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

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FACEBOOK

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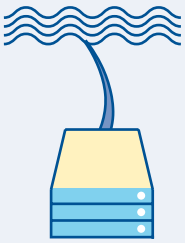
HOW DO SUBSEA CABLES GENERATE ECONOMIC IMPACT?

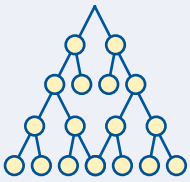
Subsea cables are the global backbone of the Internet, connecting people, businesses, and economies around the world. They connect us to the cloud, deliver streaming video, and increase efficiency and productivity for business. Subsea cables' importance is all the more apparent during the Covid19 pandemic 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 Tanzania (e.g., SEACOM, EASSy) to understand how they changed the economy.

Subsea cables arrive



Network is built out



Increased data traffic competition

Internet speed increases

Price per data unit decreases

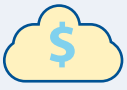
Consumers

Existing consumers enjoy better speeds, increasing their consumption of digital content, products, and services.

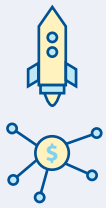
Some consumers decide to subscribe to services for the first time

Business

Increased internet speed, quality and reliability makes doing business easier



More businesses use the cloud and e-commerce for the first time



New firms and startups emerge to serve consumers and businesses

Growth in productivity, efficiency, and revenue for firms

New business opportunities

Economic Impacts

18.7%

Subsea cables led to a 18.7% increase in employment within 200 meters of fiber infrastructure

Less than 25%

Less than 25% of Tanzanians are internet users

Less than 25% of Tanzanians are internet users. We found the beginnings of economic impacts from cable landings in fiber-connected areas like Dar es Salaam. However, the impacts are not large enough or broad-based enough to be reflected in national employment or GDP per capita data. Thus, we take the findings to be a signal that there is a significant amount of economic impact potential should broadband penetration accelerate and internet usage grow.*

* To deepen our understanding of our economic analysis results, we interviewed Tanzanian telecommunications experts. They described that there is an affordability challenge for many people. Affordability appears to be adversely affected by taxes on mobile wireless services as well as a particularly expensive national fiber backbone. Higher costs are passed on to consumers, making prices higher, inhibiting uptake, slowing network expansion, and therefore mitigating the economic impact potential.

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

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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 Tanzania. 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]

For Tanzania, we focus on two recent cable landings, SEACOM and EASSy. Figure 1 describes the role that subsea cables play in internet access. Subsea cables connect the domestic terrestrial fiber network to cloud services and data resources around the world. The more robust the connection between the user and the data resource, the faster, better, and more productive is their user experience.

Home to 58 million people, Tanzania is the largest country in East Africa. It also has some of the lowest rates of internet connectivity and broadband penetration in the region. Less than 25% of the population are internet users, and only about 60% are covered by a 3G signal.

We found the beginnings of economic impacts from cable landings in fiber-connected areas like Dar es Salaam. In these areas, people who live within 200 meters of the fiber infrastructure are 18.7% more likely to be employed than people who live in the same areas but who are farther away from fiber.

The impacts are not large enough or broad-based enough to be reflected in national employment or GDP per capita data. Thus, we take the findings to be a signal that there is a significant amount of economic impact potential should broadband penetration accelerate and internet usage grow.

To deepen our understanding of our economic analysis results, we interviewed Tanzanian telecommunications experts. They described that there is an affordability challenge for many people. Affordability appears to be adversely affected by taxes on mobile wireless services as well as a particularly expensive national fiber backbone. Higher costs are passed on to consumers, making prices higher, inhibiting uptake, slowing network expansion, and therefore mitigating the economic impact potential.

This paper reviews our analysis findings, including experts' assessments of the challenges with and consequences of Tanzania's expensive middle-mile paradigm.

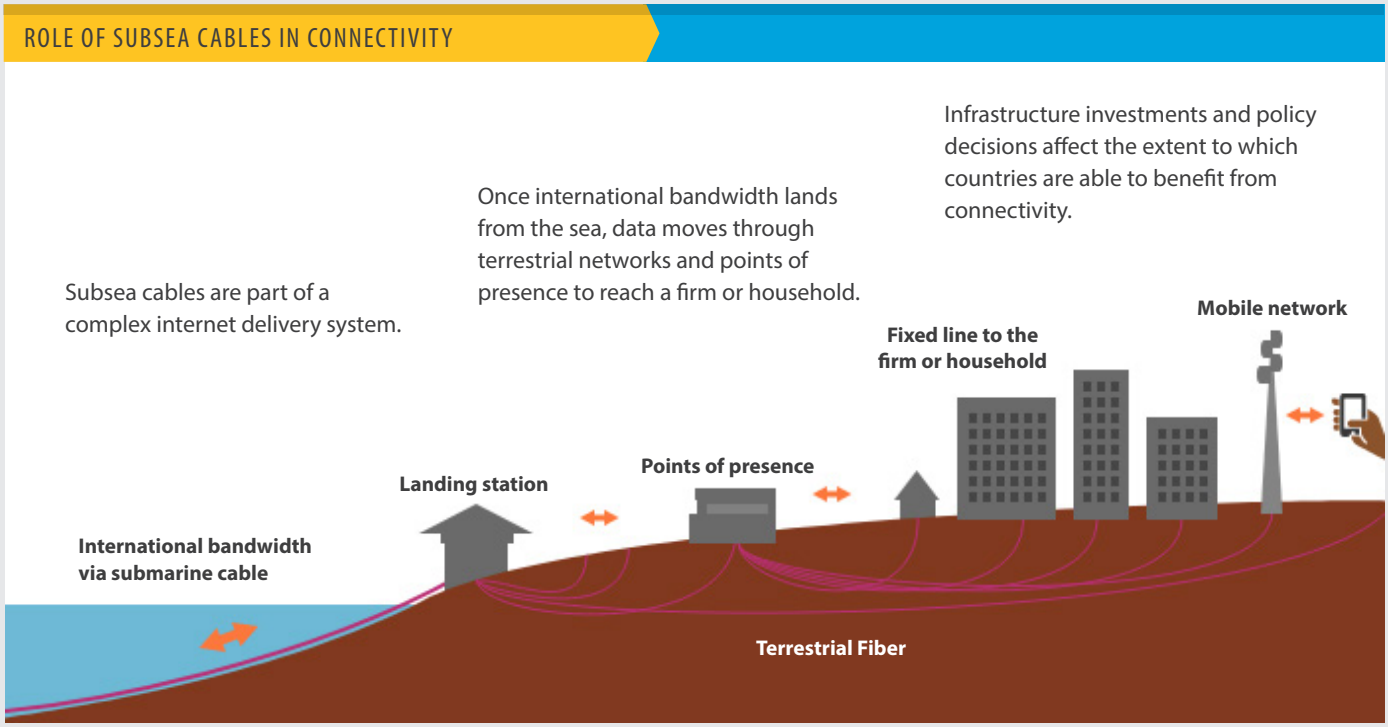
Table 1. Key Takeaways: The Economic Impact of Subsea Cables on Tanzania

INDICATOR	TIME PERIOD	OUTCOME
Employment	2009—2014	18.7% increase in the likelihood of being employed, if one lives within 200 meters of fiber infrastructure, but only in select areas

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, Nigeria, and South Africa.
7 O'Connor, A. C., B. Anderson, M. Mureithi, J. Nyaguthii, A. Brower, and S. E. Lawrence. 2020, May. *Economic Impacts of Submarine Fiber Optic Cables and Broadband Connectivity in Kenya*. Working Paper 0214363.202.4. Research Triangle Park, NC, USA: RTI International.

Figure 1. **Role of Subsea Cables in Internet Connectivity**



2. Tanzania Country Profile

Tanzania is the largest country in East Africa by both population and land area. Most of its 58 million people live along the Indian Ocean coastline and in the northern regions of the country. Although the population is predominantly rural, one third of all Tanzanians live in urban areas. The urban population has grown by at least 5% annually for the past 15 years.[8] The country's official languages are Swahili and English, with the latter used for commerce, administration, and higher education.

Tanzania's economy is directly or indirectly tied to agriculture and mining. Key commodities include coffee, cotton, diamond, gold, iron, and tobacco.[9] In nominal terms, Tanzania's gross domestic product (GDP)—the most common measure of the value of all goods and services produced by a country—was $63.2 billion in 2019, or about $1,122 per capita (nominal terms).

In truth, much of the economy is informal. The IMF Regional Outlook Report for Sub-Saharan Africa estimates that the size of the informal economy in Tanzania equaled over 50% of the official GDP between 2010 and 2014.[10] Growth rates for the informal economy are not known with great certainty, but Tanzania's average formal growth rate over the last decade was over 6% per year.[11]

Most Tanzanians with formal employment rely upon monthly wages and cash earnings to support their households. About 59% of wage-earners made less than TZS 500,000 (USD 216) per month, 23% between TZS 500,001 and 900,000 (USD 390), and 18% more than TZS 900,000 (USD 390).[12]

Another way to look at Tanzania's GDP is to take into consideration purchasing power parity (PPP). PPP accounts for differing price levels for comparable expenditure categories

8 World Bank Group. 2019 World Development Indicators. See https://databank.worldbank.org/source/world-development-indicators.
9 National Bureau of Statistics. 2019. *National Account Statistics: Popular Version 2018*. Dar Es Salaam: National Bureau of Statistics.
10 International Monetary Fund. 2017. *Regional Economic Outlook: Sub-Saharan Africa, Restarting the Growth Engine*. Washington D.C.: International Monetary Fund.
11 World Bank Group. 2019 World Development Indicators. See https://databank.worldbank.org/source/world-development-indicators.
12 National Bureau of Statistics. 2018. Formal Sector Employment and Earnings Survey, 2016. Dar Es Salaam: National Bureau of Statistics.

Table 2. **Key Indicators for Tanzania's Population and Economy**

INDICATOR		VALUE	YEAR
Population		58.0 million people	2019[a]
Literacy Rate		78% of population aged 15+	2015[b]
Primary education completing rate		65% of population aged 25+	2012[b]
Poverty rate		49% of population below WB poverty line of 1.90 USD PPP/day	2011[b]
GDP, nominal USD	• Total • Per capita	63.2 billion 1,122	2019[a]
GDP, nominal TZS	• Total • Per capita	149.7 trillion 2,581,429	2019[a]
GDP, purchasing power parity	• Total • Per capita	151 billion (2011 USD PPP) 2,701 (2011 USD PPP)	2017[a]
GDP growth rate		5.4	2018[b]
Unemployment		1.9% of labor force	2018[b]

Sources: [a]Penn World Table and [b]The World Bank.

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, Tanzania's economy is the equivalent of $151 billion (2011 USD) with a per capita GDP of $2701. Later, we will use the PPP method of quantifying the economy to generate our results, enabling impacts to be interpreted directly as improvements in living standards relative to different points in the past.

Tanzania is connected to three active submarine cables which land in Dar es Salaam: SEACOM, Eastern African Submarine Cable System (EASSy), and Seychelles East Africa System (SEAS). SEAS is a 1,930km point-to-point submarine cable connecting Seychelles to Tanzania. Unlike the other undersea cables, SEAS is intended to connect Seychelles to international bandwidth through EASSy and not to bring capacity to Tanzania. See also Figure 2.

The Tanzanian government hopes to extend its National ICT Broadband Backbone (NICTBB) to its landlocked neighboring countries. The backbone currently distributes capacity from the submarine fiber cables Dar es Salaam to over 30 points of presence throughout the country's districts (Figure 3).

Table 3. **Subsea Cables Landing in Tanzania**

CABLE	DESIGN CAPACITY (TBPS)	LOCAL LANDING STATION(S)	READY FOR SERVICE YEAR
East Africa Submarine Cable System (EASSy)	11.8	Dar es Salaam	2010
SEACOM/TATA TGN-Eurasia	4.2	Dar es Salaam	2009
Seychelles to East Africa System (SEAS)	0.32	Dar es Salaam	2012
2Africa (announced)	180	Dar es Salaam	2023

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

3. Analysis Approach

We analyzed the economic impacts of subsea cables by pairing rigorous economic analysis approaches with interviews with experts in Tanzanian internet connectivity. In so doing, not only were we able to understand what the impacts have been of past improvements in connectivity, but also identified the implications of—and barriers and facilitators to—improvements in connectivity going forward. This section offers a high-level description of our approach.[13]

Note that 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 stored abroad on shore. For many emerging economies like Tanzania, international connectivity remains critical.

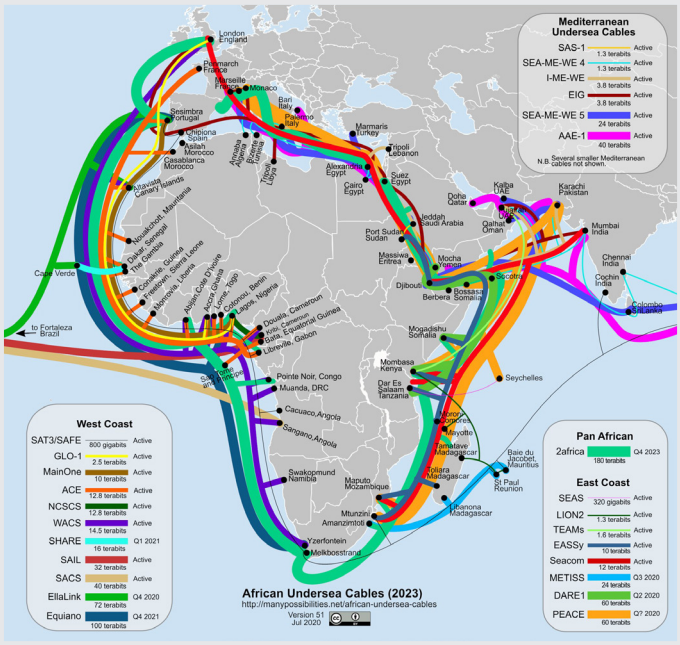
3.1 ECONOMETRIC ANALYSES

We employed two complementary econometric methods: difference-in-differences and synthetic control. Of all available econometric methods and strategies, these two offer the most robust, reliable, and accurate way to estimate causal effects in the context of subsea cables. Each one of these methods derives from cutting-edge statistical techniques[14,15,16] and have been used to investigate research questions similar to those posed by our analysis.[17,18]

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 some period of time. In this analysis, subsea cables (and increases in international data connectivity) are the intervention. The impact ("treatment effect") is identified by

Figure 2. Subsea Cables in Africa



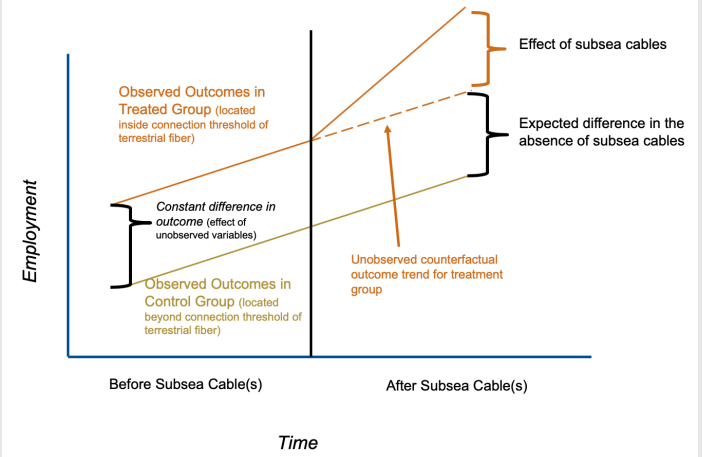
Source: Song, S. 2020. African Undersea Cables (2023). See https://www.manypossibilities.net.

Figure 3. Tanzania's National Broadband Backbone

Source: NICTBB.

13 A detailed technical addendum accompanies this report.
14 Athey, S., Imbens, G. W. 2017. The State of Applied Econometrics: Causality and Policy Evaluation. Journal of Economic Perspectives, 31(2): 3-32.
15 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.
16 Imbens, G. W., & Wooldridge, J. M. 2009. Recent developments in the econometrics of program evaluation. Journal of Economic Literature, 47(1), 5-86.
17 Hjort, J, Poulsen, J. 2019. The Arrival of Fast Internet and Employment in Africa. American Economic Review, 109(3): 1032-1079.
18 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.

Figure 4. Difference in Differences Technique for Analysis of the Impact of Subsea Cables



comparing the difference 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").

Assignment to the treatment group is based on close proximity to terrestrial fiber in the base period.[19] 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 4.

The data we used for our analysis of employment comes from the United States Agency for International Development's (USAID) Demographic and Health Surveys (DHS),[20] which ask individuals about their employment status and type of occupation. The data for our analysis of firm outcomes come from the World Bank's Enterprise Surveys (WBES).[21] The DHS data are geocoded, which enabled greater precision in our econometric approach than the less spatially explicit WBES data (which identify 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 a few 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).[22]

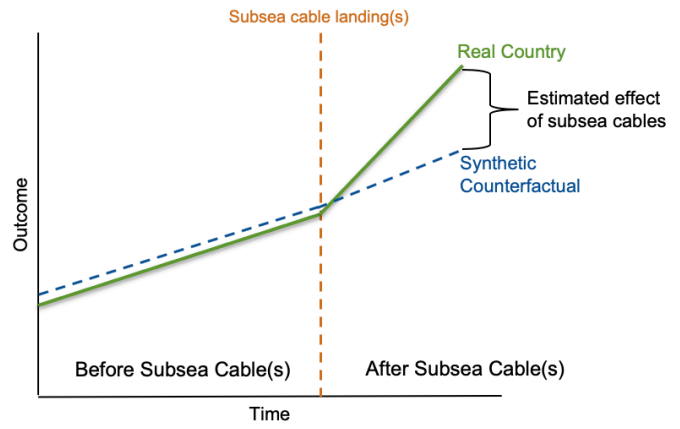
Because the firm-level data from WBES are spatially aggregated at the city level, we were unable to achieve the same level of specificity for firms as for individuals. For example, with a small number of cities, within which all firms are either assigned to the treatment or the control group (based on 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 Tanzania's actual outcomes after subsea cable arrivals to a model of Tanzania in which the cables did not arrive but for which all other prevailing economic trends continued. This latter version of Tanzania is referred to as a synthetic counterfactual.

19 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.
20 U.S. Agency for International Development. Demographic and Health Surveys. See https://dhsprogram.com/Data/.
21 World Bank Group. 2019. Enterprise Surveys. See https://www.enterprisesurveys.org/.
22 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 5. Synthetic Control Technique for Analysis of the Impact of Subsea Cables



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 Tanzania's pre-arrival state. We use a weighted combination of multiple countries because the resulting counterfactual is more like Tanzania 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.

The construction of the synthetic 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 5.

The country-level data we used for SC analysis come from the Penn World Table (PWT)[23] and the World Bank's World Development Indicators (WDI).[24] These sources provide relevant national statistics from officially recognized sources, which are then standardized using well-documented methodology. Importantly, the detailed methodology and data quality control measures used to standardize the data enable comparison across countries and over time, and thus for our application 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

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)		●

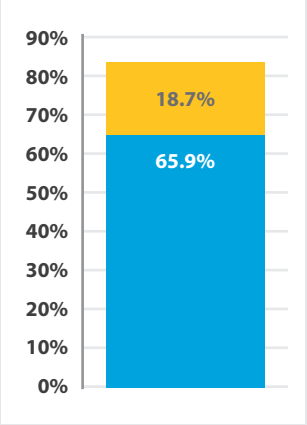
23 Feenstra, R. C., Inklaar, R., Timmer, M. 2015. The Next Generation of the Penn World Table. *American Economic Review*, 105(10), 3150-3182.
25 World Bank Group. 2019 World Development Indicators. See https://databank.worldbank.org/source/world-development-indicators.

different dimensions, as described in Table 4. By applying two econometric methods, our work provides insight into various aspects of economic impact caused by subsea cable landings.

3.2 THEMATIC ANALYSIS OF INTERVIEWS WITH KEY STAKEHOLDERS

We interviewed 13 Tanzanian experts with telecommunications firms, research entities, and government agencies. 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.

Figure 6. Effect of Subsea Cables on Employment Among Working Age Individuals in Areas Within 200 Meters of Terrestrial Fiber



Source: Authors' estimates.

4. Economic Impacts of Subsea Cable Landings

The impact of the connectivity increases delivered by subsea cables appear to be limited to those areas where the fiber infrastructure was particularly robust. This would include Tanzania's largest city, Dar es Salaam. The impacts here were not large enough to be detectable in national employment or GDP statistics. We studied 2009 to 2014 because this is a 5-year period following cable arrivals.

Looking closely at areas of impact, those who are benefiting are living within 200 meters of the fiber infrastructure. People here are 18.7% more likely to be employed than people who live within 10 kilometers of the fiber infrastructure. This is an extremely narrow connectivity radius. See Figure 6.

In cities connected to the terrestrial fiber network we found weak evidence of mixed effects on firms. The evidence could, at best, be described as signals because the robustness of the results were low.

We found that firms here were more likely to use websites to conduct business, but they were no more likely than firms in unconnected areas to leverage online training or use email for business. Ironically, we also found that these firms seemed to employ fewer people and had lower revenue per worker. The results, however, were not very robust so we have limited confidence on the inferences that can be drawn. It is likely that the effect of subsea cables on firms in connected cities vary substantially among different types of firms.[25]

We were unable to detect any impacts on GDP per capita, overall employment, employment in services, or exports of financial services exports from subsea cable landings. Analysis of effects at the aggregate level, however, obscures underlying dynamics such as the varying impact by geography, demographics, and industry sector.

Taken together, our results suggest that a narrow slice of Tanzania benefited from the subsea cable landings from 2009. This finding is notable enough, however, to suggest that there is likely significant economic development potential for the country overall if internet usage were greater.

25 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.

5. Stakeholder Perspectives on Connectivity

Broadband penetration, and therefore the ability to derive economic development value from connectivity, is low because of challenges in affordability (see Table 5). Tanzania's telecommunications market is very competitive, with multiple operators in all market segments competing under a proactive policy and regulatory framework. However, there is a government restriction on the middle mile. One key player, National ICT Backbone (NICTBB), was created by the government to reduce network resource duplication but is now viewed by experts as an obstacle to affordability, which in turn has limited broadband penetration and its associated benefits.

5.1 TELECOMMUNICATIONS MARKET STRUCTURE AND COMPETITION

The Tanzania Communications Regulatory Authority (TCRA) segments the telecommunications market into four license categories, as follows:

- Network Facility (NF) license permits a licensee to construct, install, maintain, operate, manage and make available network facilities to other licensed electronic communication providers in Tanzania;
- Network Service (NS) license permits a licensee to provide a pre-defined set of services for carrying information except those provided solely on the customer side of the network boundary;
- Application Service (AS) license permits the resale of electronic communication services to end users; and
- Content Services (CS) license permits services offered for sound, data, text or images whether still or moving except where the service transmits through private communication.

Of importance for bandwidth distribution are NF licenses, which include all the main operators (described further below). Operators are permitted to be vertically integrated but must be licensed for each service.

The government has licensed the following key players in its broadband sector. Subsea cables are SEACOM, EASSy, and SEAS. NICTBB is the principal intercity terrestrial fiber operator, but networks are also operated by Vodacom and Halotel.[26] Metropolitan fiber networks are operated by Vodacom, Airtel, Tigo, and Halotel.

At the consumer end, there are three large operators: Vodacom (33%), Airtel (26%), and Tigo (30%). Halotel, the youngest operator in the market (from 2015), now has about 10% of the market. Government-owned Tanzania Telecommunications Corporation (TTCL) holds 1% and is struggling to get a foothold in the market. The TCRA estimated that there were over 22 million mobile subscribers in 2018. About 96% of all mobile subscriptions are prepaid.[27] Roughly 95% of the population is covered under 2G technology, while 3G covers 61% and 4G covers 28%.

Table 5. Key ICT Indicators

INDICATOR	VALUE	YEAR
Electrification	33% of population with access to electricity	2017
Internet users	16% of population	2017
Fixed broadband subscribers	1.53 subscriptions per 100 inhabitants	2018
Fixed Broadband Speed	1 megabits per second	2017
Fixed Broadband Monthly Subscription Charge	12.35 2011 USD PPP	2017
Mobile Cellular Subscribers	77 subscriptions per 100 inhabitants	2018
Mobile Download Speed	10 megabits per second	2020
Mobile Broadband Prepaid Subscription Charge	1.47 2011 USD PPP per 500 megabits	2017

Source: International Telecommunication Union and Ookla Speedtest.

26 Halotel is an operation of Viettel, a Vietnamese operator.
27 GSMA. 2019. *Market Overview: Tanzania*. London: GSM Association.

In the middle mile,[28] operators carry bandwidth through terrestrial fiber networks inland with government sanctioned player, NICTBB, whose infrastructure is government-owned and managed by TTCL. NICTBB provides national coverage to regional headquarters and cross-border points for regional connectivity to Kenya, Uganda, Rwanda, Burundi, and Malawi.

Established as a strategic vehicle facilitating implementation of e-government, e-health, e-commerce and e-learning to accelerate socioeconomic development, NICTBB offers wholesale high capacity transmission services nationwide and into neighboring countries. NICTBB has 7,650 kilometers of terrestrial fiber.

A second middle mile supplier is the operators' consortium, a fiber network built in partnership with the Government of Tanzania through the Ministry of Works, Transport, and Communication. The role of the ministry is to provide rights of way for the terrestrial fiber network while the consortium provides funding to build the infrastructure. At the end of the fiber network installation, the Ministry acquires ownership of the infrastructure while the consortium gains Indefeasible Rights of Use (IRU).[29] The consortium has built 3,024km of fiber. Other operators outside the consortium can lease the fiber.

Halotel, licensed to construct fiber network infrastructure where the NICTBB network does not operate, is both in the middle and the last mile. Halotel's entry into the market changed the market dynamics by serving rural areas with fiber and 3G. Halotel has an agreement with the Tanzanian government that allowed it to build its own fiber and only lease infrastructure through NICTBB where NICTBB's infrastructure is already available. Halotel has constructed last mile connectivity from regional centers to district offices and other social service centers. Based on its license terms, it is obligated to provide free internet to all public secondary schools and charge half price for internet to government offices, hospitals, police stations, and courts.

A unique operator is Tanzanian Education and Research Network (TERNET).[30] TERNET is a network of universities and research institutions providing internet and related services to enhance sharing of education and research resources both locally and globally. Without owning its own infrastructure, TERNET is somewhat limited and resorts to relying on the licensed operators to lease bulk capacity for onward resale to academic institutions. However, it leverages its economies of scale. TERNET uses the aggregate bandwith requirements of its clients as a bargaining chip and is able to negotiate a wholesale price of US$ 3 per Mbps from a wholesale provider.

The Universal Communication Service Access Fund (UCSAF) is expanding the national network into the rural areas. UCSAF aims to deliver broadband connectivity in line with the country's National Broadband Policy. Services are being upgraded from 2G to 3G. UCSAF however continues to experience daunting expansion challenges. About 6% of Tanzania's population has no connectivity to any network while 30% of its land area has no coverage. The poorer populations in these areas are also in need of devices, airtime, and skills to operate the devices.

5.2 NETWORK EXPANSION

When subsea cables landed in 2009, the price of connectivity dropped significantly, from satellite fees of $2,500 to $3,000 per Mbps to $500 per Mbps within the first year. The price is currently at US$ 30 (depending on the operator and location of delivery). The price for broadband for the end user however is the same all over the country.

The price for the middle mile through NICTBB is a major determinant of the cost to subscribers, as per the costing for IRU and Lease (Table 6).[31] There is little competition.

For operators who want to establish their own terrestrial fiber infrastructure, the government-imposed levies (Table 7) are a barrier with the high costs incurred on both initial costs and annual maintenance.

While the government, and specifically the roads sector, had a goal to generate revenue, these levies are a great burden on fiber infrastructure buildout, according to interviewees.[32]

In addition to operational costs in Tanzania, operators face high taxation rates and fees. Taxation is a major issue for the

28 Borrowed from World Bank nomenclature – first mile is the undersea, second mile is terrestrial backhaul and third mile is consumer end connection.
29 IRU is a contractual agreement that confers an indefeasible and exclusive right of access to equipment, fibers or network capacity on a telecommunications system to another telecom operator for an agreed-upon period in return for upfront or recurring payments. An IRU agreement is usually for a longer term (e.g. 10–20 years).
30 See www.ternet.or.tz.
31 Tanzania Communications Regulatory Authority. Competition Assessment in Tanzania Telecommunications and Broadcasting Markets.
32 These levies apply to other utilities as well who wish to use the road space – oil, gas, water, electricity and roadside fuel stations. Incidentally the ICT sector is under the same Ministry.

Table 6. **Selected NICTBB pricing IRU and Lease Tariff structures**

PERIOD AND TERMS	CAPACITY PRICING	CAPACITY (MBPS)	PRICES (US$)
IRU Tariff Structure/month			
10 years lease contract	STM1	155	140,224
15 years lease contract	STM1	155	186,993
20 years lease contract	STM1	155	233,741
Lease Tariff structure			
1 Year Lease contract	STM1	155	46,748 per year
3 Year Lease contract	STM1	155	119,208 per 3 years
Initial charges	STM1	155	9,739

whole chain in the telecommunication sector including:

- 18% Value Added Tax (VAT) applicable to general services and products
- Excise duty 17% plus VAT
- Corporate Income Tax (CIT) 30% of net income of company
- TCRA fee 0.8% of turnover
- Universal Communication Access Fund Contribution 0.3% of turnover
- City levy 0.3%

Based on interviews conducted with players in Tanzania's broadband sector, new undersea cables, like 2Africa, could lead to a decrease in price on undersea bandwidth. The cost to the end user is however largely defined by NICTBB. As such, it is unclear whether any increases in competition in the subsea market would affect pricing for Tanzanian consumers.

5.3 PUBLIC POLICY PRIORITIES

Tanzania's economic development blueprint, Vision 2025, articulated a range of focus areas to create an optimal environment for the growth of the ICT industry, including infrastructure, human capital, legal and regulatory frameworks, and universal access. The government established the ICT Commission[33] in 2016 to promote investment in the ICT sector and regulate ICT professionals.

In the rural areas, UCSAF has the mandate to extend universal connectivity to the lowest administrative level and social centers through NICTBB, with the aim of making e-government services accessible to all citizens. Additionally, a priority is to create a level playing field by ensuring universal access on at least a 3G network.

Through TCRA, all regional IXPs are now housed under TCRA since they are considered critical infrastructure. TCRA also took over management of the domain name system

Table 7. **Annual Road User Charges**

TYPE OF UTILITY/FACILITY	TYPE OF STRUCTURE	UNIT	INITIAL MANAGEMENT CHARGE RATE (US$)	ANNUAL MANAGEMENT CHARGE RATE (US$)
Telephone overhead wire	Pole	Number	2	15
Telephone underground cable	Line	Kilometer	50	30
Fiber optic cable	Line	Kilometer	1,000	1,000
Duct > 0.28m^2	Line	Kilometer	100	100

Source: The Roads (Financing and Participation of Public Private Partnership) Regulations, 2013, Ministry of Works, Transport and Communications.

33 See www.ictc.go.tz.

administration. At the infrastructure level, the government is requiring a dig-once policy which is currently rolling out in major towns with operators jointly building ducts. Operators are required to cede some of the space for government use.

5.4 ECONOMIC DEVELOPMENT

The government recognizes ICT as a mechanism for growing the economy and has created institutions to champion development. These include the ICT Commission cited earlier, e-Government Agency with a mandate to promote e-government services, and the Commission of Science and Technology (COSTECH) to promote innovation in ICT. Unifying themes are economic growth, ICT utilization, entrepreneurship, and education.

The government is committed to provide a supportive environment through policy guidelines for cooperation and collaboration with regional and international ICT organizations for mutual benefit. Tanzania and other East African Community (EAC) countries established and operate coordinated communications infrastructure, including development and deployment of ICT applications and services, and promotion of postal services. A strategic objective is to harmonize ICT policies, laws and regulations in the EAC partner states, encourage establishment of communication infrastructure and services, standardize technology and services, and grow communication markets.

Within the region, Tanzania participates in various regional organizations including African Union Commission, East African Community Broadband ICT Network (EACBIN) and other initiatives under the Southern African Development Community (SADC). These efforts increase Tanzania's contribution in connectivity to landlocked countries through existing submarine cables. Cross border linkages through operators such as Liquid Telecom and Wananchi Telecom use NICTBB through the border points to connect landlocked countries.

The government has initiatives aiming to address urban-rural divides, social disadvantage, and other inequities, however it is unclear the extent to which these efforts will be sustainable or successful over the long term, given affordability challenge.

6. Conclusions

Subsea cable landings in Tanzania from 2009 generated employment benefits for people who were living in very close proximity to the terrestrial fiber infrastructure. These people were 18.7% more likely to employed than people in the same general area but further away from fiber. The benefits were not sufficiently widespread or large to have an impact on national employment or GDP. However, we take the results as a signal that the economic development potential is there.

Our analysis suggests that because such a small share of the population is connected to the internet, increasing connectivity—whether by increasing the coverage of terrestrial fiber, investing in last-mile infrastructure, working to make internet access more affordable, or addressing connection quality issues—could be among some of the most effective policy measures to positively impact national employment and income. Evidence from analyses we conducted in other countries suggest that subsea cable landings and (and by proxy, increases in international bandwidth) are complementary to and inseparable from the broadband penetration rate. Hence, increases in speed and quality without increases in penetration will only marginally contribute to the overall economy. In Tanzania's situation access (the intersection between affordability and availability) appears to be a paramount issue to address.

New subsea cable landings would certainly stimulate competition and innovation. They certainly would be impactful for Tanzania's operators. However, it is not clear the extent that they could have the most significant impact on affordability for Tanzanians overall.

For Tanzania's ICT sector to grow, there is need for the middle mile to open up for price and service competition. This will ensure operators provide services to their customers at an affordable rate. The opening up of the market, and the review of fees and policy will encourage more investment in Tanzania's ICT industry, thereby increasing accessibility for the final consumer. The government should address the affordability challenge by reviewing and lowering its taxation on devices and services. Doing so would lower prices and encourage uptake, which would stimulate economic activity (and public revenues).

This action would also address what superficially comes across as cognitive dissonance. On the one hand, there are strategies for ICT-based economic development. Connectivity for all is prioritized. On the other hand, there are public-sector cost drivers that worsen the affordability problem, undermining the ability of plans to deliver on their objectives.

Indeed, the high cost of capacity delivered by the middle mile is the key barrier identified by all interviewees. Opening up the middle mile to competition would perhaps be one of the most significant actions the government could take to address network expansion, access, and affordability.

Economic Impacts of Fiber Optic Subsea Cables and Broadband Connectivity in Tanzania

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