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

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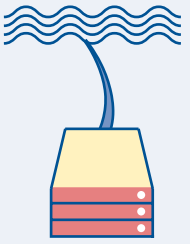
HOW DO SUBSEA CABLES GENERATE ECONOMIC IMPACT?

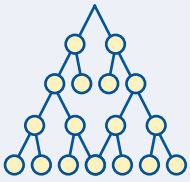
Subsea cables are the global backbone of the Internet, connecting people, businesses, and economies around the world. They connect us to the cloud, deliver streaming video, and increase efficiency and productivity. Subsea cables' importance is all the more apparent during the COVID-19 pandemic when many 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 Indonesia in 2012 to understand how they changed the economy. The results show the large impact subsea cables have had.

Subsea cables arrive



Network is built out



Internet speed increases

Price per data unit decreases

Increased data traffic competition

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 (e.g., GoJek, Bukalapak)

Growth in productivity, efficiency, and revenue for firms

Easier transition to remote work

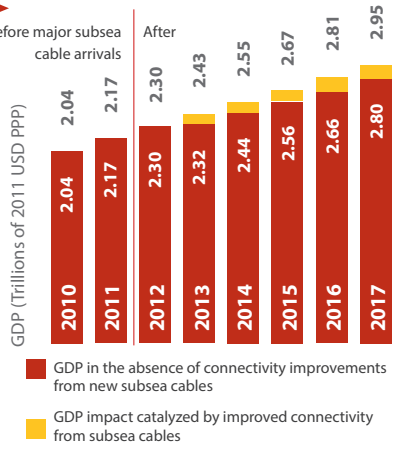
Economic Impacts

↑ Jobs ↑ GDP

The last wave of subsea cable landings led to

5.5%

increase in employment in the services sector by 2015



5.4%

increase in GDP per capita by 2017†

† Subsea cables landing in 2012 catalyzed a 5.4% increase in GDP by 2017. This chart presents values at purchasing power parity (PPP), which accounts for changes in living standards over time. Doing so presents the most accurate picture of the impact that the connectivity improvement from subsea cables makes on people's lives. At PPP, in 2017 GDP was $2.95 trillion instead of $2.80 trillion.

For reference, in nominal terms (without any adjustments to measure living standards across time and countries), Indonesia's GDP was $1 trillion in 2017.

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1. Overview

This study explores the economic impact of the internet connectivity delivered by submarine fiber optic cables ("subsea cables") on Indonesia. Subsea cables are the global backbone of the internet, connecting people, businesses, and economies around the world (Figure 1).[1,2]

Our analysis quantifies the impact that improvements in connectivity from subsea cables have had on the economy overall and on people's livelihoods. The importance of connectivity to economic growth is well-established, but rigorous studies have not been conducted for many individual countries.[3,4,5] This analysis is the first time a country-level impact study has been prepared for Indonesia using advanced econometric analysis methods paired with insights from Indonesian experts in broadband connectivity.

Known for its vibrant ecosystem of gig economy apps like GoJek and Bukalapak, Indonesia has leveraged rapid improvements in internet connectivity into economic growth. The context changes, however, outside of urban areas. In less populated, harder-to-reach areas connectivity is inconsistent. Network infrastructure economics and geography inhibit network expansion and access. The government has taken significant steps to address this challenge, particularly with the Palapa Ring, a new domestic subsea cable system.

We found that subsea cables have led to a 5.4% increase in GDP per capita between 2012 and 2017, after controlling for such things as technology trends, population characteristics, economic trends, and other important factors (Table 1). There was a 5.5% increase in services employment over the same period, equivalent to about 4.3 million jobs.

Looking back over 1997 to 2017, we found that each 10% increase in Indonesia's international data consumption per user led to a 0.41% increase in GDP per capita.

Taken together, our analysis results signal the important role subsea cables play in Indonesia's economic development.

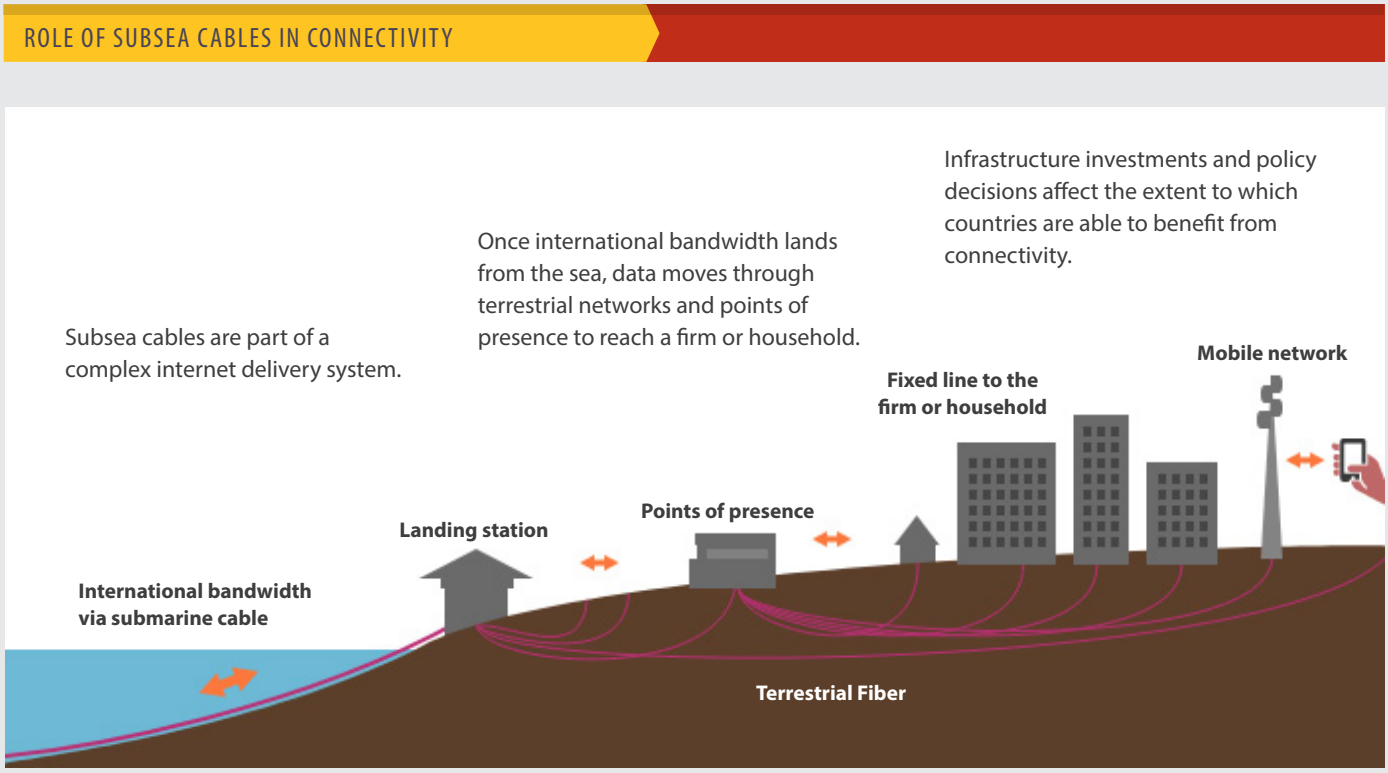
Table 1. Key Takeaways: The Economic Impact of Subsea Cables on Indonesia

INDICATOR	TIME PERIOD	OUTCOME
Economic growth	2012—2017	5.4% increase in gross domestic product (GDP) per capita
Employment	2012—2017	5.5% increase in service-sector employment over 6 years This is an increase of 4.3 million service-sector jobs
Long-term economic growth	1997—2017	0.41% increase in GDP per capita for every 10% increase in international bandwidth consumption per user Without any change in international data connectivity, the compound annual growth rate (CAGR) for GDP per capital would have been 1.32% instead of the actual rate of 2.70%

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.

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



2. Indonesia Country Profile

An archipelago nation of more than 17,000 islands (6,000 inhabited), Indonesia is the largest nation in Southeast Asia (Table 2). More than half of its 270 million people live on the island of Java, which is home to four of Indonesia's five largest cities, including Jakarta, one of the world's largest metropolitan areas with more than 30 million residents. Sumatra, Sulawesi, Kalimantan, Papua , and Bali round out the top six most-populated islands. In 2019, the government announced that a new national capital is planned for Kalimantan. The objective is to reduce pressure on Jakarta while also situating the capital more centrally and balancing development across the islands.

Indonesia has the world's 16th largest economy (in nominal terms). Its gross domestic product (GDP)—the most common measure of the value of all goods and services produced by a country—was estimated to be about $1.1 trillion in 2019. GDP per capita was $4,136. Key economic sectors include agriculture, forestry, and fishing; oil, gas, and mining; and manufacturing. About 80% of the formal economy is concentrated on the islands of Java and Sumatra.

Another way to look at Indonesia'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, Indonesia's economy is the equivalent of $3 trillion (2011 USD)—ranking 7th worldwide—with a per capita GDP of $11,173. Later, we will use the PPP method of quantifying the Indonesian economy to generate our results, enabling impacts to be interpreted directly as improvements in living standards relative to different points in the past.

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

INDICATOR	VALUE	YEAR	SOURCE
Population	270.6 million people	2019	The World Bank
Literacy Rate	96% of population aged 15+	2018	The World Bank
Primary education completion rate	78% of population aged 25+	2018	The World Bank
Poverty rate	5% of population below WB poverty line of 1.90 USD PPP/day	2018	The World Bank
GDP, nominal USD • Total • Per capita	 1.1 trillion USD 4,136 USD	2019	The World Bank
GDP, purchasing power parity • Total • Per capita	 2,950 billion (2011 USD PPP) 11,173 (2011 USD PPP)	2017	Penn World Table
GDP, rupiah	15.8 quadrillion	2019	Penn World Table
GDP growth rate	5%	2018	The World Bank
Unemployment	4.3% of labor force	2018	The World Bank

Given its geography, it is not surprising that many subsea cables traverse Indonesia's waters and connect its islands (Figure 2). Table 3 lists key cables and their landing sites.

Note that because terrestrial fiber and wireless networks connect users to subsea cables' landing stations, we include them in the analysis. 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. However, international connectivity remains critical to access the global Internet.

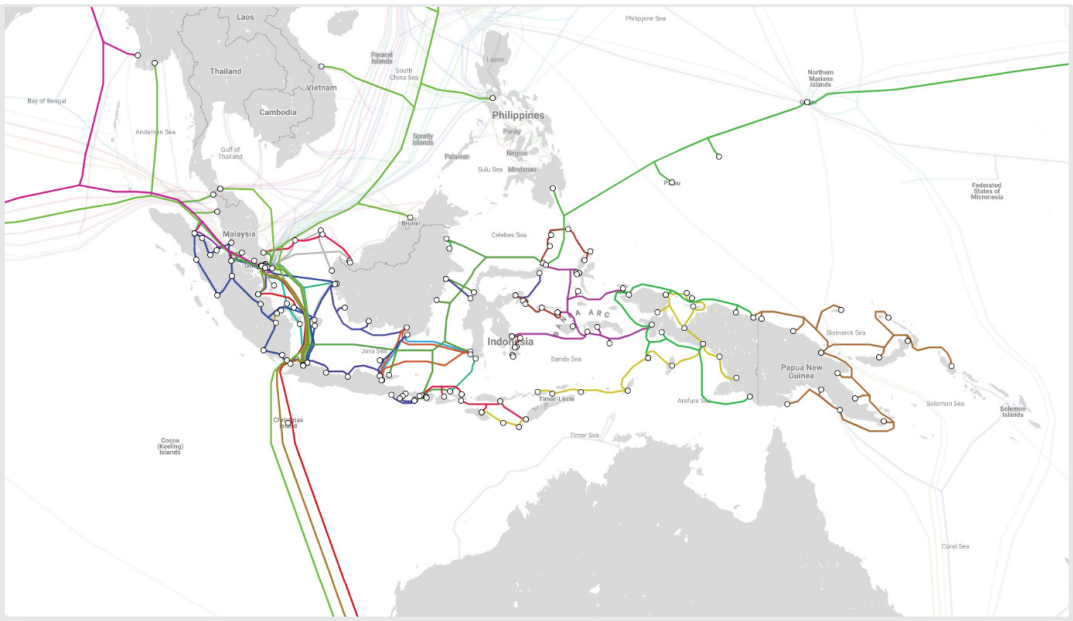


Figure 2.

Map of Indonesia's Subsea Cables

Source: Telegeography.

Table 3. **Recent Important International Subsea Cable Landings for Indonesia**

CABLE	DESIGN CAPACITY (TBPS)	LOCAL LANDING STATION(S)	READY FOR SERVICE YEAR
Australia-Singapore Cable	60	Anyer	2018
Indonesia Global Gateway (IGG) System	32	Bali, Balikpapan, Batam, Dumai, Jakarta, Madura, Makassar, Manado, Tarakan	2018
SEA Cable Exchange (SEAX-1)	225	Batam	2018
SEA-US	20	Kauditan	2017
SeaMeWe-5	36	Dumai, Medan	2016
Jakarta-Bangka-Bintan-Batam-Singapore (B3JS)	1.4	Batam, Batu Prahu, Jakarta, Pesaren	2012

Sources: Telegeography's Submarine Cable Map & STF Analytics' Submarine Cable Almanac.

3. Analysis Approach

Our study paired rigorous statistical analysis methods with interviews with more than 25 executives and market analysts in the Indonesian Internet ecosystem. This approach permitted us to acquire comprehensive insights into what the quantitative analysis results tell us. A detailed technical addendum accompanies this report.

3.1 ECONOMETRIC ANALYSES

We employed two complementary econometric methods to quantify the impacts of subsea cable landings: synthetic control and simultaneous equations model. Of all available analysis methods, these two offer the most robust, reliable, and accurate way of estimating the impacts caused by subsea cable landings in Indonesia. Both methods derive from cutting-edge statistical techniques[6,7,8] and have been used to investigate similar issues.[9,10]

3.1.1 Synthetic Control (SC)

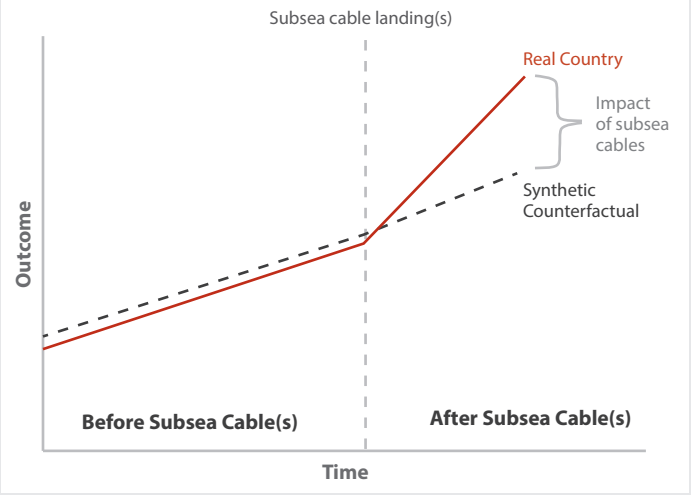
SC estimates the impact of subsea cables on economic outcomes by comparing Indonesia's actual outcomes after subsea cable arrivals to a model of Indonesia in which the cables did not arrive but for which all other prevailing economic trends continued. This latter version of Indonesia is referred to as 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 Indonesia's pre-cable arrival state. We use a weighted combination of multiple countries because the resulting counterfactual is more like Indonesia 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.

6 Imbens, G. W., & Wooldridge, J. M. 2009. Recent developments in the econometrics of program evaluation. *Journal of Economic Literature*, 47(1), 5-86.
7 Athey, S., Imbens, G. W. 2017. The State of Applied Econometrics: Causality and Policy Evaluation. *Journal of Economic Perspectives*, 31(2): 3-32.
8 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.
9 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.
10 Roller, L.H., Waverman, L. Telecommunications infrastructure and economic development: A simultaneous approach. *American Economic Review*, 91.4 (2001): 909-923.

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 3.

Figure 3. Synthetic Control Technique for Analysis of Subsea Cables

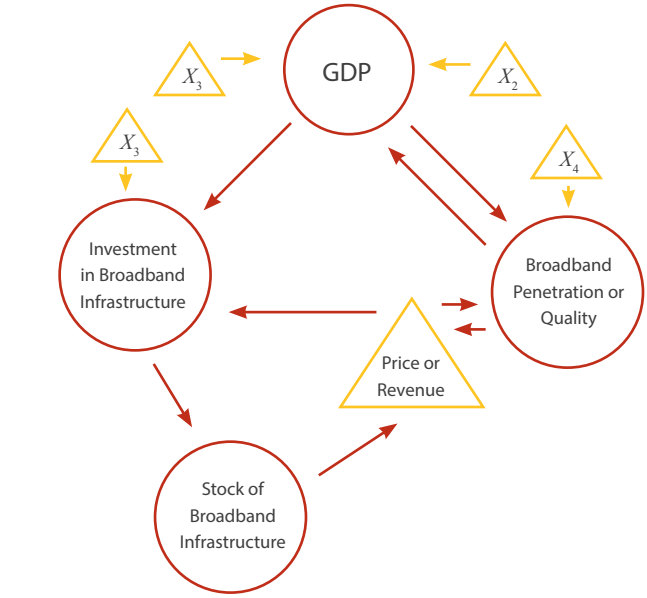


Data for the analysis are sourced from the Penn World Table (PWT)[11] and the World Bank's World Development Indicators (WDI).[12] These sources acquire national statistics from officially-recognized sources and standardize them using well-documented methodologies. Importantly, the rigor, standardization, and quality control used by PWT and WDI enable cross-country comparisons over time. This means that we have a high degree of confidence in the ability (and accuracy) of SC to match on a variety of important macroeconomic characteristics and outcomes.

3.1.2 Simultaneous Equations Model (SEM)

SEM estimates the effect of subsea cables on GDP per capita over a long period of time by modeling national economic output and the market for broadband as a system of simultaneous equations. International bandwidth is highly correlated with economic growth (GDP per capita),[13] but this alone does not reveal anything about the causal relationships between the two. It could be the case that international bandwidth has a positive effect on GDP per capita, if broadband speed enables the formation of new start-ups and/or the growth of some existing businesses. Meanwhile, or alternatively, it could be true that GDP per capita has a positive effect on international bandwidth because more resources are potentially available to invest in subsea cables and other broadband infrastructure. Moreover, it could be that neither of these variables cause change in the other and that instead the two vary together because both are driven by other distinct variables. These complexities are illustrated in Figure 4.

Figure 4. Simultaneous Equations Model Schema for Analysis of Subsea Cables



Jointly estimating the system of equations representing the aggregate economy and the dynamics of supply and demand within the broadband market enables us to more accurately approximate the causal impact of subsea cables on GDP per capita. The SEM approach accounts for the mutually reinforcing relationships (potential feedback loops arising from reverse causality) as well as other key explanatory factors, thus isolating the effects of a) increases in economic growth attributable to international bandwidth, and b) increases in the demand and supply of international bandwidth attributable to increases in economic growth.

11 Feenstra, R. C., Inklaar, R., Timmer, M. 2015. The Next Generation of the Penn World Table. *American Economic Review*, 105(10), 3150-3182.
12 World Development Indicators, The World Bank Group, 2019, https://databank.worldbank.org/source/world-development-indicators.
13 The Economist Intelligence Unit. Who dominates global data flows? Retrieved from https://perspectives.eiu.com/an-analysis-of-underwater-internet-cables

Table 4. **Similarities and Differences of Econometric Analysis Strategies**

IMPACT DIMENSION		SYNTHETIC CONTROL	SIMULTANEOUS EQUATIONS MODEL
Treatment	subsea cables (explicitly)	●	
	international bandwidth (implicitly related to subsea cables)		●
Temporality	discrete point-in-time impacts	●	
	average impact over the long run		●
Outcome	employment	●	
	economic growth	●	●
Geography	spatially-inspecific impacts (at the country-level)	●	●
Data aggregation	macroeconomic data on countries (national statistics)	●	●

The country-level data we used for SEM analysis come from the PWT, the WDI, and the International Telecommunication Union's (ITU) World Telecommunication/ICT Indicators Database.[14] These datasets are standardized to enable valid comparisons over time and thus are appropriate for use as time series variables in SEM.

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

3.2 THEMATIC ANALYSIS OF INTERVIEWS WITH KEY STAKEHOLDERS

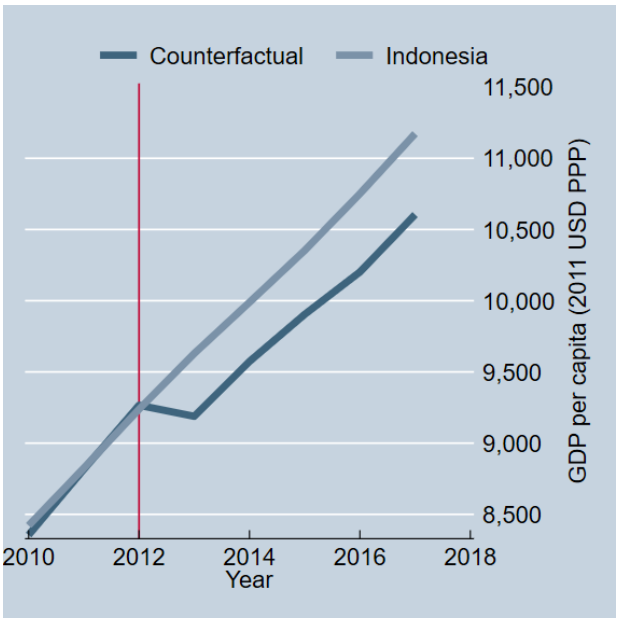
We interviewed more than 25 Indonesian broadband connectivity experts with telecommunications firms, government agencies, the subsea cable industry, other related sectors (e.g., internet service providers, content providers, app and service developers, data center providers), and trade and business associations. 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 would 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.

14 World Telecommunication/ICT Indicators Database, 22nd Edition, International Telecommunication Union, 2018, https://www.itu.int/en/ITU-D/Statistics/Pages/publications/wtid.aspx.

4. Economic Impacts of Subsea Cable Landings

Subsea cables have caused notable economic growth in Indonesia, over both the short and the long term. Over the short term, they have caused a 5.4% increase in GDP per capita between 2012 and 2017. They also increased the number of jobs in the service sector by 4.3 million. Over the long-term, we found that for every 10% increase in international bandwidth consumption per user, there was a 0.41% increase in GDP per capita.

Figure 5. Estimated Effect of Subsea Cables on GDP per Capita, 2012 to 2017



4.1 IMPACTS TO DATE

Figure 5 compares actual, observed GDP growth in Indonesia from 2010 to 2017 with what would have happened had subsea cables had not arrived. We focused specifically on cable landings between 2012 and 2016 (e.g, Jakarta-Bangka-Bintan-Batam-Singapore and SeaMeWe-5).[15] Studying the most recent landings allows us to better understand the incremental impact cable landings have.

In 2017, 5 years after the first of these arrivals, Indonesia's actual GDP per capita was about $568 greater (5.4% greater) than it otherwise would have been. In other words, without these cables, we estimate that Indonesia's GDP per capita in 2017 would have been $10,604 instead of $11,173 as shown in Table 5.[16] The impact was greatest within the first year of arrival, with additional impacts in subsequent years smaller but still positive.

Over a 20-year period, we found a large positive effect of increases in international bandwidth per user consumption (IBWPU) on GDP per capita. Our estimates suggest that each 10% increase in Indonesia's IBWPU leads to a 0.41% increase in GDP per capita.[17] See Table 6. Illustratively, the impact of IBWPU over the past 20 years amounts to an increase in GDP per capita of about $2,065.

Figure 6 depicts Indonesia's actual GDP per capita growth between 1997 and 2017. The compound annual growth rate (CAGR) was about 2.70% over this period. In the absence of any change in IBWPU, we estimate that Indonesia's GDP per capita would have grown only at roughly a CAGR of 1.32%. Subsea cables also appear to have impacts on the national labor market, showing a greater shift towards services. Figure 7 shows Indonesia's actual services employment as a percentage of its population compared to the synthetic counterfactual for 2010 to 2018. Clear divergence appears beginning in 2015, indicating a somewhat lagged effect from the first cable (e.g. Jakarta-Bangka-Bintan-Batam-Singapore) and/or greater effects from later cables (e.g. SeaMeWe-5).

In 2018, 6 years after the first of the subsea cable arrivals within recent years, Indonesia's actual share of the population employed in services was 30.5%, which is 5.5% greater than the synthetic counterfactual of 28.9%. In other words, without these subsea cables, we estimate that Indonesia's services employment in 2018 would have been 28.9% rather than the actual 30.5%. This difference amounts to approximately 4.3 million service sector jobs. The cumulative effect grows from 2015 to 2018, with the largest incremental impact occurring in 2016.

15 We focused on the cable arrivals in this timespan for SC our analysis because they contributed most substantially to a discrete increase in international bandwidth, and importantly, there were no major subsea cable arrivals during the few years prior to this set of arrivals.

16 All U.S. dollar values are in 2011 USD PPP. All Indonesian rupiah values are in 2011 rupiah.

17 These estimates describe the average effect of past changes in IBWPU in Indonesia on GDP per capita but are not necessarily predictions of the effects of future changes, which will be determined in part by future circumstances of the country.

Table 5. **Impact of Subsea Cables on GDP per Capita**

		2012	2017
2011 USD PPP	Actual	9,238	11,173
	Counterfactual	—	10,604
	Difference	—	568
2011 Indonesia Rupiah	Actual	33,364,978	40,352,944
	Counterfactual	—	38,300,135
	Difference	—	2,052,809

Figure 6. **Long-Term Trends in Actual and Counterfactual GDP per Capita and International Bandwidth Consumption per User, Indonesia**

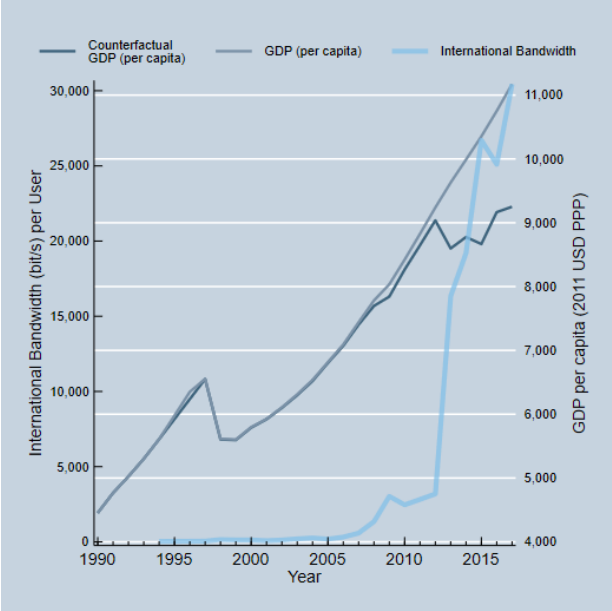


Figure 7. **Estimated Effect of Subsea cables on Employment in Services, Indonesia**

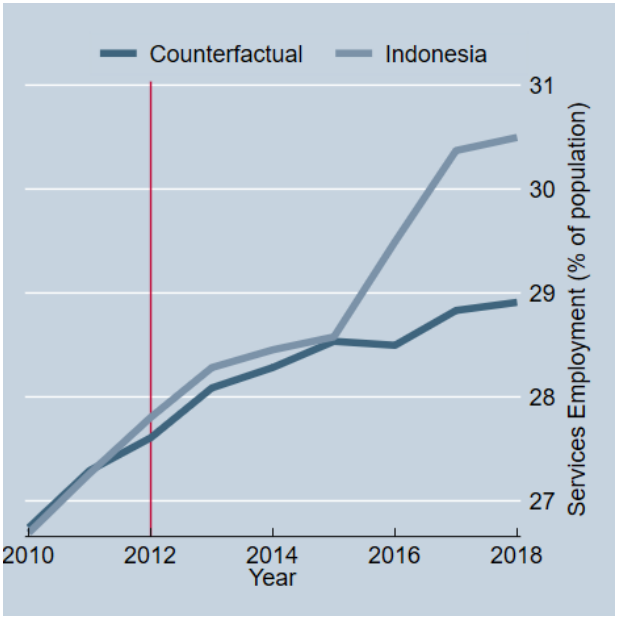


Table 6. **Long-Term Impact of International Bandwidth per User on GDP per Capita, Indonesia**

For every **10%** increase in IBWPU, there has been a **0.41%** increase in GDP per capita	Years: 1997 – 2017 Range of Estimate 0.30%‡ – 0.52%†

‡ p-value = 0.951 † p-value = 0.174

Of these additional service sector jobs, some are likely to have been created in financial services and insurance, information and communication, and company services. These industries comprised 4%, 8%, and 7% of jobs in the services sector in 2018, respectively, according to the Statistics Indonesia. Other large industries in the services sector that likely benefited include educational services and health services and social activities. Respectively, these industries comprised 26% and 8% of service sector jobs in 2018.

The findings lead us to conclude that subsea cables have caused productivity increases in Indonesia. Impacts on GDP per capita found using both analysis approaches are complemented by evidence from interviews (described later) indicating increases in the proportion of formal employment accounted for by services. We did not find a discernable increase in *overall* employment. Thus, relative to the number of new formal jobs, there is much greater economic output as a result of subsea cable arrivals.

Figure 8 illustrates cables' overall impact on Indonesia's GDP. Better connectivity stimulated the economy, causing it to grow more quickly than it otherwise would have. By 2017, the annual impact on GDP was equivalent to about $150 billion (at PPP).

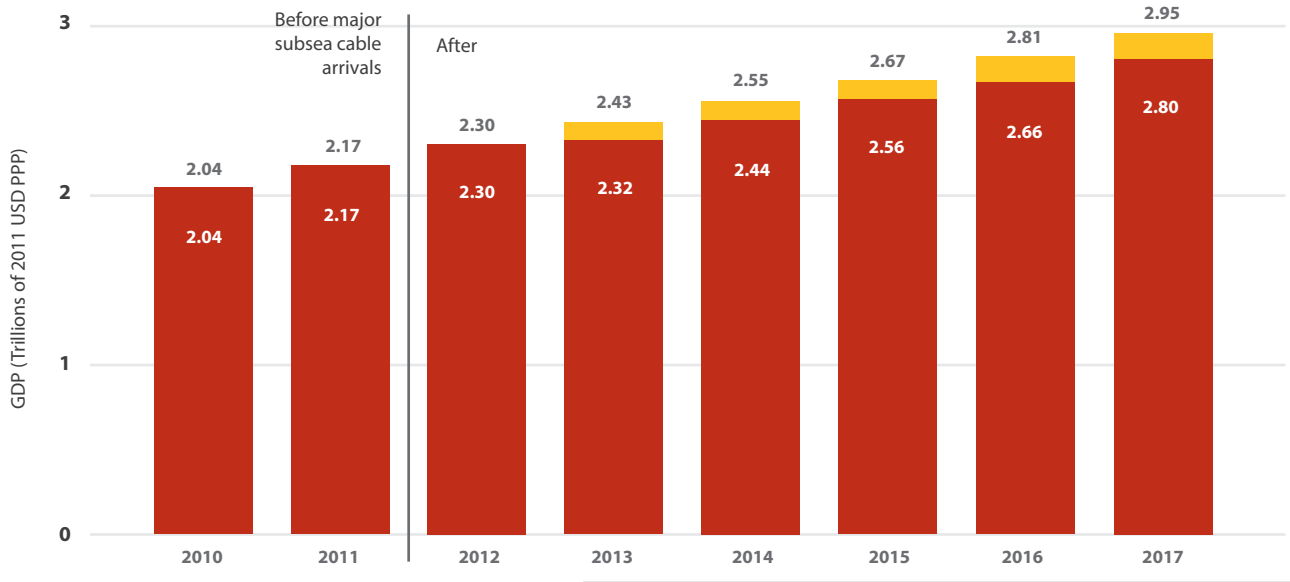
Altogether, the evidence suggests that subsea cables have driven impressive growth in GDP per capita mostly by facilitating modernization and enhanced productivity in the Indonesian economy. It is possible that the same economic dynamism enabled by subsea cables that has driven growth may also help to create and preserve jobs in the long run.

4.2 FORWARD-LOOKING IMPLICATIONS OF ECONOMETRIC ANALYSES

Numerous factors play a role in determining if future subsea cable landings will have similar impacts to those discussed above. Important factors include improvements to technology, Indonesia's future terrestrial broadband infrastructure, changes in the skills of the labor force, and policy changes.

The evidence of impact on overall growth in Indonesia from subsea cables is overwhelmingly positive so far; however, effects likely vary for specific demographics of the population and types of firms. As more of Indonesia's economy shifts towards industries leveraging connectivity, highly educated and skilled segments of the labor force may be relatively better poised to take advantage of the technology. This, in turn, could contribute to widened disparities in socioeconomic outcomes across certain demographics if left unaddressed. Policies that expand geographic access and improve access through greater competition while maintaining broadband quality would likely further amplify cables' impact on overall growth while mitigating the emergence of inequities.

Figure 8. Estimated Impact of Subsea Cables' Connectivity on Indonesia's GDP at PPP



Subsea cables landing in 2012 catalyzed a 5.4% increase in GDP by 2017. This chart presents values at purchasing power parity (PPP), which accounts for changes in living standards over time. Doing so presents the most accurate picture of the impact that the connectivity improvement from subsea cables makes on people's lives. At PPP, in 2017 GDP was $2.95 trillion instead of $2.80 trillion.

For reference, in nominal terms (without any adjustments to measure living standards across time and countries), Indonesia's GDP was $1 trillion in 2017.

5. Stakeholder Perspectives on Connectivity

Interviewees concurred with our quantitative analysis results, emphasizing how gains in connectivity allowed for entrepreneurs and start-ups to leverage apps to overcome the logistical challenges of serving an archipelago nation. According to one executive, demand is expected to grow by 5 times by 2025. For key indicators, see Table 6.

The strength of connectivity is greatest on the major islands of Sumatra, Java, and Bali and in urban areas. In other locales, connectivity can be inconsistent. In response, the Indonesian government intervened with the construction of the Palapa Ring, a 12,000 km fiber ring connecting islands, and other projects to boost access.

5.1 NETWORK EXPANSION

5.1.1 The Palapa Ring

For Indonesia, geography conspires against even and comprehensive connectivity. The 43,000 km of domestic cables linking the major islands, and 25,000 km of foreign cable passing through Indonesian waters, are vulnerable to breaks from natural disasters, seismic activity, and shipping. Experts emphasize that these factors present headwinds to private-sector investment.

To boost access, the government built the Palapa Ring, more than 12,000 km of subsea cables that bridge gaps in private-sector infrastructure and facilitate connectivity. BAKTI, the government agency, is moving to ensure the Ring works for the last mile. It has a mandate to develop infrastructure for the universal service obligation. According to one long-time industry executive some 10% of Indonesians—28 million people—are estimated to have poor or no internet availability.

To address this, BAKTI launched a tender for a second project: a multifunction high-throughput satellite that can provide 150 Gbps of capacity via 116 spot beams to some 150,000 public facilities. BAKTI considered other options, but realized it would take years to build terrestrial networks, so they are pursuing a dual track process, where they will put out tenders for fiber connections but rely on satellites until the connections are ready, assumed to be about a decade. "Gradually when the last mile is connected this reliance on satellite can be reduced," said one advisor to the project. "BAKTI is essentially taking on itself the role of trying to solve the issue of connecting from points of presence of the Palapa Ring to the end user."[18]

The government meanwhile is trying to make things simpler for companies wanting to build out infrastructure on the back of the Ring. For example, an online single submission

Table 6. Key ICT Indicators, Indonesia

INDICATOR	UNITS	YEAR
Electrification	98% of population with access to electricity	2017[a]
Internet users	32% of population	2017[a]
Fixed broadband subscribers	3.28 subscriptions per 100 inhabitants	2018[a]
Fixed Broadband Speed	10 megabits per second	2017[a]
Fixed Broadband Monthly Subscription Charge	18.37 2011 USD PPP	2017[a]
Mobile Cellular Subscribers	120 subscriptions per 100 inhabitants	2018[a]
Mobile Download Speed	14 megabits per second	2020[b]
Mobile Broadband Prepaid Subscription Charge	3.22 2011 USD PPP per 500 megabits	2017[a]

[a] International Telecommunication Union
[b] Ookla Speedtest

18 A consortium led by PT Pasifik Satelit Nusantara won the tender in 2019 and plans to launch in 2022. See also https://theinsiderstories.com/indonesias-psn-consortium-wins-us1-5b-satellite-multifunction-project/.

service will allow contractors and others to complete their paperwork more easily. BAKTI is also interceding where it can to expedite and facilitate in those instances where obstacles impede progress.

5.1.2 Mobile Wireless

The rise of Indonesian unicorns offers a view into how Indonesia exploits existing technologies to overcome bottlenecks, and a possible glimpse of how the deployment of subsea cables to the country's outlying islands may unleash new forms entrepreneurship. It is still a mobile world, and an affordable one, with prices costing half or less of some of its neighbors. However, quality trails, according to data from Ookla's Speedtest (Table 7). Improvements in international connectivity could improve these stats.The mobile-mainly world favors startups which work around the logistical limitations, or create solutions. One senior telecoms executive pointed out that for a long time the conventional wisdom in Indonesia had been that e-commerce would never take off because of the twin problems of logistics and payments, neither of which looked like being solved any time soon. But GoJek and Grab, and other companies like Bukalapak, have turned those challenges to their advantage, leveraging existing logistical infrastructure or transportation, and building their own mobile wallets and payments systems.

Many of these companies only took off in 2015, some 4 to 5 years after they were founded, propelled in part by improved internet speeds and cheaper devices. In 2016 there was a 142% growth in mobile data traffic in Indonesia, compared to 86% in China and 76% in India. New cable landings had a substantial impact.

This has been largely the case in highly-populated areas. Beyond them, the challenge is greater, as alluded to above. A survey conducted by the E-commerce Association of Indonesia (idEA) and Marketing Research Indonesia (MARS) in 2016 reported that only 11% of those in rural areas shopped online, compared to 39% in towns.[19] This has forced e-commerce companies to be creative: Bukalapak delivers physical goods around the country via a network of 900,000 kiosks, whose deployment largely mirrors the local quality of internet connectivity.

For now, logistical challenges create opportunities for start-ups to forge a competitive advantage. One company said it checks where the user is based before pushing the app to them. In a Tier 1 city, a user would have the standard app, whereas one in Tier 3 cities and lower (those with less than 500,000 people) would have a lighter, smaller app which is likely to run better and faster on a phone with a slower connection. As the network expands, regional variations will likely give way to more uniform service provision.

Table 7. **Key ICT Indicators, Indonesia**

COUNTRY	MOBILE DATA SPEED (MBPS DEC 2019)	FIXED BROADBAND SPEED (MBPS, DEC 2019)	AVERAGE MOBILE COST OF 1 GB (USD)	FIXED BROADBAND PRICE PER MONTH (USD)
Indonesia	13.83	20.11	1.21	30.02
Thailand	25.98	125.12	2.78	23.82
Singapore	57.16	200.12	3.67	43.80
Philippines	16.76	25.55	3.16	43.80
Malaysia	23.80	78.03	1.18	31.75
Vietnam	30.27	43.26	1.31	11.23
Laos	25.54	34.48	3.42	47.24
Myanmar	23.86	18.90	0.87	36.82
Cambodia	15.22	20.89	1.49	32.63

Sources: Ookla Speedtest, Cable.co.uk.

19 Budiono, F., Lau, S., Tibben, W. 2018. Cloud Computing Adoption for E-Commerce in Developing Countries: Contributing Factors and Its Implication for Indonesia. *PACIS 2018 Proceedings*.

5.1.3 Fixed Broadband

Cable landings and building out the necessary ancillary infrastructure could yield the rise of more fixed broadband subscribers, especially among industry, which could experience lower connectivity costs and/or rises in productivity.

Fixed broadband accounts for a small share of the number of subscribers, meaning that there are still plenty of opportunities to cater to desktop/laptop-based services and those requiring intense or extremely low latency bandwidth.

High-speed fixed broadband penetration (connections over 5 megabits per second, or Mbps) is increasing. DBS Bank said in a research note that penetration had risen to 10% in 2Q19, from 4% in the first half of 2017. DBS also reckoned 8 million new households would be added by 2021, bringing penetration to 20%.[20] Thus, the market remains modest, but it will mean millions of Indonesians will be able to access high definition video and gaming more seamlessly, as well as widen opportunities for freelancers and studio businesses working on data-heavy projects.

5.1.4 Further Expansion

This evolution of Indonesia from tech backwater to home of logistics-busting apps like GoJek has naturally influenced thinking at the telcos. The greater connectivity the Ring provides to otherwise less attractive markets within the archipelago presents an opportunity. There is growing interest among telcos in building their markets beyond Java, and investing in the infrastructure to do it, pivoting off the capability provided by the Ring.

This is a reverse of the past few years, when some companies switched off base stations because of the cost of backhaul and the expense of maintaining them. Now nearly all telcos are committing significant funds to building networks beyond Java.

XL Axiata, for example, has been deploying fiber in all provincial capitals and major cities on the islands of Java, Madura, Sumatra, Kalimantan, Sulawesi, Bali, and Lombok. Currently, fiber serves some 30% of BTS – mainly covering the Java region – but its target was that by the end of 2019, 50% of BTS would be connected to fiber networks, increasing to around 60-70% by the end of 2020. In November 2019 Telkomsel announced that it had recently deployed about 15,000 BTS, with many of them in the country's so-called 'Frontier, Outermost and Disadvantaged' (3T) regions.

5.2 ECONOMIC DEVELOPMENT

The government has long pursued a policy of ensuring equal access to broadband internet. The Palapa Ring and initiatives to boost network availability are products of these policies. Like other countries, Indonesia adopted programs from the UN's Sustainable Development Goals, where broadband is one of the infrastructures that should be available and developed by the government. Beyond that, broadband connectivity is important for national unity, to provide equality among the provinces, where the emphasis is not just on Bali, Sumatra, and Java. President Jokowi has been explicit in saying he wants the economic focus to be in other parts of the country. So, the country's Indonesia Broadband Plan goes beyond what the UN calls for: it sees internet connectivity in terms of national unity and equal opportunities for other people.[21]

Indonesia is a nation of entrepreneurs: There are nearly 60 million micro- and small enterprises, constituting some 99.9 percent of companies in Indonesia, and accounting for about 97 percent of the workforce, while contributing between 58-61% of gross domestic product. And while most of them are sole proprietorships, they have usually been quick to exploit the opportunities provided by communication technologies.

In the early 2000s, for example, having a mobile phone meant that a *sate* seller could receive orders by SMS overnight and anticipate the day's demand before she went to the morning market to buy the necessary ingredients, often doubling her daily earnings. This same trend is now playing out with the rise of Indonesian decacorns – mega-startups that offer a smorgasbord of ecommerce opportunities to those looking to amplify their business.

The initial GoJek service itself, which 'professionalized' the informal sector where people – effectively individual entrepreneurs in a cash economy – ferried passengers between homes, offices and bus stops, also served to connect some 80,000 of them to the internet for the first time via the app, as well as helping a quarter million of them open their first bank accounts. The addition of other services has had the same

20 DBS Indonesia Telecom Report, 2019 October.

21 See Rosalia Adisti, Human Development Impact of the Implementation of Broadband, A case study of the Indonesian Palapa Ring Project, and Indonesia Digital for Future Economy and Inclusive Urban Transformation, Eddy Satriya, Deputy Assistant for ICT and Utility, Ministry

effect on other sectors: Nearly all food stall-holders and cafe owners who sold their wares via GoJek's Go-Food service, for example, have seen their transaction volume grow. Indeed, data suggests that as GoJek moves into these other areas, its contribution to the economy will grow considerably.[22] Clearly none of this would have happened without the necessary connectivity, ubiquity and affordability of devices, and familiarity with the technology, irrespective of age and education. As this level of comfort spreads, so do owners of small enterprises shift their services from offline to online selling.

But this is uneven. Many of the country's successful startups emerged *because* of the inadequacies of existing infrastructure and services, from transport to payment, rising to fill such gaps by leveraging cheap and ready connectivity (see above). But where the connectivity is lacking, so are the opportunities for SMEs. While more than 60% of SMEs were online 2017, there's still an imbalance: according to the Ministry of Cooperatives and Small and Medium Enterprises, the lack of internet connections in less developed areas of the country create challenges for SMEs. This is partly why those parts of the population form a key justification for the rollout of the Palapa Ring.

Connectivity gains are critical for future industries and key internet of things and other 4th Industrial Revolution technologies that rely on robust connectivity. There is also a sense that Indonesia is on the cusp of breaking into the business process outsourcing market. Aside from strictly online industries, improved digital infrastructure is crucial to government plans to encourage high-value industrial development and boost local manufacturing. The Making Indonesia 4.0 road map launched in April 2018 seeks to diversify the economy away from a reliance on natural resources by developing higher-tech export industries. Areas of focus include 3D printing, artificial intelligence, human-machine interface, robotics and sensor technology, all of which require advanced digital capacity. Planners hope that the strategy will create between 7 million and 19 million new jobs between 2018 and 2030 and lift the industrial sector's gross domestic product contribution from 20 percent to 30 percent over the same period. McKinsey believes that with the necessary investments, automation in Indonesia could create many more jobs than it displaces: a net gain of four million to 23 million full-time-equivalent jobs.

There's hope that improvements in connectivity will help bring government services to remote villages, and, in turn to stem the migration of youth to the cities: e-government, e-health, and e-education are all seen as services that could be provided over the new network connections.

Particularly for education, the boost will be welcome. Access to education and its quality remain concerns. On the OECD's most recent Programme for International Student Assessment (PISA), Indonesia scored second lowest among all countries surveyed in terms of the percentage of high-achieving students who expect to complete tertiary education. This means that students who qualified enough to study more aren't, often because they don't have the money, or the facilities are not available. This shows up in the workforce: Indonesia came last in terms of the percentage of employed adults with tertiary education. Indonesia was, perhaps not unexpectedly, second last when it came to expectations for their career among top performing math and science students.

6. Conclusion

The international connectivity provided by subsea cables led to a 5.4% increase in GDP per capita. By 2017, the total GDP impact was equivalent to roughly $150 billion (at PPP).

What is more, subsea cables have been key to the emergence of the gig economy apps that define modern Indonesia. We attribute shifts towards service sector employment (+4.3 million jobs) and digital transformation to the gains in connectivity, improvements in internet quality, and consequent price reductions and increases in access.

The evidence also affirms Indonesia's development goals that emphasize improvements in connectivity and access. Over the long term (>20 years), for every 10 percent increase in international bandwidth per user, there has been a 0.41% increase in GDP per capita.

Our results underscore the economic development significance of subsea cable landings, international connectivity, and policies and programs that are bringing connectivity beyond the beach across the archipelago.

22 Academic research found that two of the company's services contributed 15.1 trillion rupiah to the economy in 2017; in 2018 it was calculated the overall company had contributed between 44 and 55 trillion rupiah.

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