

Economic Impacts of Submarine Fiber Optic Cables and Broadband Connectivity in Nigeria

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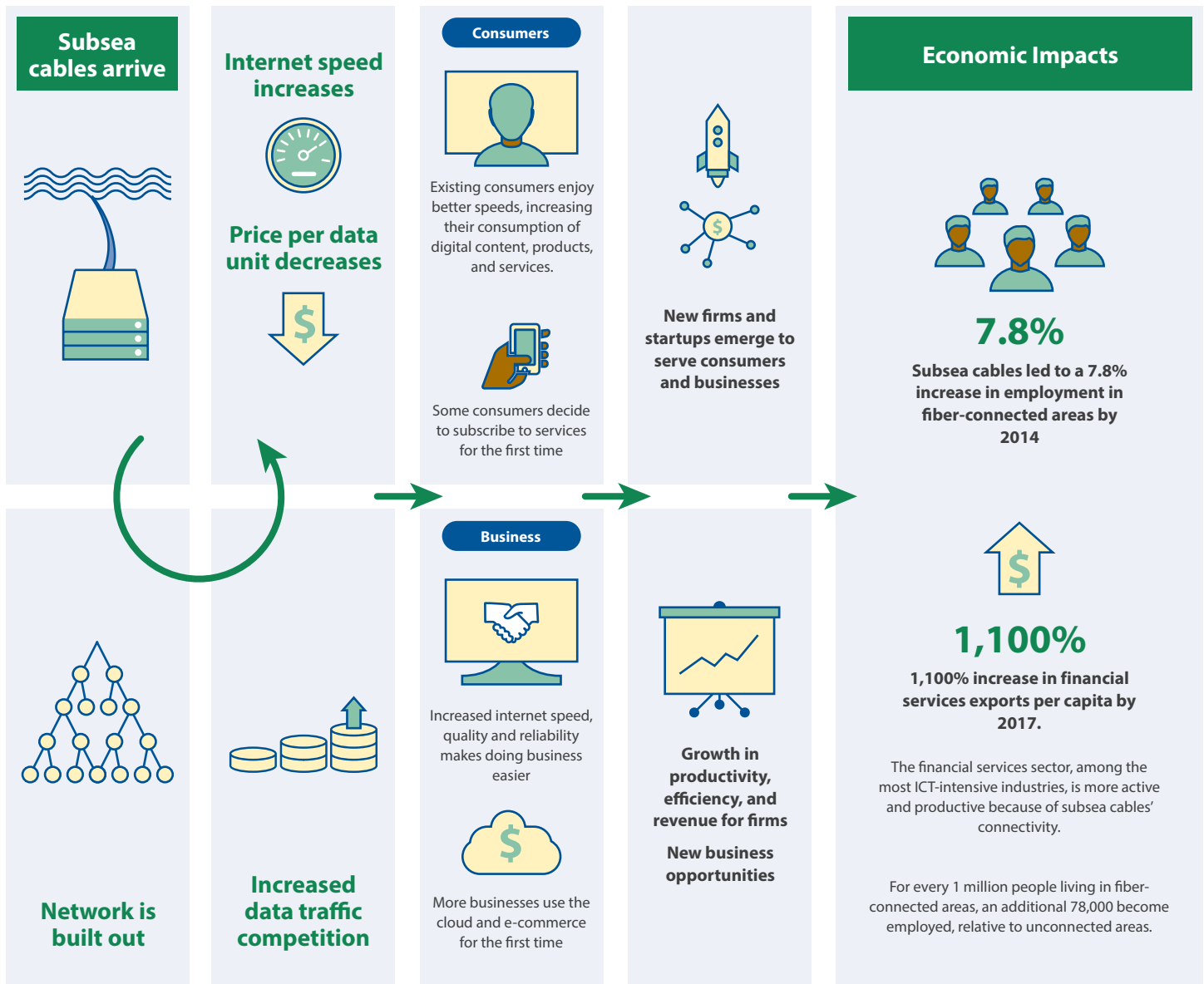


Economic Impacts of Submarine Fiber Optic Cables and Broadband Connectivity in Nigeria

HOW DO SUBSEA CABLES GENERATE ECONOMIC IMPACT?

Subsea cables are the global backbone of the Internet, connecting people, businesses, and economies around the world. They connect us to the cloud, deliver streaming video, and increase efficiency and productivity for business. Subsea cables' importance is all the more apparent during the Covid19 pandemic when many of us have switched to working from home, remote learning, and online gaming and entertainment.

We studied the economic impacts from subsea cables that arrived in Nigeria (e.g., WACS) to understand how they changed the economy. Improved connectivity led to increases in internet usage and decreases in costs, but infrastructure and affordability challenges meant that impacts were limited to select urban areas. Our results signal the promise connectivity improvements could have in other parts of the country.



Unfortunately, we didn't detect any impacts on employment or GDP beyond fiber-connected areas. Nigeria suffers from a fragmented network infrastructure (and underdeveloped infrastructure overall). Subsea cables land in Lagos, and bandwidth begins to fall off quickly thereafter. Experts interviewed for this work note that network operators face a high-cost, high-risk environment that presents strong disincentives to network expansion. The new national broadband strategy has good ideas for addressing the country's challenges, but the plan from 2015 went unimplemented and there are concerns that the same fate could befall the one from 2020.

Download the full report at rti.org/subsea-cables-africa

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1. Overview

This study explores the economic impact of the international data connectivity delivered by submarine fiber optic cables (“subsea cables”) on Nigeria. Subsea cables are the global backbone of the internet, connecting people, businesses, and economies around the world (Figure 1).^{1,2}

The importance of connectivity to economic growth is well-established—and further underscored by our collective experience during the COVID-19 pandemic—but rigorous studies have not been conducted for many countries.^{3,4,5} This study is one in a series our team prepared about how improvements in international data connectivity have generated economic growth for countries in Africa.⁶ We focus in particular on recent cable landings, such as Africa Coast to Europe and West African Cable System.

In brief, we found that subsea cables have increased the likelihood of being employed by 7.8% in areas connected to Nigeria’s terrestrial fiber infrastructure (Table 1). This means that for each 1 million people living in these areas, 78,000 additional people tend to become employed, after controlling for such things as technology trends, population

characteristics, industries, and other important factors.

We also found signals that firms in connected areas are experiencing positive outcomes by leveraging the internet for business. For example, the financial services sector, generally one of the most ICT-intensive sectors, saw its exports increase 1,100% by 2017. Thus, the economic development reward for solving the connectivity challenges is significant.

Unfortunately, we didn’t detect any impacts on employment or GDP beyond fiber-connected areas. Nigeria suffers from a fragmented network infrastructure (and underdeveloped infrastructure overall). Subsea cables land in Lagos, and bandwidth begins to fall off quickly thereafter.⁷

Experts interviewed for this work note that network operators face a high-cost, high-risk environment that presents strong disincentives to network expansion. The new national broadband strategy has good ideas for addressing the country’s challenges, but the plan from 2015 went unimplemented and there are concerns that the same fate could befall the one from 2020.

Table 1. Key Takeaways: The Economic Impact of Subsea Cables on Nigeria

INDICATOR	TIME PERIOD	OUTCOME
Employment	2008—2013	7.8 increase in likelihood of being employed in fiber-connected areas For every 1 million people living in connected areas, an additional 78,000 become employed, relative to unconnected areas
Economic growth	2010—2017	1,100% increase in financial services exports per capita The financial services sector, among the most ICT-intensive industries, is more active and productive because of subsea cables’ connectivity. The impact is equivalent to a 1,100% increase in exports

Source: Authors’ estimates.

1 Clark, K. 2019. *Submarine Telecoms Industry Report, 7th Edition*. Submarine Telecoms Forum.

2 Brake, D. 2019. *Submarine Cables: Critical Infrastructure for Global Communications*. Information and Technology Foundation.

3 Hjort, J, Poulsen, J. 2019. The Arrival of Fast Internet and Employment in Africa. *American Economic Review*, 109(3): 1032-1079.

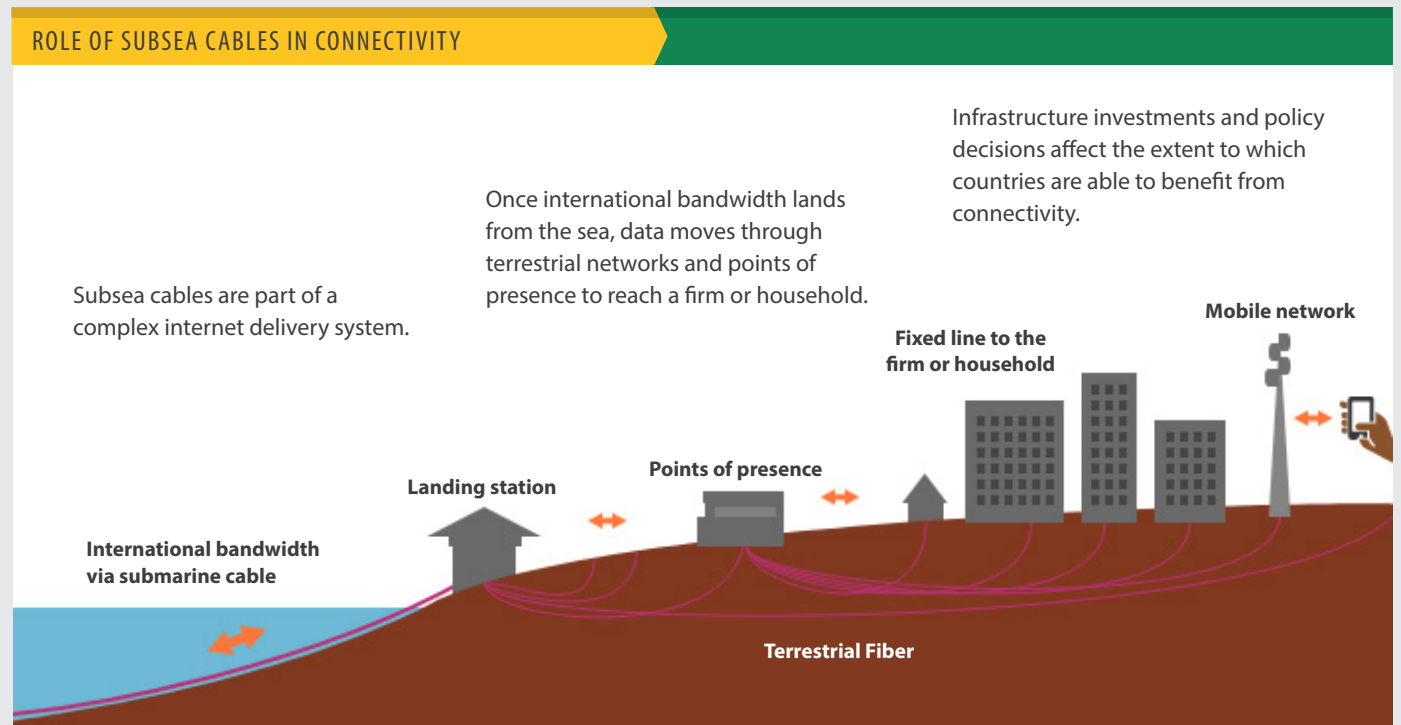
4 Minges, M. 2015. Exploring the Relationship between Broadband and Economic Growth. WDR 2016 Background Paper; World Bank, Washington, DC.

5 Khalil, M., Dongier, P., & Zhen-Wei Qiang, C. 2009. *Information and Communications for Development: Extending Reach and Increasing Impact*. World Bank.

6 Other countries included in this series are the Democratic Republic of Congo, Kenya, Mozambique, South Africa, and Tanzania.

7 In the country’s absence of a National Backbone Network private operators have built transmission infrastructure, microwave radio, terrestrial fiber and satellite links with which they carry (primarily) their own traffic. Theoretically this infrastructure could comprise a national backbone. In reality however, the vast, competing and disorganized collection of operators, service providers and contractors do not provide a viable means to use this infrastructure effectively.

Figure 1. Role of Subsea Cables in Internet Connectivity



2. Nigeria Country Profile

Nigeria is Africa’s most populous country with about 200 million people, half of whom live in rural areas.⁸ The International Telecommunications Union (ITU) estimates that, unfortunately, only about 42% of the population has access to the internet. Access is highly concentrated in Lagos and other major cities.

Nigeria is a country of extremes. It also has the largest economy on the continent. In 2019, its gross domestic product—the most common measure of the total value of all goods and services produced by a country — was \$448 billion (nominal terms), but the national wealth is concentrated in a small urban elite. Overall, there is high poverty, low literacy, and low educational attainment. See also Table 2.

A distinguishing feature of the economy is that Nigeria is the largest exporter of crude petroleum in Africa.⁹ Agriculture and services are also important sectors, together contributing nearly half of the country’s GDP (approximately 25% each).¹⁰ Informal work in Nigeria is common. The IMF estimates that between 2010 and 2014 the size of the informal economy was equivalent in magnitude to roughly 65% of official GDP.¹¹

Nigeria’s economy is also marked by dynamism and creative production. For example, the country is home to “Nollywood”, one of the world’s largest entertainment sectors, that took root over 20 years ago. Nollywood contributed 2.3% to the country’s GDP in 2016 and has been identified as a target growth sector.¹² A country of extremes indeed.

⁸ World Bank Group. 2019. World Development Indicators.

⁹ Simoes, AJG and CA Hidalgo. 2011. The Economic Complexity Observatory: An Analytical Tool for Understanding the Dynamics of Economic Development. Workshops at the Twenty-Fifth AAAI Conference on Artificial Intelligence. Data retrieved December 2019. <https://oec.world/en/profile/hs92/2709/>.

¹⁰ National Bureau of Statistics. 2019. NBS E-Library. Available at <https://nigerianstat.gov.ng/elibrary>.

¹¹ International Monetary Fund. 2017. *Regional Economic Outlook: Sub-Saharan Africa, Restarting the Growth Engine*. Washington D.C.: International Monetary Fund.

¹² PricewaterhouseCoopers. 2017. Spotlight: *The Nigerian Film Industry*. Available at <https://www.pwc.com/ng/en/assets/pdf/spolight-the-nigerian-film-industry.pdf>.

Table 2. Key Indicators for Nigeria's Population and Economy

INDICATOR	VALUE	YEAR	
Population	201 million people	2017	
Literacy Rate	62% of population aged 15+	2017	
Primary education completing rate	60% of population aged 25+	2015	
Poverty rate	54 % of population below World Bank poverty line of 1.90 USD PPP/day	2014	
GDP, nominal	• Total • Per capita	448.1 billion USD 2,230 USD	2019
GDP, purchasing power parity	• Total • Per capita	1,006 billion (2011 USD PPP) 5,027 (2011 USD PPP)	2017
GDP, NGN	145.6 trillion	2017	
Unemployment	6% of labor force	2018	

Sources: Penn World Table and The World Bank.

Another way to look at Nigeria's GDP is to take into consideration purchasing power parity (PPP). PPP accounts for differing price levels for comparable expenditure categories between countries. By applying PPP one can assess, both between countries and over time, real year-on-year changes and economic trends based on actual living standards.

Through the lens of PPP, Nigeria's economy is the equivalent of \$1 trillion (2011 USD) with a per capita GDP of \$5,027. Later, we will use the PPP method of quantifying the Nigerian economy to generate our results, enabling impacts to be interpreted directly as improvements in living standards.

Nigeria hosts all its active subsea landings in Lagos (see Table 3). Globacom is planning to commission Globacom-2 (Glo-2) in Q2 2020, which will connect the cities of Bonny, Kwa Ibo, and Lagos with a capacity of 12 Tbps (GloWorld).¹³ Thus there will be some diversification away from Lagos.

New international cables are expected. A consortium of partners led by Facebook announced they will land a cable in Nigeria, 2Africa. Google also announced its intention to run a cable between South Africa and Portugal that will also land in Nigeria. See Figure 2.

Table 3. Subsea Cables Landing in Nigeria

CABLE	DESIGN CAPACITY (TBPS)	LOCAL LANDING STATION(S)	READY FOR SERVICE YEAR
Africa Coast to Europe (ACE)	12.8	Lagos	2013
Globacom-1 (Glo-1)	12.8	Lagos	2010
MainOne Cable	28.8	Lagos	2010
Nigeria-Cameroon Cable System (NCSCS)	15.36	Lagos	2015
South Atlantic 3	54	Lagos	2002
West Africa Cable System (WACS)	55	Lagos	2012
2Africa (announced)	180	Lagos	2023
Equiano (announced)	100	Lagos	2021
Globacom-2 (Glo-2) (announced)	225	Lagos, Bonny, and Kwa Ibo	2021

Source: Telegeography's Submarine Cable Map and STF Analytics' Submarine Cable Almanac.

¹³ Glo (2018): 'Glo plans new submarine cable to boost telecom services in Nigeria', Globacom, Lagos, <https://www.gloworld.com/ng/latest-news/glo-plans-new-submarine-cable-to-boost-telecom-services-in-nigeria/>

3. Analysis Approach

We analyzed the economic impacts of subsea cables by pairing rigorous economic analysis approaches with interviews with experts in Nigerian internet connectivity. In doing so, not only were we able to understand the impacts of past improvements in connectivity, but also the implications of (and barriers and facilitators to) improvements in connectivity going forward. This section offers a high-level description of our approaches.¹⁴

Note: Because terrestrial fiber and wireless networks connect users to subsea cables' landing stations, we include them in the analysis. However, we emphasize that the impacts quantified are for the international connectivity associated with subsea cables and not domestic connectivity. Increasingly, nationally hosted internet exchanges, local content delivery networks, and data centers are bringing data resources on shore. Despite this trend, for many emerging economies such as Nigeria, the vast majority of cloud services and data resources accessed domestically are stored abroad. This makes international connectivity critical.

3.1 ECONOMETRIC ANALYSES

We employed two complementary econometric methods: difference-in-differences (DID) and synthetic control (SC). Of all available econometric methods and strategies, these two methods offer the most robust, reliable, and accurate way to estimate causal effects in the context of subsea cables. Each one is derived from cutting-edge statistical techniques^{15,16,17} and have been used to investigate research questions similar to those posed by our analysis.^{18,19}

3.1.1 Difference-in-Differences (DID)

DID estimates the causal impact of subsea cables on employment and firm-level outcomes. It consists of identifying the impacts associated with a specific intervention or treatment over a period of time. In this analysis, international data connectivity via subsea cables is the intervention. The impact ("treatment effect") is identified by comparing the difference

¹⁴ A detailed technical addendum accompanies this report.

¹⁵ Athey, S., Imbens, G. W. 2017. The State of Applied Econometrics: Causality and Policy Evaluation. *Journal of Economic Perspectives*, 31(2): 3-32.

¹⁶ Baum-Snow, N, Ferreira, F. 2017. Causal Inference in Urban and Regional Economics. National Bureau of Economic Research (NBER) Working Paper Series. Working Paper 20535.

¹⁷ Imbens, G. W., & Wooldridge, J. M. 2009. Recent developments in the econometrics of program evaluation. *Journal of Economic Literature*, 47(1), 5-86.

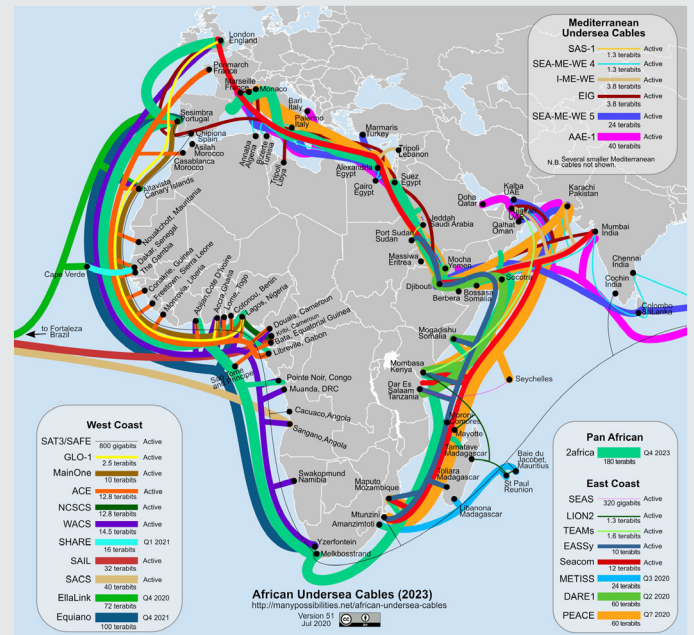
¹⁸ Hjort, J, Poulsen, J. 2019. The Arrival of Fast Internet and Employment in Africa. *American Economic Review*, 109(3): 1032-1079.

¹⁹ Abadie, A., Diamond, A., Hainmueller, J. 2010. Synthetic control methods for comparative case studies: Estimating the effect of California's tobacco control program. *Journal of the American Statistical Association*, 105.490 (2010): 493-505.

²⁰ We use the baseline terrestrial fiber to assign treatment to avoid upward biasing the estimates. Note that the expansion of terrestrial fiber between baseline and endline only makes the estimates more conservative.

²¹ U.S. Agency for International Development. Demographic and Health Surveys. See <https://dhsprogram.com/Data/>.

Figure 2. African Undersea Cables

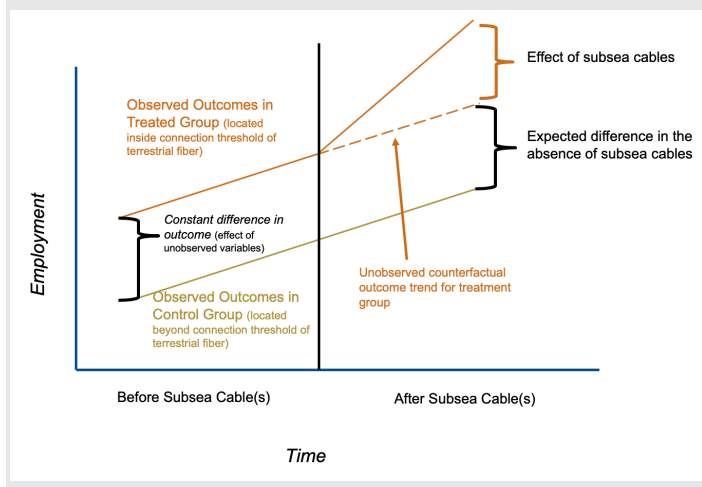


Source: Song, S. (Many Possibilities). 2020. African Undersea Cables (2023).

in outcomes before and after the intervention for the group exposed to the intervention ("the treatment group") to the same difference for the unexposed ("the control group"). In our approach, assignment to the treatment group is based on close proximity to terrestrial fiber in the base period.²⁰ Being located near terrestrial fiber is a key factor that would enable individuals/firms to access the benefits of subsea cables. Because DID estimation is based on the differences in the changes that occurred between the two groups pre- and post-subsea cables, the technique inherently controls for many time-invariant factors such as age and gender. See Figure 3.

The data on individuals for our analysis of employment comes from the United States Agency for International Development's (USAID) Demographic and Health Surveys (DHS),²¹ which asks individuals about their employment status and type of occupation. The data on firms for our

Figure 3. Difference in Differences Technique for Analysis of the Impact of Subsea Cables



analysis of firm outcomes comes from the World Bank’s Enterprise Surveys (WBES).²² The DHS data are geocoded, which enabled greater precision in our econometric approach than the less spatially explicit WBES data (identifies the location of firms down to the city level).

Using the DHS data, we were able to compare changes in employment outcomes (before and after subsea cables) for individuals located within a few hundred meters of the terrestrial fiber to the same changes for individuals located just beyond this distance but still located within 10 kilometers of the fiber. Excluding individuals located farther than a few kilometers from terrestrial fiber and focusing on changes between groups located just on either side of a narrow margin produces a control group with high comparability to the treatment group. The resulting groups are similar in terms of both demographic and geographic characteristics, and they would arguably be subject to the same shocks (i.e. there would not be an event that affected a majority of one group but not the other) with the exception of subsea cables. Essentially, the only aspect differentiating individuals in the treatment group from members of the control group is that individuals in the treatment group may have much greater potential to access (or benefit from) high-speed internet after subsea cables arrive. Applying DID in this way enables us to tease out the effect of subsea cables from various potential confounding factors such as distance to other infrastructure and arguably any other shocks that may affect employment

status, in addition to time invariant characteristics (which are inherently controlled for in DID).²³

Because the firm-level data from WBES are spatially aggregated at the city level, we were unable to achieve the same level of specificity in our construction of the treatment and control groups for the DID approach. For example, with a small number of cities, within which all firms are either assigned to the treatment or the control group (based on whether the city is connected to the terrestrial fiber in the baseline period), it is conceivable that an event unrelated to the arrival of subsea cables affected the outcomes of a large share of firms in one group but not the other (e.g. municipal policy changes). Therefore, we regard the impacts on firms using our DID approach as suggestive.

3.1.2 Synthetic Control (SC)

SC estimates the impact of subsea cables on economic outcomes by comparing Nigeria’s actual outcomes after subsea cable arrivals to a model of Nigeria in which the cables did not arrive but for which all other prevailing economic trends continued. This latter version of Nigeria is referred to as a synthetic counterfactual.

The synthetic counterfactual is a weighted combination of similar countries which did not receive subsea cable landings during the time period of interest and that is calibrated to Nigeria’s pre-arrival state. We use a weighted combination of multiple countries because the resulting counterfactual is more like Nigeria across a variety of important and relevant dimensions than any single comparison country alone. Key dimensions include GDP per capita, labor composition by industry sector, and the proportion of people living in urban areas, for example.

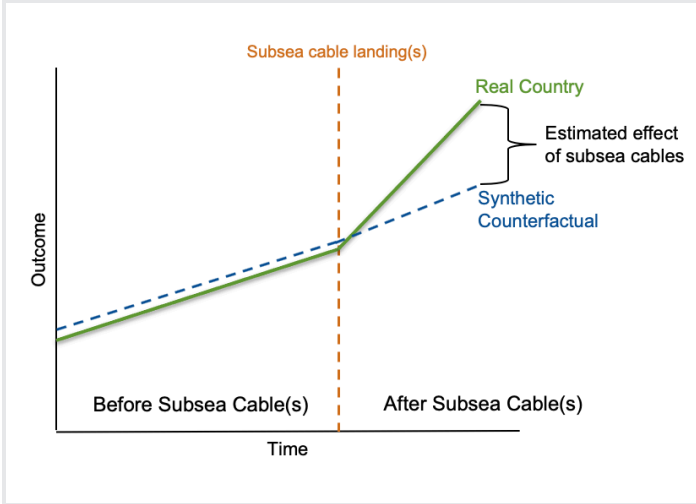
The construction of the counterfactual is completely computationally driven and optimizes the fit of the counterfactual based on the countries’ actual data. Importantly, the counterfactual can be tested for its robustness and reliability, which helps assess confidence in each set of results. See Figure 4.

Data are sourced from the Penn World Table (PWT)²⁴ and the World Bank’s World Development Indicators (WDI).²⁵ These sources acquire national statistics from officially recognized sources and standardize them using well-documented

²² World Bank Group. 2019. Enterprise Surveys. See <https://www.enterprisesurveys.org/>.

²³ Many things affect employment status, but factors that would bias the DID estimates are events that occurred between the baseline and endline surveys that differentially affected the outcomes of the two groups. Based on the method of treatment assignment, it is highly unlikely that an event systematically affecting employment outcomes for one group but not the other occurred between the two periods, besides the addition of subsea cables.

Figure 4. Synthetic Control Technique for Analysis of Subsea Cables



methodologies. Importantly, the rigor, standardization, and quality control used by PWT and WDI enable cross-country comparisons over time. This means that we have a high degree confidence in the ability (and accuracy) of SC to match on a variety of important macroeconomic characteristics and outcomes.

The estimated effects using DID and SC provide complementary insights due to their similarities and differences across different dimensions, as described in Table 4. By applying two econometric methods, as well as qualitative interviews, our research sheds insight into various aspects of economic impact caused by subsea cable landings.

3.2 THEMATIC ANALYSIS OF INTERVIEWS WITH KEY STAKEHOLDERS

We interviewed 10 Nigerian broadband connectivity experts representing telecommunications operators, government agencies, and related stakeholders. Interview topics included current connectivity trends and challenges (e.g., network expansion, latency, affordability), public-sector priorities driving network expansion, role of subsea cables in the broader landscape of connectivity and internet quality, role of connectivity in economic development, and future trends and issues. So that interviewees could be open and candid, we advised that participation could be confidential, that we would not attribute responses to individuals, and that only the synthesized remarks of all interviewees would be presented in our reports.

Table 4. Similarities and Differences of Econometric Analysis Strategies

IMPACT DIMENSION		DIFFERENCE IN DIFFERENCES	SYNTHETIC CONTROL
Treatment	Subsea cables (explicitly)	●	●
Temporality	Discrete point-in-time impacts	●	●
Outcome	Employment	●	●
	Economic growth	●	●
Space	Spatially-specific impacts (specific to fiber-connected areas)	●	
	Spatially-inspecific impacts (at the country-level)		●
Data aggregation	Microdata geocoded to identify individuals/firms in fiber-connected/unconnected areas within countries	●	
	Macrodata on countries (national statistics)		●

24 Feenstra, R. C., Inklaar, R., Timmer, M. 2015. The Next Generation of the Penn World Table. *American Economic Review*, 105(10), 3150-3182.

25 World Bank Group. 2019 World Development Indicators. See <https://databank.worldbank.org/source/world-development-indicators>.

4. Economic Impacts of Subsea Cable Landings

Our analyses found that subsea cables have generated positive impacts in areas with good broadband infrastructure. In fiber-connected areas, we found a 7.8% impact on employment. There was more limited evidence of positive effects on specific industries and firms. Nationally, however, we could not identify any impacts subsea cables could be having on employment or GDP growth. This is likely because most of the country lacks broadband infrastructure and internet usage is less than 50%.

The section below describes our economic analysis results. Section 5 presents expert consensus on the findings below as well as barriers and facilitators to Nigeria's ability to derive further development value from international data connectivity in the future.

4.1 IMPACTS TO DATE

Subsea cable arrivals have caused significant increases in employment in areas connected to terrestrial fiber, which has benefited places like Lagos and Abuja. We looked specifically at differences between people who live within a few hundred meters of fiber (the average connectivity radius) and people who live within 10 km. This tight comparison helps us control for regional disparities and other issues.

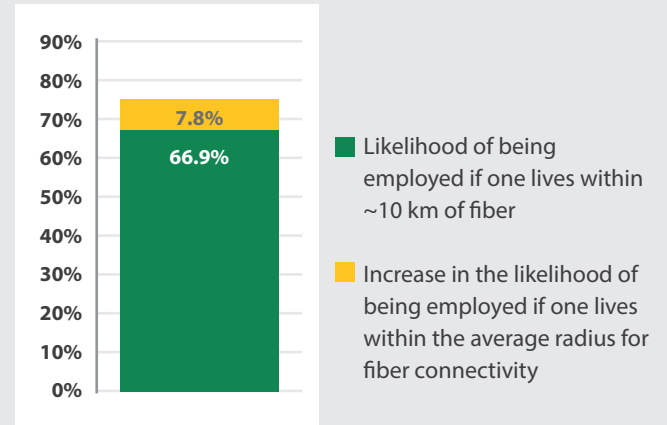
The likelihood of being employed was 7.8% greater for people living in the connectivity radius (Figure 5). This means that for each 1 million people living in an area that is or becomes fiber-connected, 78,000 additional people tend to be or become employed.

We also found signals of positive impacts on firms, although the results were not conclusive. We noticed that firms in connected areas tended to have more employees, were more likely to offer training to them, had more revenues and exports per employees, were more likely to use email for business and were more likely to use websites to conduct business. Effects likely vary among different types of firms.²⁶

These results imply that subsea cables contribute to the creation of higher-quality, more-productive jobs for the average firm in a connected area. This is consistent with other evidence that indicates increases in skilled jobs and increased economic activity and growth in certain business sectors.

²⁶ Unfortunately, the high degree of geographic clustering in the WBES sample prevented us from further disaggregating our analysis to examine how effects on firm-level outcomes varied by industry or other characteristics of the business.

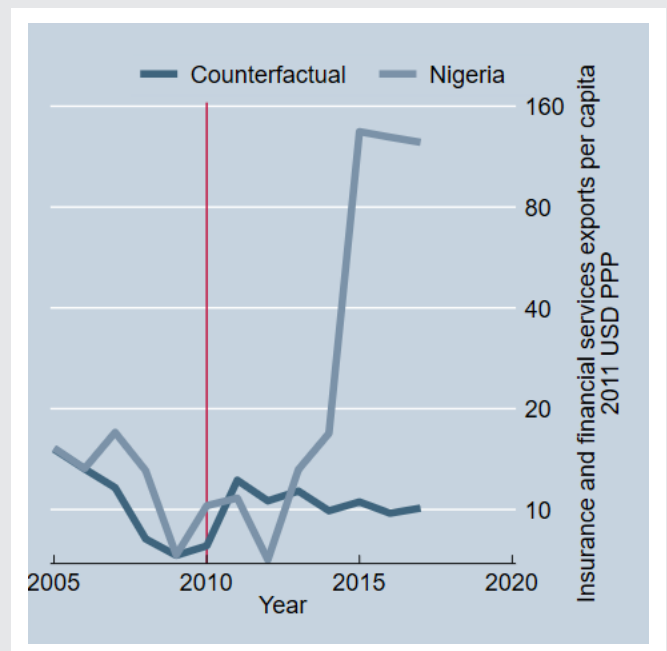
Figure 5. Impact of Subsea Cables on Employment Among Working Age Individuals in Areas Near Terrestrial Fiber



Source: Authors' estimates.

At the national level, we found evidence of increases in financial services exports caused by the arrival of subsea cables from 2010 to 2016 (e.g., MainOne, WACS, ACE). Figure 6 shows the divergence of Nigeria from the estimated synthetic counterfactual. In other words, what would have happened had subsea cables not arrived.

Figure 6. Estimated Effect of Subsea Cables on Financial Services Exports



Source: Authors' estimates.

Table 5. Impact on Financial Services Exports per Capita

		2010	2017
2011 USD PPP	Actual	10	125
	Counterfactual	—	10
	Difference	—	115
2011 Naira	Actual	774	9,406
	Counterfactual	—	761
	Difference	—	8,645

Source: Authors' estimates.

In 2017, 7 years after the first of these arrivals, Nigeria's actual per capita financial services exports were approximately \$115 greater (1,100% greater) than they otherwise would have been (Table 5). In other words, without these subsea cables, we estimate that Nigeria's per capita financial services exports in 2017 would have been \$10 (N761) rather than the actual exports of \$125 (N9,406).²⁷ This result implies that subsea cables played an instrumental role in unleashing growth in Nigeria's financial services industry.

The impact on financial services may seem surprisingly large but the magnitudes are reasonable considering Nigeria's substantial financial sector trade growth since 2014. In addition, other studies have found that financial services are among those industries most positively impacted by subsea cables due to the industry's relatively intense ICT utilization.²⁸ Financial services, more so than almost any industry, are inherently dependent upon trade in order to grow, and thus greater volumes of trade are associated with a healthy financial sector. Increases in international financial trade indicate increases in the liquidity of capital and external confidence in the country's financial institutions. The size and health of the financial sector is in turn critical to aggregate economic growth because it enables the finance of new business in other sectors of the economy.

Despite positive signals in fiber-connected areas and for financial services, we found no evidence of impacts on GDP per capita or employment at the national level. The areas of Nigeria that are fiber-connected are home to a relatively small share of the total population. Thus, we conclude that subsea cables are causing growth in fiber-connected areas

and among sectors that leverage broadband technology for growth, but if there is any net effect on national growth and employment it either does not exist or it is too small to detect.

4.2 FORWARD-LOOKING IMPLICATIONS OF ECONOMETRIC ANALYSES

The positive effects identified on employment in fiber-connected areas offer the best estimate of the likely impacts for areas that will be connected to fiber in the future. To estimate potential job creation, we must assume that the causal effects already estimated for fiber-connected areas holds, on average, for areas that are still unconnected.

Figure 7 depicts the estimated actual and potential job creation for all of Nigeria, calculated by applying the effect on employment (i.e. the increase in the likelihood of being employed) by population density. For connected areas, the map shows the actual estimated job creation. For unconnected areas, the map shows potential job creation if these areas were connected (assuming the average causal effect holds). The key implication is that connecting the most densely populated areas that are currently unconnected would translate to the greatest increases in employment over time. In comparing outcomes between people who are and who are not in fiber connected areas, people are similarly situated in life to benefit from connectivity, and the only difference is network availability and access.

Of course, numerous factors influence whether the estimated effects will hold in areas that are connected in the future. These include improvements to the subsea cable technology,

²⁷ All U.S. dollar values are in 2011 USD PPP. All Nigerian naira values are in 2011 NGN.

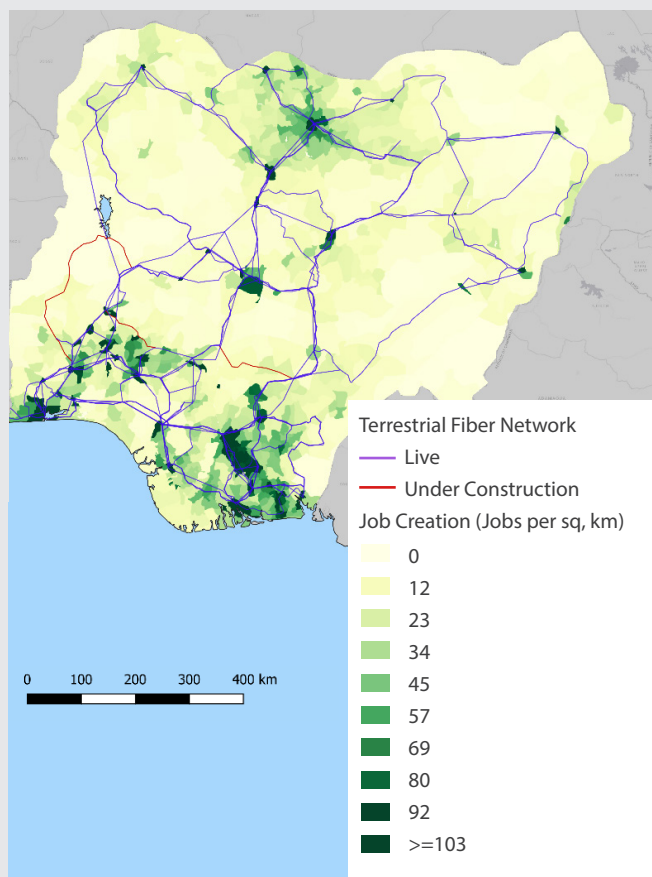
²⁸ World Bank. Information and Communications for Development 2006: Global Trends and Policies. 2006. Washington, DC: World Bank.

education levels of people living in newly connected areas, and the composition of those local economies. Obviously, the farther into the future one forecasts, the greater the uncertainty there is around the magnitude of the impacts, owing to the potential for a large degree of change from current conditions. Nonetheless, even if the effect of connecting new areas turned out to be smaller than for the connected areas included in this study, the potential employment gains would be socially and economically meaningful.

5. Stakeholder Perspectives on Connectivity

Interviews with Nigerian telecommunications experts revealed how bandwidth availability in Lagos is expanding business growth opportunities for firms located there. They also described challenges with network expansion and access for Nigerians beyond connected areas. Nigeria has not been able to realize the full economic growth potential of increased internet access because there is no national backbone for wholesale data traffic from which to provide access. Interviewees offered perspectives on why expansion of terrestrial networks that would offer enhanced connectivity from subsea cables remains difficult.

Figure 7. Actual and Potential Job Creation as a Result of Subsea Cables and Expanded Terrestrial Fiber



Source: Authors' estimates.

5.1 TELECOMMUNICATIONS MARKET STRUCTURE AND COMPETITION

The Nigerian telecommunications market is dominated by mobile network operators (MNOs) who carry voice and data traffic to serve consumers and enterprises nationwide. 3G mobile wireless is typical. The main providers are MTN, Glo, Airtel, 9mobile, ntel, Smile, Swift, and Spectranet. Across these operators, 96% of data subscriptions are prepaid.²⁹ MTN is the largest and has the most expansive radio and fiber infrastructure in the country.

Up to 90-95% of the country's geography is thought to be covered by GSM networks. Yet, it is also estimated that about 22-30% of Nigerians fall into zones of no service, regardless of the capacity of the network. One interviewee estimated that about 30 million Nigerians have no signal, and thus no ability to make voice calls. According to the ITU, as of 2018, 94.33% of the population was covered by a mobile-cellular network and 75.48% of the population was covered by at least a 3G mobile network. Given the population size, this would mean 13.9 million Nigerians have no mobile-cellular network and 87.8 million are without mobile 3G or better.

Nigeria's mobile phone uptake has been strong and there are enough SIM subscriptions to account for over 75% of the population, but many people have multiple SIM subscriptions so it is difficult to tell how much of the population uses SIM subscriptions. Mobile broadband subscriptions are less common at roughly 40 subscriptions per 100 inhabitants.

²⁹ GSMA. 2019. *Market Overview: Nigeria*. London: GSM Association.

Investments in fiber optic cable infrastructure are driven principally by the need for greater and less expensive backhaul capacity for MNOs, ISPs, and major corporate buyers so they can improve bandwidth and network performance in the largest markets in the country. Tower companies like IHS Telecoms, American Towers, and PAT host and manage a vast majority of MNO radio sites. Over the past 13 years, MNOs have sold a lot of their tower assets to new tower companies, IHS Towers, American Tower Company, and Helios. The telcos sold their tower assets to get them off their balance sheets and to release cashflow. But the problem of congestion still exists in spite of this.

On the fiber side, providers have developed modest carrier-grade fiber networks in parts of the country, none of which, unfortunately, is national in scale or scope. As a result of demand for high capacity, there has been an increase in Fiber-To-The-Site connections by MNOs, Towercos and other operators.

There are very few fixed broadband subscriptions, only about four subscriptions per 10,000 Nigerians in 2018.³⁰The Nigerian National Broadband plan states that right-of-way costs are too high for operators to sustain affordable leasing and transmission of fiber lines. The Nigerian Communications Commission (NCC) plans to streamline the permitting processes for fiber deployments through the removal of excessive taxes and licensing requirements.³¹

5.2 NETWORK EXPANSION

Nigeria has good international connectivity, but that connectivity faces a lot of obstacles as it moves from landing stations

inland. There is limited national backbone to move wholesale traffic from the sea into the interior.

For Nigeria’s telecommunications market to realize its full potential—both building out the national fiber infrastructure and meeting consumer demand—it will have to disentangle a complex web of economic, political, and cultural drivers that disincentivize network development. The solution may be a frontline approach or a negotiated one that cuts through the layers of existing barriers, most of which are human-made and political in nature. Until then, national access to affordable internet with 3G, 4G, and 5G service will remain spotty and unmet demand for Africa’s most populous country will persist.

Reducing or eliminating the country’s heavy reliance on radio technologies for backhaul transmission and shifting inland traffic to fiber infrastructure is a key priority of state and private actors. Achieving this objective, however, has proven to be very challenging. For example, state governments continue to charge telecommunication companies commercially unsustainable rates for rights-of-way and permits.

Table 6 below presents a selection of key ICT indicators to provide context of current conditions. Nigeria’s share of the population using the internet, prices of fixed and mobile broadband subscriptions, and fixed broadband speeds are among the most relevant indicators for understanding the impacts presented in this study.

5.2.1 Network Expansion Costs

One of the key reasons for lack of infrastructure development are high costs. Rates for long-haul transmission of bandwidth

Table 6. Key ICT Indicators

INDICATOR	VALUE	YEAR
Electrification	54% of population with access to electricity	2017
Internet users	42% of population	2017
Fixed broadband subscribers	0.04 subscriptions per 100 inhabitants	2018
Fixed Broadband Speed	20 megabits per second	2017
Fixed Broadband Monthly Subscription Charge	17.08 2011 USD PPP	2017
Mobile Cellular Subscribers	88 subscriptions per 100 inhabitants	2018
Mobile Download Speed	16 megabits per second	2020
Mobile Broadband Prepaid Subscription Charge	2.16 2011 USD PPP per 500 megabits	2017

Source: International Telecommunication Union and Ookla Speedtest.

³⁰ Source: World Bank Development Indicators.

³¹ Nigerian Federal Ministry of Communications and Digital Economy. 2020. Nigeria National Broadband Plan 2020–2025.

within the country is a key driver. There is a huge difference in cost between wholesale bandwidth in Lagos and any other part of the country. One interviewee noted that “it is cheaper to buy data from London [to Lagos] than between Lagos and any other city in Nigeria.” Beyond this, operators also face challenges of significant operational costs and poor power availability at radio sites.

High costs are further exacerbated by layers of fees, taxes, and other demands that operators face when they seek to build out their terrestrial network. One interviewee claimed that 70% of the installation costs for fiber deployments are related to right-of-way costs or fees. In addition, companies have to negotiate with several levels of government and others who can influence the ability to install fiber. Government taxes at the local, state, and federal levels are collected on top of these fees.

Compounding these costs are events such as unintentional destruction by road construction crews or intentional destruction by vandals. During (and after) construction, companies may encounter payment requests from individuals, street by street or house by house.

All of these costs are passed along to consumers. The effect is that costs of broadband access for the average Nigerian is high.

5.2.2 Rewards and Risks

The huge Nigerian consumer market offers excellent business opportunities. One interviewee stated that “Nigeria brings big risks and big rewards.” For example, MTN took a risk with Nigeria (GSM) in 2001 and has been heavily rewarded since. Similarly, a company that takes a large risk on developing fiber may also have significant rewards, but the risks to developing fiber infrastructure nationally are equally high. The current telecommunications infrastructure is the product of “work-arounds” that make network expansion today more complex than it should be.

Structurally, the network is characterized by spurs and rings scattered across the nation, known as tromboning, due to individual operators’ “best efforts.” Companies are then faced with the challenge of building out a network from a weak and fractured foundation. As a result, there can be multiple fiber installations along the same route which are neither interconnected nor interoperable.

Although the Nigerian Communications Commission is implementing passive infrastructure sharing (relating to co-location of network equipment such as masts, poles, and power generators)³² and is considering active infrastructure sharing regulations (which covers spectrum, switches, base stations, etc.),³³ operators apply these sharing principles mainly to towers and radio sites. Private fiber networks in the country may share routes, ducts, and trenches but are not interconnected because active sharing regulations have yet to be developed.

One interviewee noted that if Nigeria had better underlying infrastructure (e.g. roads, powerlines, rail lines, etc.), it would greatly help to improve broadband development because the paths through which fiber installations are laid would be more secure and protected. Field network repairs can only be made during daylight due to safety concerns. This combined with frequent power outages makes it difficult for service providers to guarantee high quality service. To make this endeavor riskier for the private sector, the government does not guarantee infrastructure protection or insurance, and there are no incentives to encourage network expansion in the hinterland.

The effect of all this is that the weaker points of the network suffer from congestion and poor response to outages, which results in slow internet speeds and latency for the end-user.

In terms of geography, all subsea cables land in a small section of Lagos, Victoria Island. Victoria Island is the central business district and location of international hotels. If Victoria Island were affected by a natural or human disaster, much of Nigeria’s network would suffer because it is dependent on a single point for cable landings. On another note, risks for service expansion in the Northeastern part of the country are high due to insurgency and terrorists.

To reduce the risk of running terrestrial networks, industry players, led by ATCON and ALTON, have been seeking a Presidential order declaring telecoms as critical economic infrastructure like oil and gas. They have also been pushing for global right-of-way protection to ensure that network deployments can be carried out without hindrance and be commercially sustainable. Although the national government has been receptive, these efforts have yet to bear fruit.

32 Nigerian Communications Commission. 2006. Guidelines on Colocation and Infrastructure Sharing.

33 Nwagbara, C. 2019. NCC moves to regulate infrastructure sharing regulations. Nairametrics.com.

5.2.3 Limited Cooperation and Inconsistent Political Will

Many interviewees stressed that while Nigeria does not have a national fiber backbone for wholesale data, service providers have privately laid a considerable amount of fiber across much of the country, about 38,000 kilometers in total. However, the lack of collaboration among private sector companies has resulted in duplicative fiber networks laid along the same routes. The vacuum created by the absence of action to implement Nigeria's national fiberization strategy has resulted in a fragmented terrestrial network largely owned by MNOs and ISPs to serve their own needs. The likelihood of these routes being shared going forward is low which makes cross-metro and long-haul fiber difficult to accomplish.

One way the government has sought to solve this problem is by establishing InfraCos to lay fiber in six regions of the country. The InfraCo license grants' rights and obligations for the development of regional transmission networks based on fiber infrastructure. A total of seven licenses have been issued, one for each of the country's six geopolitical zones plus Lagos Metropolis. However, none of the InfraCos have rolled out yet due mainly to right-of-way difficulties, low investor appetite, and lack of incentives from the government paired with a desire by the MNOs to maintain their own potential to develop these networks in the future. Because the MNOs bring notable revenue to the government, the political will to go against the MNOs is low. Like many places around the world, the government will likely need to provide incentives to encourage InfraCos and other operators to extend fiber to reach all 774 local districts and to serve rural or under-served communities.

Another example of the need for more political will to see the development of fiber networks is in the City of Lagos. Lagos is starting to take the lead role for city-wide metro fiber initiatives that are exclusively owned and controlled by state governments.

5.3 UPTAKE PROPOSITION: AFFORDABILITY, QUALITY OF SERVICE, AND CONTENT

Nigerian operators are innovative and aggressive at figuring out how to keep costs down and create products that are affordable to customers. The expert consensus is that cost of data needs to come down at two levels, device acquisition

and subscriptions, so that low-income earners can afford services.

Operators are currently working to create cheaper bundles for daily and weekly subscriptions. Though billing rates for data services are gradually coming down, they are still prohibitive due mainly to the twin problems of operational costs and the high rates operators incur moving wholesale traffic from Lagos to other parts of the country.

Nevertheless, operators and ISPs have been developing lower cost options for subscriptions. It is now possible to get online for as low as N25 per day. On the downside, one MNO has drastically reduced its 4G deployments because of pessimistic financial projections stemming from affordability issues.

To address high device acquisition costs, MTN, in one instance, has partnered with a Chinese producer to make a popular, cheap minimalist smart phone which sells for N8000 and can use social media platforms.

Broadband speeds are gradually improving but still well below global or continental averages. Due to weak speeds there are content limitations. Applications such as medical imaging do not work well. Social networking apps (e.g. Twitter, Facebook, Instagram, SnapChat, and WhatsApp) generally do, however, as does online banking, all of which have experienced explosive increases in usage.

Nigeria's internet market is being driven by its youth population. Their desires for high speed data and sheer numbers is changing the landscape. Data use has had a huge spike with IrokoTV, Netflix, Iflix, and more TV content being streamed over mobile internet. These trends indicate that government will have to solve the fiber problem because of digitization and market demand for high speed data.

The interviews revealed the dilemma faced by industry players. On the one hand, stakeholders believe that the fiber potential of the country is high and there is much room for growth. Presently, terrestrial networks can only carry 3 Tbps whereas the lit capacity of subsea cables is 9 Tbps. On the other hand, national fiber is underdeveloped and content is negligible. Suburbs and rural areas are difficult to reach. Broadband is concentrated in major cities. Shortly before the outbreak of COVID-19, Glo cut down 4G deployment because business projections were not being realized. The effect of all these challenges is low broadband penetration overall, despite the potential and promise that fiber seems to offer.

5.4 PUBLIC POLICY PRIORITIES

Many interviewees noted that there is broad agreement among industry and policy leaders that Nigeria's new National Broadband Plan of 2020 is a valuable tool for prioritizing Nigeria's efforts for broadband expansion.³⁴

The plan outlines the vision of the national government to connect communities with high speed internet through pervasive 4G deployments and the execution of progressive digital economy policies and strategies. As with the previous broadband plan, the government intends to establish an open access regime for enabling infrastructure and removing right-of-way constraints on fiber installations in the country.

Specific targets include ambitions to serve 90% of the population with 4G/5G coverage delivered to urban and rural areas at minimum speeds of 25Mbps and 10Mbps respectively, and to ensure that fiber is extended to 90% of LGAs and within 5km of every public institution. Other goals are to attain digital literacy for at least 60% of the population, 100% female inclusion and connect all unserved areas. All of these and more are to be achieved by 2025. Tackling the issues that are laid out in the national broadband plan should help address issues of high cost, high market risks and the challenge of inadequate cooperation among service providers.

The broadband plan leverages on the Digital Economy Policy document released November 2019.³⁵ This policy describes the government's ambitions to develop digital regulations, digital literacy, infrastructure, digital services, emerging technologies, and local content. On March 19, 2020, the presidency issued a long-awaited executive directive declaring telecoms assets as critical national infrastructure requiring the full protection of the state.

On the whole, while it is too early for a meaningful assessment as the new National Broadband Plan has just been released, it appears to provide a clear path forward for high speed internet and policy priorities that can be followed to improve terrestrial internet infrastructure. However, a clear issue is how the strategies described in the plan will be funded given that the predecessor 2015 plan was neither funded nor implemented. The capital estimate for the next five years is US\$3.5 to 5 billion. It remains to be seen how the government will raise the resources required to implement the new plan.

5.5 ECONOMIC DEVELOPMENT AND SOCIAL EMPOWERMENT

Despite obstacles, Nigeria holds tremendous potential to change the economy of the country with robust fiber networks which will help improve access to education, increasing the number of jobs in telecommunications related occupations, and the distribution of content for the creative economy of "Nollywood" and digital streaming services such as Iroko TV. Nigeria's booming population coupled with emerging efforts to create smart cities and other kinds of hubs across the country can generate the demand to drive change in the market if prices are affordable. For now, upgrades in internet infrastructure will likely be incremental and occur in pockets within the country's major cities particularly in Lagos, Abuja, Port Harcourt and, to some extent, Kano.

The internet has improved efficiency of financial services and commerce. Small businesses and farmers now sell on social media as opposed to only just at the store front. Online shopping platforms such as Konga and Jumia have emerged as a result of better internet connectivity. Some tech hubs (e.g., Andela, cCHub, NG Hub) have emerged. The Yaba suburb of Lagos Metropolis has been nicknamed Yabacon Valley.

More people are being introduced to online content. The increase in access to content and entertainment including YouTube, Instagram, and Facebook has encouraged Nigerians to develop and broadcast their own content that is viewed by global audiences. Universities are offering online learning options.

Not surprisingly, demand for streaming grows unabated. Consumers are beginning to switch from traditional cable and TV as subscriptions are becoming too expensive to maintain. They are increasingly turning to the internet to stream entertainment. Cost of data needs to come down so low-income earners can afford services.

In addition, the increased use and transparency of social media has changed the political landscape. For examples, video clips of a policeman unjustly beating up a motorcycle driver and a senator slapping a retail store clerk went viral in 2019, leading to formal state action against these public officers.

³⁴ Nigerian Federal Ministry of Communications and Digital Economy. 2020. Nigeria National Broadband Plan 2020–2025.

³⁵ Nigerian Federal Ministry of Communications and Digital Economy. 2019. National Digital Economy Policy and Strategy.

6. Concluding Remarks

The connectivity delivered by subsea cables have caused employment and business growth in fiber-connected areas. On the average, people here experience a 7.8% increase in the likelihood of being employed. While we were unable to detect positive impacts on GDP in the short-run, such impacts may be seen in the long-run if subsea cables continue to facilitate growth and fiber infrastructure is built out. Evidence of positive impacts on employment and firms in connected areas and on financial services, nationally, are indicative of the promise for more widespread impact on a national scale.

This finding is important because it implies that if the terrestrial fiber network expanded to more areas across the country and more people were connected, there would be greater economic opportunity for them. This conclusion is consistent with recent reports from the Nigerian government, World Bank,³⁶ and others about the critical role connectivity plays in Nigeria's economy.

If connectivity is not built out more robustly across the country, regional disparities between connected and unconnected areas will be further exacerbated. While the exact impact potential for currently unconnected areas is unknown, improving access country-wide while maintaining broadband quality still seems to be among the most effective potential strategies for economic growth and employment.

Advancing policy to improve better connectivity must also consider the impacts on individuals and on industries in the short-term. While the average person and firm in fiber-connected areas appear to benefit from subsea cables, evidence regarding how effects vary across individuals based on their demographics is less clear. Furthermore, economic change and transition can affect some industries more than others. Connectivity could provide a catalyst to some, or headwinds to others. Thus, policy makers need to consider trade-offs (and mitigation plans) between job creation, widening of socioeconomic disparities, and any consequences for the different industries.

Ultimately, Nigerian policy makers must muster up the political will to invest in the country by making long-term decisions to create the environment in which Nigerians and their businesses can realize the potential greater internet connectivity promises. Immediate next steps are to reduce risks for network developers. This can be done by lowering fees and permitting barriers, easing right-of-way constraints, addressing challenges in infrastructure protection, and promoting infrastructure sharing.

Experts in the country know how to do this—the country has a solid national broadband plan—but questions remain about the ability and willingness to execute this plan to achieve the vision. It is an excellent time for Nigerian policy-makers to harness potential and implement their broadband plan to accelerate growth and development.

³⁶ Zottel, S., Lixi, M., and Neto, M. I. 2019. Nigeria Digital Economy Diagnostic Report. Washington, D.C.: World Bank Group.

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