 pandemic both internal and cross-border movements of livestock herders were restricted. More recently, both Benin and Togo have closed their borders to pastoralists from the Sahel due to political insecurity, affecting long-established transhumance patterns (LASDEL, 2024).

Monitoring these changes and their impacts on the livelihoods of West African populations should be a priority for local governments and international organisations. Currently, the most advanced effort in this area is the transhumance tracking tool developed by the International Organization for Migration (IOM), which collects data on disruptions to herder flows in certain regions of West Africa (IOM, 2020). Building on an understanding of the spatial and social network factors that underpin the geographic organisation of the livestock trade network can help identify areas that are vulnerable to shocks and to quantify their potential impacts. For example, combining information on trade flows along transportation routes with information on the shifting geography of political violence (OECD/SWAC, 2020) could help quantify the potential impacts on flows in the trade network.

Figure 6.
Monthly cattle trade flows in West Africa, 2009-22



Source: Authors based on CILSS data.

PERSPECTIVES

Intra-regional trade is lower in West Africa than in other regions of the world. This is mainly due to multiple non-tariff barriers that delay the movement of goods, particularly perishable agricultural products. The increasing population growth and urbanisation observed in the region will reinforce the importance of these trade networks in the coming years and the necessity to better understand which shocks can disrupt them. In recent years, sudden shocks—such as border closures, extreme weather events and currency devaluation—have combined with more gradual changes, including exchange rate volatility, climate change, regional conflict and epidemics.

While the trade of agricultural goods occurs at the regional level across West Africa, limited data curtails our understanding of the geographic organisation of these networks and their resilience to various types of shocks. Against this background, this note is a first attempt to integrate the spatial, social and temporal aspects that influence these trade patterns and produce a valuable tool for policymakers seeking to enhance their resilience. To demonstrate the utility of this approach, three examples were explored using trade data collected by CILSS from 2013 to 2017, which could be further expanded with more recent data in future research.

This analysis suggests that network data can help allocate trade flows along transportation routes in order to understand how shocks will affect cities and markets, certain segments of roads, or entire regions. Spatialising trade flows at a regional scale could also help to integrate trade data collected at the regional level with national border trade surveys.

Mapping the social structure of the trade networks could further strengthen market information systems and disease surveillance efforts, which rely heavily on the movement of goods, people, livestock and capital across the region. Finally, greater attention should be given to the temporal evolution of trade networks, due to their ability to rapidly respond to changes in consumer preferences, national bans on certain products, differences in national regulation and political unrest.

Together, these examples highlight the value of applying a spatial and social network approach to regional agricultural trade data in order to enhance policymaking for agricultural development, regional integration and resiliency.

REFERENCES

Acemoglu, D., A. Ozdaglar and A. Tahbaz-Salehi (2015), "Networks, shocks, and systemic risk", *National Bureau of Economic Research*, Working Paper No. 20931.

Adelaja, A. and J. George (2019), "Effects of conflict on agriculture: Evidence from the Boko Haram insurgency", *World Development*, Vol. 117, pp. 184-195.

Aker, J. C. et al. (2014), "Borders, ethnicity and trade", *Journal of Development Economics*, Vol. 107, pp. 1-16.

Al Jazeera (2023), "Niger coup sanctions drive Ghana's onion prices up, deepen food crisis", 8 September.

Andris, C. and D. O'Sullivan (2021), "Spatial network analysis", in *Handbook of Regional Science*, Springer Berlin Heidelberg, pp. 1727-1750.

Andris, C. and D. Sarkar (2022), "Social networks in space", in *Handbook of Spatial Analysis in the Social Sciences*, Edward Elgar Publishing, pp. 400-415.

Bailey, M. et al. (2021), "International trade and social connectedness", *Journal of International Economics*, Vol. 129.

Barigozzi, M., G. Fagiolo and G. Mangioni (2011), "Identifying the community structure of the international-trade multi-network", *Physica A: Statistical Mechanics and its Applications*, Vol. 390, 11, pp. 2051-2066.

Bernard, A. B. and A. Moxnes (2018), "Networks and trade", *Annual Review of Economics*, Vol. 10, pp. 65-85.

Bensassi, S., J. Jarreau and C. Mitaritonna (2016), "Determinants of cross-border informal trade: The case of Benin", *AGRODEP Technical Report*.

Bouët, A., L. Cosnard and D. Laborde (2017), "Measuring trade integration in Africa", *Journal of Economic Integration*, pp. 937-977.

Cerqueti, R., G. Ferraro, G. and A. Iovanella (2019), "Measuring network resilience through connection patterns", *Reliability Engineering & System Safety*, Vol. 188, pp. 320-329.

Chaney, T. (2018), "The gravity equation in international trade: An explanation", *Journal of Political Economy,* Vol. 126/1, pp. 150-177.

Chung, M. G., K. Kapsar, K. A. Frank and J. Liu (2020), "The spatial and temporal dynamics of global meat trade networks", *Scientific Reports*, Vol. 10/1, 16657.

Davis, K. F., Downs, S. and J. A. Gephart (2021), "Towards food supply chain resilience to environmental shocks", *Nature Food*, Vol. 2/1, pp. 54-65.

De Bruijne, K. and C. Gehrling (2024), *Dangerous Liaisons. Exploring the risk of violent extremism along the border between Northern Benin and Nigeria*, Clingendael Report.

Dong, J. et al. (2022), "Identification of international trade patterns of agricultural products: the evolution of communities and their core countries", *Geo-spatial Information Science*, pp. 1-15.

Duijn, P. A., V. Kashirin and P. M. Sloot (2014), "The relative ineffectiveness of criminal network disruption", *Scientific Reports*, Vol. 4/1, 4238.

Ercsey-Ravasz, M. et al. (2012), "Complexity of the international agro-food trade network and its impact on food safety", *PloS One*, Vol. 7/5, e37810.

Fair, K. R., C. T. Bauch and M. Anand (2017), "Dynamics of the global wheat trade network and resilience to shocks"*, Scientific reports,* Vol. 7/1, 7177.

FAO et al. (2017), *The State of Food Security and Nutrition in the World. Building Resilience for Peace and Food Security*, Rome, Food and Agriculture Organization.

FAO (2018), *The State of Agricultural Commodity Markets. Agricultural Trade, Climate Change and Food Security*, Rome, Food and Agriculture Organization.

FAO (2021), *Framework for Boosting Intra-African Trade in Agricultural Commodities and Services,* Rome, Food and Agriculture Organization.

FEWS NET (2023), *Nigeria Food Security Outlook*, available at: https://fews.net/west-africa/nigeria/food-security-outlook/february-2023#seasonal-calendar-for-a-typical-year

Grégoire, E. (2002), "Major Sahelian trade networks: past and present", in *Societies and Nature in the Sahel*, Routledge, pp. 114-132.

Gutiérrez-Moya, E., B. Adenso-Díaz and S. Lozano (2021), "Analysis and vulnerability of the international wheat trade network", *Food Security*, Vol. 13, pp. 113-128.

ICG (2023), *ECOWAS, Nigeria and the Niger Coup Sanctions: Time to Recalibrate*, 5 December.

IOM (2020), *How COVID-19 Affects Nomadic Herders: IOM's Transhumance Tracking Tool Launched in Mauritania*, available at: https://www.iom.int/news/how-covid-19-affects-nomadic-herders-ioms-transhumance-tracking-tool-launched-mauritania.

Jafari, Y., H. Engemann and A. Zimmermann (2023), "Food trade and regional trade agreements – A network perspective", *Food Policy*, Vol. 119, 102516.

Jafari, Y., H. Engemann and A. Zimmermann (2022), *The Evolution of the Global Structure of Food and Agricultural Trade: Evidence from Network Analysis*, Background Paper for The State of Agricultural Commodity Markets (SOCO), Rome, FAO.

Jedwab, R. et al. (2021), *Estimating the Spillover Economic Effects of Foreign Conflict: Evidence from Boko Haram,* World Bank Technical Paper, Washington, D.C.

Karakoc, D. B. and M. Konar (2021), "A complex network framework for the efficiency and resilience trade-off in global food trade", *Environmental Research Letters*, Vol. 16/10, 105003.

Knox, J. et al. (2012), "Climate change impacts on crop productivity in Africa and South Asia", *Environmental Research Letters*, Vol. 7/3, 034032.

Koné, M. (2015), *Marchands ouest-africains et marchés frontaliers: construction d'une communauté d'affaires*, Doctoral dissertation, Université Michel de Montaigne-Bordeaux III; Université Abdou Moumouni.

Kuépié, M., M. Tenikue and O. J. Walther (2016), "Social networks and small business performance in West African border regions", *Oxford Development Studies*, Vol. 44/2, pp. 202-219.

Lamarque, H. and P. Nugent (2022), *Transport Corridors in Africa*, Boydell & Brewer.

LASDEL (2024), *La transhumance transfrontalière à l'épreuve de l'insécurité: Bénin, Burkina Faso, Niger et Togo*, Niamey, LASDEL.

Motta, P. et al. (2017), "Implications of the cattle trade network in Cameroon for regional disease prevention and control", *Scientific Reports*, Vol. 7/1, 43932.

OECD (2019), "Population and Morphology of Border Cities", *West African Papers*, No. 21, OECD Publishing, Paris, https://doi.org/10.1787/80dfd9d8-en.

OECD/FAO (2022), *Agricultural Outlook 2022-2031*, OECD Publishing, Paris.

OECD/SWAC (2025), *Roads and Conflicts in North and West Africa*, West African Studies, OECD Publishing, Paris, https://doi.org/10.1787/77474489-en.

OECD/SWAC (2023), *Urbanisation and Conflicts in North and West Africa*, West African Studies, OECD Publishing, Paris, https://doi.org/10.1787/3fc68183-en.

OECD/SWAC (2020), *The Geography of Conflict in North and West Africa*, West African Studies, OECD Publishing, Paris, https://doi.org/10.1787/02181039-en.

OECD/SWAC (2019), *Women and Trade Networks in West Africa*, West African Studies, OECD Publishing, Paris, https://doi.org/10.1787/7d67b61d-en.

OECD/SWAC (2017), *Cross-border Co-operation and Policy Networks in West Africa*, West African Studies, OECD Publishing, Paris, https://doi.org/10.1787/9789264265875-en.

Quarles Van Ufford, P. E. J. (1999), *Trade and Traders: the making of the cattle market in Benin*, Amsterdam, Thela.

Raleigh, C., H. J. Choi and D. Kniveton (2015), "The devil is in the details: An investigation of the relationships between conflict, food price and climate across Africa", *Global Environmental Change*, Vol. 32, pp. 187-199.

Testa, A. C., M. N. Furtado and A. Alipour (2015), "Resilience of coastal transportation networks faced with extreme climatic events", *Transportation Research Record,* Vol. 2532/1, pp. 29-36.

Torreggiani, S. et al. (2018), "Identifying the community structure of the food-trade international multi-network", *Environmental Research Letters*, Vol. 13/5, 054026.

Valerio, V. C. (2024), "Unravelling West African livestock trader networks", *West African Papers*, No. 48, Sahel and West Africa Club, OECD Publishing, Paris.

Valerio, V. C. et al. (2020), "Network analysis of regional livestock trade in West Africa", *PloS One*, Vol. 15/5, e0232681.

Van Den Hoek, J. (2017), "Agricultural market activity and Boko Haram attacks in northeastern Nigeria", *West African Papers*, No. 9, OECD Publishing, Paris.

Walther, O. J. (2024), *Insecurity and Food Crises in the Sahel and in West Africa*, Food Crisis Prevention Network, Paris, 3-5 April 2024.

Walther, O. J., S.M. Radil and D. G. Russell (2024), "The Spatial Conflict Life Cycle in Africa", *Annals of the American Association of Geographers*, pp. 1-22.

Walther, O. J. and D. Retaillé (2021), "Mapping the Sahelian space", in *The Oxford Handbook of the African Sahel*, Oxford University Press.

Walther, O. J. et al. (2020), "Mapping travel time to assess accessibility in West Africa: The role of borders, checkpoints and road conditions", *Journal of Transport Geography*, Vol. 82, 102590.

Walther, O. J. (2015), "Business, brokers and borders: The structure of West African trade networks", *The Journal of Development Studies*, Vol. 51/5, pp. 603-620.

Walther, O. J., A. M. Howard and D. Retaillé (2015), "West African spatial patterns of economic activities: Combining the 'spatial factor' and 'mobile space' approaches", *African Studies*, Vol. 74/3, pp. 346-365.

Williams, T. O., B. Spycher and I. Okike (2006), Improving livestock marketing and intra-regional trade in West Africa: Determining appropriate economic incentives and policy framework. Nairobi, Kenya.

Zhang, Q. and B. Batinge, B (2021), "A social network analysis of the structure and evolution of intra-African trade", *African Development Review*, Vol. 33/1, 204-217.

WEST AFRICAN PAPERS

THE RESILIENCE OF AGRICULTURAL TRADE NETWORKS IN WEST AFRICA

Trade networks for agricultural products play an important role in agricultural development and regional integration in West Africa. However, mapping these networks is challenging due to the lack of a comprehensive analytical framework that supports evidence-based policymaking. This note represents a first attempt to integrate the spatial, social and temporal aspects that influence trade patterns in the region. The paper begins by examining how external shocks, such as border closures and pandemics, affect agricultural trade networks in West Africa and how these networks respond to such shocks. The paper then uses data on livestock movements, collected from 2013 to 2017 by the Permanent Interstate Committee for Drought Control in the Sahel (CILSS), to illustrate the benefits of spatialising trade networks over time. The paper argues that a more network-based approach to regional trade could help to identify specific places, routes and key actors that are particularly vulnerable to external shocks, and design place-based policies that would strengthen their resilience.