FONDATION POUR LES ÉTUDES ET RECHERCHES SUR LE DÉVELOPPEMENT INTERNATIONAL

LA FERDI EST UNE FONDATION RECONNUE D'UTILITÉ PUBLIQUE.
CETTE PUBLICATION A BÉNÉFICIÉ D'UNE AIDE DE L'ÉTAT FRANCAIS AU TITRE
DU PLAN D'INVESTISSEMENT FRANCE 2030 PORTANT LA RÉFÉRENCE ANR-16-IDEX-0001.

Mobile Connectivity: A Vector for Rural Transformations in the WAEMU?*

Joël Cariolle

Joël Cariolle, Research Officer, FERDI

Digitalisation presents a significant challenge for the development of rural areas in sub-Saharan Africa, where basic infrastructure and public services are often lacking, the financial sector is dysfunctional, insecurity is widespread, climatic conditions are often unfavourable, and farmers are geographically distant from agricultural markets (Aker & Mbiti, 2010; De Janvry & Sadoulet, 2022; Suri & Udry, 2022; Aker & Cariolle, 2023). These obstacles to development are particularly pronounced in rural communities of West African countries, which rely heavily on rain-fed agriculture and are increasingly vulnerable to climatic, geopolitical, and socio-political risks. These risks have negative repercussions on food security, agricultural commodity prices, and productivity (De Longueville, 2020; Sers & Mughal, 2020; Bouët et al., 2023; McGuirk & Nunn, 2023, 2024).

• • • / • • •

policy brief 273 October 2024 note brève

* This document was produced as part of the FERDI-WAEMU agreement (AS-3).

.../... Over the past two decades, feature phones have become widely accessible in the region, offering a unique combination of informational, communication, and financial tools in a simple and affordable device. This technological diffusion holds significant potential to transform agricultural markets and improve livelihoods, particularly in rural areas (Aker & Mbiti, 2010; Aker & Cariolle, 2023). As a communication tool, mobile phones enable users to access real-time information on agricultural prices, production conditions, farming techniques, and non-farm employment opportunities at minimal cost. Furthermore, with the advent of mobile money services, and more recently mobile banking, mobile phones have bridged the gap between formal financial institutions and unbanked households, providing a cost-effective, rapid, and efficient way to store, convert, and transfer money (Suri *et al.*, 2023).

While empirical studies on the impact of mobile technologies on agricultural productivity in African countries present mixed results (Abate *et al.*, 2023; Suri & Udry, 2023), the literature emphasizes the positive effect of mobile connectivity on price convergence for certain agricultural products. This convergence is attributed to improved spatial allocation, enhanced agricultural supply, and the strengthened bargaining power of farmers and traders, who are better informed thanks to mobile phones (Jensen, 2007; Svensson & Yanagizawa, 2009; Goyal, 2010; Aker, 2010; Tack & Aker, 2014; Aker & Fafchamps, 2015; Soldani *et al.*, 2023). However, demand-side mechanisms affecting food price dynamics have often been overlooked, despite evidence that digitalisation can improve rural household consumption, food security, financial inclusion, and access to off-farm employment opportunities (Jack & Suri, 2014; Nakasone & Torero, 2016; Suri *et al.*, 2023; Bahia *et al.*, 2021, 2024).

This raises the question: could the rural transformations facilitated by mobile connectivity in West Africa extend beyond family farms? This brief paper seeks to explore potential answers, drawing on the key findings of a study that analysed the economic transformations driven by the expansion of connectivity and the spread of mobile telephony within the WAEMU (Cariolle & Carroll, 2024).[1]

Results

Method

This study conducts a region-wide analysis of the impact of mobile connectivity and mobile technology adoption on food prices and the livelihoods of both urban and rural households within the West African Economic and Monetary Union (WAEMU). The analysis is based on data from the Harmonised Household Living Conditions Surveys (EHCVM-LSMS), collected in 2018-2019. The dataset includes information on 59,319 households and 146 food items, distributed across 4,983 enumeration areas (EAs) and 481 departments within the eight WAEMU Member States.

The empirical analysis is divided into three stages, employing several models to assess the effects of expanded mobile connectivity. First, the impact on the level and dispersion of prices for 146 food commodities traded across the WAEMU region is evaluated. Second, the study examines the role of food demand in driving price dynamics and household consumption levels of agricultural commodities, with a particular focus on rural areas. Third, the factors contributing to rising demand in rural areas—and consequently to price convergence—are explored. These include financial inclusion via mobile money and income diversification.

Figure 1 below illustrates the extent of mobile coverage in 2019, showing the distance of enu-

1. This is a report commissioned by the UEMOA Commission, entitled "Nouvelles dynamiques autour de l'économie numérique: La digitalisation au service des marchés et des ménages agricoles dans l'UEMOA", the results of which were summarised and expanded by Cariolle & Carroll (2024).

meration areas from the nearest 2G, 3G, or 4G (2G+) mobile antenna.

To address potential endogeneity biases—such as omitted variable bias and reverse causality between mobile connectivity and agricultural performance—we employ an instrumental variable (IV) approach, following the methods of Guriev *et al.* (2021) and Manacorda & Tesei (2020). This involves using an instrument based on the average exposure of the study areas to lightning strikes during the period 1998-2013 to predict network coverage in 2018-2019.

During the econometric estimations, we control for a range of factors including geographic and demographic characteristics of the study areas, local development conditions, household and farm characteristics, as well as their exposure to adverse shocks. Additionally, we incorporate fixed effects at the level of survey waves, food items, and reference geographical areas. These controls help account for unobservable heterogeneity and reduce the risk of omitted variable bias in our analysis.

Mobile connectivity and the convergence of food prices

This empirical study offers several key insights. First, improved mobile internet connectivity in enumeration areas (EAs) is found to facilitate the convergence of food prices, largely driven by higher prices in rural areas (Table 1). On average, food prices in EAs located within two kilometres of a network antenna are 10-12% higher than in EAs situated further away. This price effect is primarily due to a 15% average price increase in rural areas, while prices in urban areas remain unchanged.

At the departmental level, a 10% increase in network coverage is associated with a 5% reduction in the coefficient of variation for food prices. Interestingly, the magnitude of these effects aligns with findings from other studies in low-income countries, particularly in Africa (Jensen, 2007; Aker, 2010; Goyal, 2010; Soldani *et al.*, 2023).

Figure 1. Distance of enumeration areas from the nearest mobile network, WAEMU

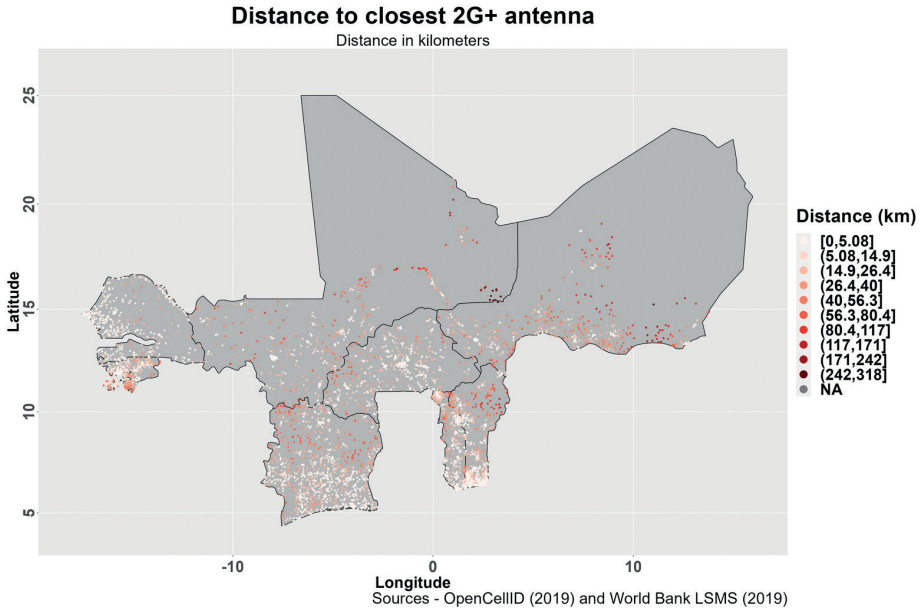

Table 1. Mobile Connectivity and Food Price Convergence in the WAEMU

	(1)	(2)	(3)
Dep. var. :	**Price (Ln, XOF)**		**CV price (%)**
Distance 2G+ <2km (0/1)	0.111***	0.152***	
	(0.035)	(0.039)	
Distance 2G+ <2km x urban (0/1)		-0.119***	
		(0.046)	
2G+ coverage (% dpt.)			-0.518**
			(0.205)
Control variables	Yes	Yes	Yes
EF Product department	Yes	Yes	No
EF Region-prod.	No	No	Yes
EF survey wave	Yes	Yes	Yes
Comments	129 670	129 670	19 399
AR F-stat	0.000802	3.84e-05	0.00598
KP Wald F-stat	47.24	23.78	41.82
LM-weak	31.70	37.73	41.51

Standard errors in brackets, robust to heteroscedasticity and grouped by district in columns (1) to (5), and by product region in column (6).

Mobile Connectivity and Household Food Demand

A second key finding of this study contrasts with previous work that has focused on improved agricultural supply allocation mechanisms or the enhanced bargaining power of informed farmers. Instead, the increase in total food demand within enumeration areas (EAs) is identified as the main driver of the observed price dynamics. At the household level, the estimates presented in Table 2 reveal that when a household acquires a mobile phone in an area covered by the mobile network, it significantly increases its food expenditure by 13%, with an even more pronounced effect in rural areas (+37.5%).

Additionally, mobile connectivity boosts both the quantities of food consumed and purchased, while reducing households' reliance on self-consumption. Connected households see a 20% increase in the quantities of food consumed and a 29% rise in food purchases, while the quantities self-consumed decrease by 9%. This effect is particularly strong for rural households, where food consumption and purchases increase by 41% and 61%, respectively, alongside a 19% drop in self-consumed quantities.

Mobile Connectivity, Financial Inclusion, and Income Diversification

Thirdly, the analysis shows that financial inclusion—facilitated by the adoption of mobile money accounts—partially explains the effect of mobile connectivity on household food demand, but not entirely (**Table 3**). Income diversification, through a relative increase in off-farm activities and non-farm entrepreneurship, also emerges as a key consequence of digitalisation, contributing to the rise in demand in rural areas (**Table 4**).

Table 2. Mobile Connectivity and Food Demand in the WAEMU.

	(1)	(2)	(3)	(4)	(5)	(6)
Dep. Var:	**Food expenditure/head (XOF, ln)**			**Quantity consumed (grams, ln)**		
		Urban	Rural		Urban	Rural
(A) Dist. 2G+ <2km (o/1) × # tel.	0.128***	0.110**	0.375***	0.196***	0.226***	0.406***
	(0.030)	(0.048)	(0.145)	(0.023)	(0.042)	(0.075)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
EF ZE	Yes	Yes	Yes	Yes	Yes	Yes
EF survey wave	Yes	Yes	Yes	Yes	Yes	Yes
Comments	56 817	23 220	33 597	950 458	480 658	469 374
AR F-test (p-val.)	1.22e-05	0.0321	7.03e-05	0	4.07e-07	0
KP Wald F-stat	102.2	47.68	12.13	323.4	153.1	59.07
KP rank LM-stat	67.63	21.33	9.804	212	91	47.33

Standard errors in brackets, robust to heteroskedasticity and grouped by household. * p < 0.1, ** p < 0.05, *** p < 0.01. First-stage statistics robust to heteroskedasticity and clustering. Control variables additively include, among others, number of mobile phones and Internet access.

Finally, additional findings by Cariolle and Carroll (2024) suggest that the relationships observed become less robust when examining the impact of household internet access on agricultural markets and food consumption. The changes observed are more strongly linked to access to basic mobile services (calls, SMS, mobile money) than to internet services, which remain limited in rural areas.

Conclusion

The proposed analysis provides an original and coherent perspective on the rural transformations driven by the expansion of mobile connectivity in West Africa. It demonstrates that connectivity reduces food price dispersion by enabling price catch-up in rural areas. While this finding of price convergence for agricultural commodities aligns with the conclusions of previous studies conducted on a smaller scale or focused on specific agricultural products (Jensen, 2007; Aker, 2010; Goyal, 2010; Aker & Fafchamps, 2015; Soldani *et al.*, 2023), this study uniquely emphasizes the role of rural consumption in explaining the spatial convergence of prices across a broad range of foodstuffs.

Supporting this result, the analysis shows that mobile connectivity leads to increased food demand among connected rural households, while simultaneously reducing their reliance on self-consumption. Furthermore, income diversification through off-farm activities and non-farm entrepreneurship, along with financial inclusion via mobile money, emerge as key factors explaining the observed price convergence.

As a result, the analysis highlights the importance of ongoing efforts to expand network coverage and enhance its quality, while also promoting the digital absorption capacity of households, particularly in rural areas. Although

Table 3. Mobile Money and Food Expenditure

	(1)	(2)	(3)	(4)
Dep var: expenditure on food/head (XOF, ln)			Urban	Rural
Dist. 2G+ <2km (0/1) × # tel.		0.097***	0.095**	0.318**
		(0.029)	(0.048)	(0.144)
Dist. 2G+ <2km (0/1) × MM	0.212***	0.174**	0.063	0.320*
	(0.067)	(0.068)	(0.105)	(0.185)
Controls	Yes	Yes	Yes	Yes
EF ZE	Yes	Yes	Yes	Yes
EF survey wave	Yes	Yes	Yes	Yes
Comments	56 188	56 188	22 988	33 200
AR F-test (p-val.)	0.00103	1.89e-05	0.127	9.06e-05
KP Wald F-stat	108.8	50.02	24.52	5.461
KP rank LM-stat	69.61	66.16	21.58	8.814

Standard errors in brackets, robust to heteroskedasticity and grouped by household. * p < 0.1, ** p < 0.05, *** p < 0.01. First-stage statistics robust to heteroskedasticity and clustering. Control variables additively include, among others, the number of mobile phones, ownership of a mobile money account, and Internet access.

the findings point to an overall positive impact on the functioning of food markets and the livelihoods of rural populations, they also raise concerns about the risk of impoverishment for digitally excluded households, who may face rising food prices in connected areas. Thus, both the lack of digital usage and the absence of connectivity could contribute to widening spatial and economic inequalities in the region.

References

- **Abate G. T., Abay K. A., Chamberlin J., Kassim Y., Spielman D. J., Tabe-Ojong M. P. J.** (2023a) "Digital tools and agricultural market transformation in Africa: Why are they not at scale yet, and what will it take to get there?" *Food Policy*, vol. 116, 102439.
- **Aker J. C.** (2010) "Information from Markets Near and Far: Mobile Phones and Agricultural Markets in Niger", *American Economic Journal: Applied Economics*, vol. 2 (issue 3), pp. 46-59. DOI: 10.1257/app.2.3.46.
- **Aker J., Cariolle J.** (2023) *Mobile Phones and Development in Africa: Does the Evidence Meet the Hype*? Palgrave Studies in Agricultural Economics and Food Policy Series, Palgrave MacMillan, Springer Nature.
- **Aker J. C., Fafchamps M.** (2015) "Mobile phone coverage and producer markets: Evidence from West Africa", *The World Bank Economic Review*, vol. 29 (issue 2), pp. 262-292.
- **Aker J. C., Mbiti I. M.** (2010) 'Mobile phones and economic development in Africa', *Journal of Economic Perspectives*, vol. 24 (issue 3), pp. 207-32. DOI: 10.1257/jep.24.3.207.
- **Bahia K., Castells P., Cruz G., Masaki T., Rodriguez-Castelan C., Sanfelice V.** (2021) "Mobile broadband Internet, poverty and labor outcomes in Tanzania", World Bank *Policy Research Working Paper* 9749.
- **Bahia K., Castells P., Cruz G., Masaki T., Pedrós X., Pfutze T., [...] Winkler H.** (2024) "The welfare

Table 4. Mobile Connectivity, Off-Farm Income and Non-Farm Entrepreneurship

Var dep.:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	of household earning off-farm income			of household earning income from the farm			# of non-agricultural businesses in the household		
		Urban	Rural		Urban	Rural		Urban	Rural
Dist. 2G+ <2km (0/1) × # tel.	0.089***	0.081***	0.271***	0.056***	0.026	0.169**	0.113**	0.096	0.266*
	(0.019)	(0.030)	(0.105)	(0.015)	(0.027)	(0.068)	(0.045)	(0.111)	(0.148)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
EF ZE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
EF wave	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Comments	56,814	23,217	33,597	56,814	23,217	33,597	56,814	23,217	33,597
AR F-test (p-val.)	5.1e-07	0.00484	5.0e-06	0.00024	0.363	0.00055	5.1e-07	0.00484	5.0e-06
KP Wald F-stat	99.65	47.46	11.54	99.65	47.46	11.54	99.65	47.46	11.54
KP rank LM-stat	65.47	21.16	9.357	65.47	21.16	9.357	65.47	21.16	9.357

Standard errors in brackets, robust to heteroskedasticity and grouped by household. * p < 0.1, ** p < 0.05, *** p < 0.01. First-stage statistics robust to heteroskedasticity and clustering. Control variables additively include, among others, number of mobile phones and Internet access.

effects of mobile broadband Internet: Evidence from Nigeria", *Journal of Development Economics*, 103314.

- **Bouët A., Laborde Debucquet D., Traoré F.** (2023) "West Africa faces mixed food security impacts from the Russia-Ukraine conflict", in Glauber J., Laborde D. (eds) *The Russia-Ukraine Conflict and Global Food Security*, chap. 29, pp. 150-153.
- **Cariolle J., Carroll II D. A.** (2024) "From Phone Access to Food Markets: Is Mobile Connectivity Transforming West-African Livelihoods?", FERDI *Working Paper* P341.
- **De Janvry A., Sadoulet E.** (2022) "The Puzzle of Lagging Sub-Saharan Africa Agriculture: Toward a Theory of Connectedness", in *Modern Agricultural and Resource Economics and Policy: Essays in Honor of Gordon Rausser*, Cham, Springer International Publishing, pp. 279-297.
- **De Longueville F., Ozer P., Gemenne F., Henry S., Mertz O., Nielsen, J. Ø.** (2020) "Comparing climate change perceptions and meteorological data in rural West Africa to improve the understanding of household decisions to migrate", *Climatic Change*, vol. 160, pp. 123-141.

Goyal A. (2010) "Information, direct access to farmers, and rural market performance in central India", *American Economic Journal: Applied Economics*, vol. 2 (issue 3), pp. 22-45.

- **Guriev S., Melnikov N., Zhuravskaya E.** (2021) "3g Internet and confidence in government", *The Quarterly Journal of Economics*, vol. 136 (issue 4), pp. 2533-2613.
- **Jack W., Suri T.** (2014) "Risk sharing and transactions costs: Evidence from Kenya's mobile money revolution", *American Economic Review*, vol. 104 (issue 1), pp. 183-223.
- **Jensen R.** (2007) "The digital provide: Information (technology), market performance, and welfare in the South Indian fisheries sector", *The Quarterly Journal of Economics*, vol. 122 (issue 3), pp. 879-924.
- **Manacorda M., Tesei A.** (2020) "Liberation technology: Mobile phones and political mobi-

lization in Africa", *Econometrica*, vol. 88 (issue 2), pp. 533-567.
• **Masaki T., Ochoa R., Rodríguez-Castelán C.** (2020) "Broadband Internet and household welfare in Senegal", World Bank *Policy Research Working Paper* 9386.
• **McGuirk E. F., Nunn N.** (2023) "Development Mismatch: Evidence from Agricultural Projects in Pastoral Africa".
• **McGuirk E. F., Nunn N.** (2024) "Transhumant pastoralism, climate change, and conflict in Africa", *Review of Economics Studies*, [forthcoming]. Nakasone E., Torero M. (2016) "A text message away: ICTs as a tool to improve food security", *Agricultural Economics*, vol. 47 (suppl.), pp. 49-59.
• **Sers C. F., Mughal M.** (2020) "Covid-19 outbreak and the need for rice self-sufficiency in West Africa", *World Development*, vol. 135, 105071.
• **Soldani E., Hildebrandt N., Nyarko Y., Romagnoli G.** (2023) "Price information, inter-village networks, and "bargaining spillovers": Experimental evidence from Ghana", *Journal of Development Economics*, 103100.
• **Suri T., Udry C.** (2022) "Agricultural technology in Africa", *Journal of Economic Perspectives*, vol. 36 (issue 1), pp. 33-56.
• **Suri T., Aker J. C., Batista C., Callen M., Ghani T., Jack W., Klapper L., Riley E., Schaner S., Sukhtankar S.** (2023) "Mobile money", *VoxDevLit*, vol. 2 (issue 2), p. 3.
• **Svensson J., Yanagizawa D.** (2009) "Getting prices right: the impact of the market information service in Uganda", *Journal of the European Economic Association*, vol. 7 (issue 2-3), pp. 435-445.
• **Tack J., Aker J. C.** (2014) "Information, mobile telephony, and traders' search behavior in Niger", *American Journal of Agricultural Economics*, vol. 96 (issue 5), pp. 1439-1454.

FERDI

Created in 2003 , the **Fondation pour les études et recherches sur le développement international** aims to promote a fuller understanding of international economic development and the factors that influence it.

Contact
www.ferdi.fr
contact@ferdi.fr
+33 (0)4 43 97 64 60

n° ISSN : 2275-5055

Publication director: Patrick Guillaumont

policy brief 273 October 2024 note brève