The poverty reduction effects of mobile broadband in Africa:

Evidence from Nigeria

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Attribution

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Contents

Executive summary

The COVID-19 pandemic has brought home the salience of digital technologies as vital elements of today's economic and social systems. Technology plays an integral role in spurring economic growth, helping to create new job opportunities, promote greater efficiency and generate innovation.

Mobile technology, in particular, constitutes the primary – and often only – method of digital access for people around the world, with almost 4 billion mobile broadband subscribers globally.[1] It plays a particularly important role in Africa, where a large majority of people access the internet through mobile phones rather than through fixed broadband. That said, Africa also lags behind in the rollout of mobile broadband infrastructure. Almost a quarter of the continent's population is not covered by a mobile broadband network and almost three quarters do not use mobile internet, meaning they are unable to benefit from the digital revolution that has swept across the world over the past two decades.

Against this background, however, there is little evidence that speaks to the question of how access to mobile broadband can affect the welfare of people in Africa – particularly those living in poverty. This has become increasingly important as there are signs of widening digital gaps in access to the internet across countries as well as along demographic and socioeconomic lines, which could exacerbate existing inequalities.

To answer this question, the GSMA and the World Bank developed an innovative, ground-breaking study to subject to empirical scrutiny the impact of mobile broadband on welfare and poverty reduction, using data from Nigeria[2] – the largest mobile market and economy in Africa. The analysis shows that having at least one year of mobile broadband coverage increases total consumption by about 6%. This estimate reaches 8% after two years of coverage. Similarly, the proportion of households below the extreme poverty line ($1.90 per day) drops by about 4 percentage points after one year of gaining mobile broadband coverage and by about 7 percentage points after two or more years of coverage. This corresponds to moving approximately 2.5 million people out of extreme poverty. The study also shows that rural households in particular stand to gain more than urban households from such benefits in relative terms.

Mobile technology – and mobile broadband in particular – can play a significant role in poverty reduction. While it remains to be seen whether mobile broadband has had equivalent effects in other African countries, it is important to accelerate the rollout of mobile broadband infrastructure in those countries lagging behind.

1. GSMA, The State of Mobile Internet Connectivity Report 2020
2. This short paper presents the main findings of the GSMA and World Bank's study. For detailed results and methodology download the full study

These findings call for policymakers, international organisations and other decision makers to put the development of digital infrastructure at the heart of strategies to reduce poverty and promote inclusive growth in Africa. Three policy lessons can be derived from this work:

1. **Expanding broadband coverage to rural and remote areas can reduce extreme poverty**. Globally, there are still almost 600 million people that do not live within reach of either a 3G or 4G network – around half of them in Africa. Most of them live in rural and remote areas. Bridging the digital divide between rural and urban areas and providing universal mobile broadband coverage can be an effective instrument to alleviate inequality and reduce poverty.

2. **Policies to address the usage gap across socioeconomic groups are necessary to ensure everyone benefits from digital technologies**. In Nigeria, as in many parts of the world, inequalities persist in access to mobile broadband services by gender, location and education, as well as between people with and without disabilities. For example, in 2019 the gender gap in mobile internet usage in Nigeria was 29% (meaning that women were 29% less likely than men to use mobile internet). These underserved groups face a multitude of barriers to fully reaping the benefits of mobile internet, including limited purchasing power, affordability of services and devices, relevance of content, lack of digital skills, and online safety and security.[3]

3. **Complementary policies are needed to realise the social and economic benefits of digital connectivity for all**. Our study suggests that increased labour force participation is one of the key mechanisms through which mobile broadband infrastructure enhances the welfare of individuals and households. Expansion of digital infrastructure and access to the internet can not only help create more jobs, but can also reduce transaction costs for people finding jobs and can improve productivity.[4] Well-functioning markets, strong institutions and complementary investments including road infrastructure, competition in input and output markets, and high-quality public services, help the deployment of infrastructure in rural and remote areas and need to interact with mobile broadband access to maximise its potential welfare effects.

Nigeria mobile market:

103m mobile subscribers

68m mobile internet subscribers

3G coverage:

2010	2015	2020
21%	57%	78%

Impact of mobile broadband coverage:

Household total consumption increases by:

6% after 1 year of 3G/4G coverage and by 8% after 2 years

The proportion of households in extreme poverty decreases by:

- 4 percentage points after 1 year of coverage
- and by
- 7 percentage points after 2 years

Effects comparable with moving **2.5m people** out of extreme poverty between **2010 – 2015**

Welfare effects are more pronounced among rural households

3G/4G coverage improves welfare through labour force participation.

3. See GSMA, State of Mobile Internet Connectivity, 2020, for detailed data and analysis on these barriers.
4. Other studies also show that the internet can help create new job opportunities and increase labour productivity. See Paunov and Rollo 2014; Fernandes et al. 2019; Chun and Tang 2018; Hjort and Poulsen 2019; Viollaz and Winkler 2020.

1 The role of mobile broadband in poverty reduction

Over the past three decades, the world has made considerable progress in reducing extreme poverty, with the share of people living on less than $1.90 per day (in 2011 purchasing power parity, PPP) falling from 36% in 1990 to roughly 10% in 2015, or approximately 736 million people (World Bank, 2018). Despite this impressive progress, poverty remains ubiquitous across much of Sub-Saharan Africa, which hosts 27 of the 28 poorest countries in the world and was home to 41% of people living in extreme poverty in 2015. Also, as of 2015 about one in eight of the world's extreme poor resided in Nigeria (World Bank, 2018). Under a business-as-usual scenario, the region will likely fall short of achieving the United Nations Sustainable Development Goal of eradicating poverty by 2030.[5] On top of this, the World Bank recently estimated that the current COVID-19 pandemic and its associated economic crisis could push between 71 and 100 million people into extreme poverty.[6]

With more than 5 billion subscribers of mobile services and almost 4 billion subscribers of mobile internet globally,[7] mobile technology has been the primary – and often only – method of digital access for people around the world, but especially in low- and middle-income countries. According to the International Telecommunications Union (ITU), in 2019, mobile accounted for 87% of broadband connections in developing countries.[8] It plays a particularly important role in Africa, where a large majority of people access the internet through mobile phones rather than through fixed broadband.[9] That said, Africa also lags behind in the rollout of mobile broadband infrastructure. Almost a quarter of the continent's population is not covered by a mobile broadband network[10] and almost three quarters do not use mobile internet, meaning they are unable to benefit from the digital revolution that has swept across the world over the past two decades.

In this context, the objective of this brief is to illustrate the potential role mobile broadband can play in accelerating the pace of poverty reduction in Africa, based on evidence from a case study of Nigeria. The COVID-19 pandemic has brought home the salience of digital technologies as vital elements of today's economic and social systems. From teleworking and e-commerce to telemedicine and remote learning, digital technologies have supported continued access to education, healthcare, essential goods and services, and family and friends. Businesses have also had to accelerate digitisation, reshape the way they are run and how they interact with the rest of the economy. Therefore, expanding the evidence base on the importance of mobile broadband to improving livelihoods is a priority policy issue.

A rapidly growing body of research shows that the internet – particularly mobile broadband – has widespread positive macroeconomic impacts, improving the utilisation of labour and capital, and increasing productivity. For example, recent studies have shown that a 10% increase in broadband penetration raised annual per-capita growth by 0.9–1.5% in OECD countries, and provide a 1.5–2.5% increase in GDP in developing countries.[11] A study by GSMA Intelligence shows that the positive economic impact of mobile technology increases as it is upgraded from 2G to 3G[12] and 4G.[13]

5. Beegle and Christiaensen (2019)
6. Mahler et al. (2020)
7. GSMA, The State of Mobile Internet Connectivity Report 2020
8. Source: ITU. Developing countries in this analysis are categorised according to UN classifications.
9. The number of active mobile broadband subscriptions per 100 inhabitants in Africa in 2017 was 34.0, while the corresponding rate for fixed broadband subscriptions was 0.4 (ITU 2019).
10. Mobile broadband is defined as the provision of 3G or 4G coverage, which enables high-speed access to the internet, and excludes 2G coverage as it only provides for limited internet browsing and applications.
11. Czenich et al., 2011 for OECD countries; ITU, Katz and Callorda (2018) and ITU (2019)
12. 2G technologies enable voice, SMS, and limited internet access, while 3G technologies or above enable more rapid internet browsing and data downloading.
13. Bahia, Castells and Pedros (2020).

However, there is little evidence that speaks to the question of how access to mobile broadband can affect the welfare of individuals and households at the micro level, particularly among the extreme poor. In fact, only a few studies subject the impact of mobile broadband on welfare to rigorous empirical testing.[14] One reason is a lack of high-quality and sufficiently granular data available over time, both in terms of access to mobile broadband and individual measures of welfare for the same individuals or households. A second reason is that the direction of impact can work both ways. Individuals that use mobile broadband may already have higher levels of consumption than those that do not, and mobile operators are more likely to deploy networks in higher-income areas that have higher expected returns.

Furthermore, the benefits to be gained from the internet may not necessarily accrue to people uniformly; there can be significant gaps in terms of who stands to benefit. For instance, some evidence suggests that the internet may benefit more educated individuals who are better able to realise the full value of digital technologies.[15] This could exacerbate digital divides and widen inequalities in other socioeconomic indicators, such as education.[16]

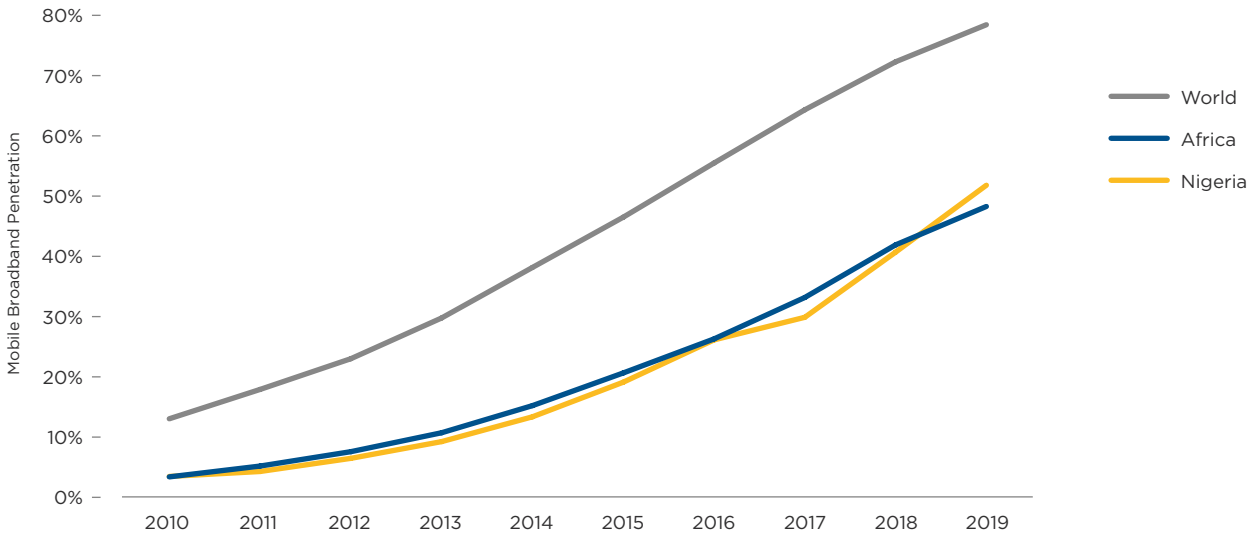
14. Of the few studies that have assessed the causal impact of digital technology, especially in low- and middle-income countries, the focus has generally been on mobile coverage (including 2G) and mobile money. While these represent important advances, there is a lack of evidence that considers the causal impact of mobile internet in a rigorous manner. For a detailed list of references on this topic, see Bahia et al. (2020).
15. See World Bank (2016) and Hjort and Poulsen (2019)
16. See Autor and Acemoglu (2011) for a comprehensive review of the literature on the impacts of information and communication technologies on the labour market.

2 Nigeria case study

In a recent joint GSMA and World Bank study, we analyse the welfare impact of mobile broadband based on data from Nigeria, the largest mobile market and economy in Africa.[17] The country offers an interesting case study to test a potential causal linkage between mobile broadband and welfare. Nigeria has witnessed rapid expansion in mobile broadband penetration over the past decade, which mirrors the overall trend for the entire Africa region (Figure 1). At the end of 2019, there were more than 170 million mobile connections, 60% of which used 3G or 4G technology.

Figure 1

Mobile broadband penetration, based on connections, 2010–2019



Source: GSMA Intelligence. Penetration is calculated by dividing the total number of 3G/4G connections by total population. A mobile connection is a unique SIM card (or phone number, where SIM cards are not used) that has been registered on a mobile network. Connections differ from subscribers as a unique subscriber can have multiple connections.

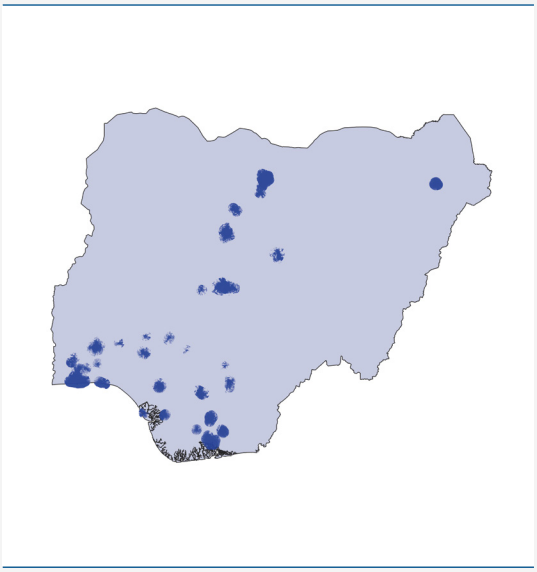
Within Nigeria, mobile broadband coverage expanded rapidly from a few main cities initially to a large number of intermediate cities and rural areas between 2010 and 2015 (see Figure 2). This represented an increase in population coverage from 21% to 57%.[18] By contrast, during the same period, penetration of fixed broadband in the country averaged around 2%, reaching just over 5% in 2016. Mobile technology has therefore been the primary platform for users in Nigeria to access broadband services. Based on these facts, the goal of this study was to identify whether households covered by 3G have experienced any gains in their overall welfare (or consumption) and whether the rollout of 3G has resulted in a reduction in poverty.

17. GSMA and World Bank, The Welfare Effects of Mobile Broadband Internet: Evidence from Nigeria (2020)
18. Note that coverage is distinct from usage. The latter refers to when an individual has a SIM card that can be used in a mobile phone to access the internet. Coverage refers to when an individual lives within range of a 3G/4G cellular signal, irrespective of whether or not they use mobile.

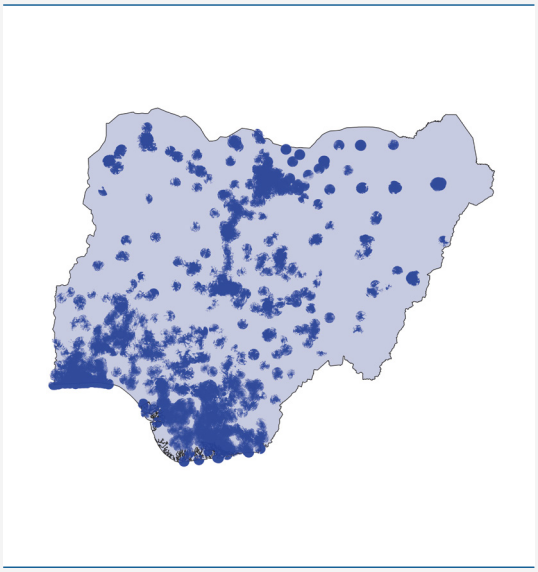
Figure 2

Changes in 3G coverage area within Nigeria, 2010–2015

A) 2010



B) 2015



Source: GSMA Mobile Coverage Maps (www.mobilecoveragemaps.com)
Blue = areas covered by 3G.

The main issue when identifying the effects of mobile broadband on household welfare is separating the impact solely attributable to internet access from other confounding factors that may simultaneously affect internet access and welfare outcomes. For instance, urban areas tend to have greater access to 3G compared to rural areas. When simply comparing households with and without 3G coverage, one would expect to see those covered by 3G enjoying a higher level of welfare and lower poverty compared to those not covered by 3G. But this does not mean that 3G coverage *per se* has caused the former to be wealthier than the latter. Urban areas also provide better access to economic opportunities and jobs as well as other types of services such as education and healthcare, which would explain better observable outcomes for households in urban areas.

To alleviate this concern, the study utilised longitudinal data of household-level consumption and poverty collected over three waves of the General Household Survey (GHS) of Nigeria (2010/11, 2012/13 and 2015/16). One of the key advantages of the data is that the same households were tracked across the three waves, allowing us to observe how the welfare level of each household changed over time. Next, we merged this data with the high-resolution coverage maps of mobile broadband networks provided by mobile

19. To produce 3G/4G coverage maps for Nigeria over time, we collected network infrastructure data directly from three of the four largest mobile network operators (MNOs) in Nigeria and calculated mobile broadband coverage based on a radio propagation model – a tool used by MNOs to plan the deployment and coverage of their infrastructure.
20. The data is matched with the maximum offset of 45 metres.

operators[19] based on the (almost) exact locations of households.[20] Using this unique dataset, we can compare those households that gained coverage of mobile broadband technologies over time (or during the period of study) and those that had not yet gained coverage; and test if the former experienced faster growth in welfare.[21] Furthermore, we studied several sub-samples to explore heterogeneous effects by: gender; initial level of consumption of each household; region; age; area (urban/rural) of residence; education of the household head or respondent; and the presence of children under the age of three.

Main results

Our analysis shows that the deployment of mobile broadband infrastructure has played a significant role in increasing household welfare and reducing poverty in Nigeria. The welfare effects are different depending on how long households have been exposed to coverage:

- Total consumption of households is expected to increase by around 6% for at least one year of 3G/4G coverage and reaches 8% after two years of coverage (Figure 3a).
- The proportion of households in extreme poverty declined by about 4 percentage points for at least one year of coverage and about 7 percentage points for at least two or more years of coverage (Figure 3b). The result corresponds to moving approximately 2.5 million people out of extreme poverty.
- The welfare effects of 3G/4G are particularly pronounced among rural households (Figure 4).
- One of the key mechanisms through which 3G/4G coverage affects welfare is its impact on labour force participation.

21. Even then, there is still a potential concern with our difference-in-difference strategy. For instance, it is plausible that the rollout of mobile broadband is not random over time, since operators may target areas that are more prosperous and growing faster, which in turn are likely to have faster growth in consumption levels. However, our results turn out to be robust to alternative approaches that strongly suggest a causal effect. Indeed, the consumption and poverty trends for both households that eventually are and are not covered by mobile broadband are similar before the rollout of mobile broadband; and the results also hold when looking at the impact on households that receive mobile broadband coverage unintentionally due to surrounding terrain features – which should not be directly correlated with welfare.

Figure 3a

Impact of 3G/4G access on total consumption (point estimates)

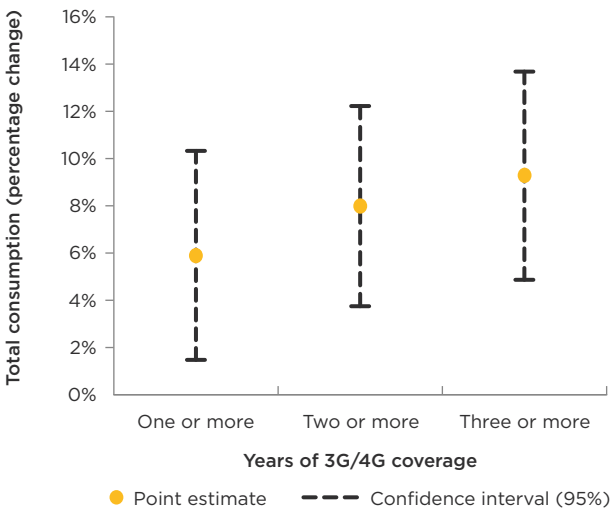
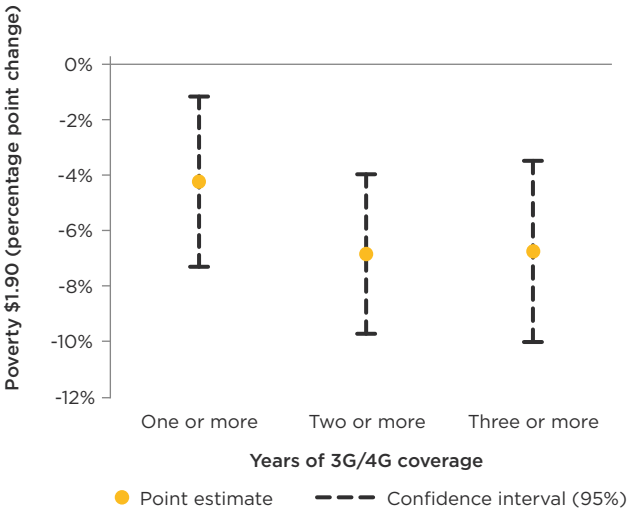


Figure 3b

Impact of 3G/4G access on poverty ($1.90) (point estimates)



Source: Bahia et al. 2020
Notes: Point estimates at 5% confidence interval. Difference-in-difference estimators across total consumption and poverty. Standard errors are clustered by Local Government Authorities (LGAs). Additional controls include access to electricity, ownership of dwelling, household size and a wealth index, although the coefficients for these variables are not reported to save space. Poverty measure is equal to 1 if the household per-capita consumption is less than the international extreme poverty line of $1.90 per day (measured in purchasing power parity).

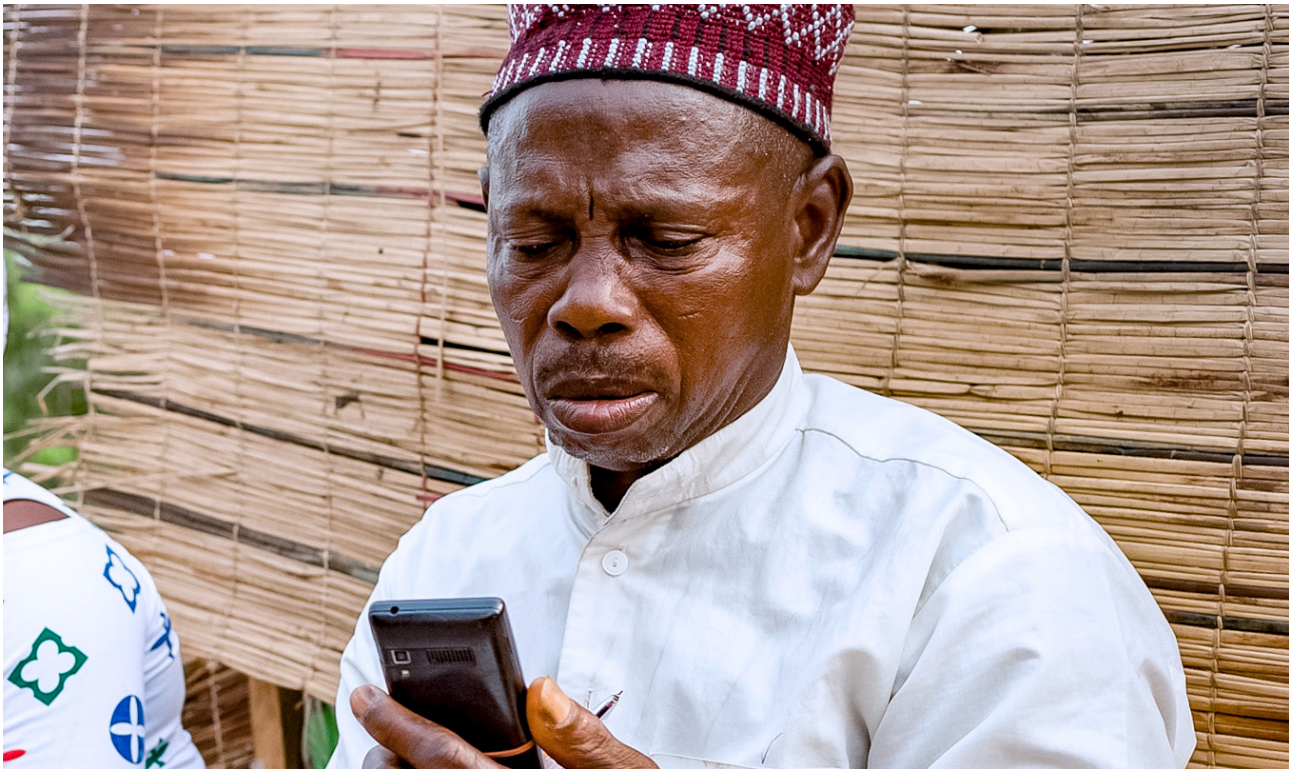
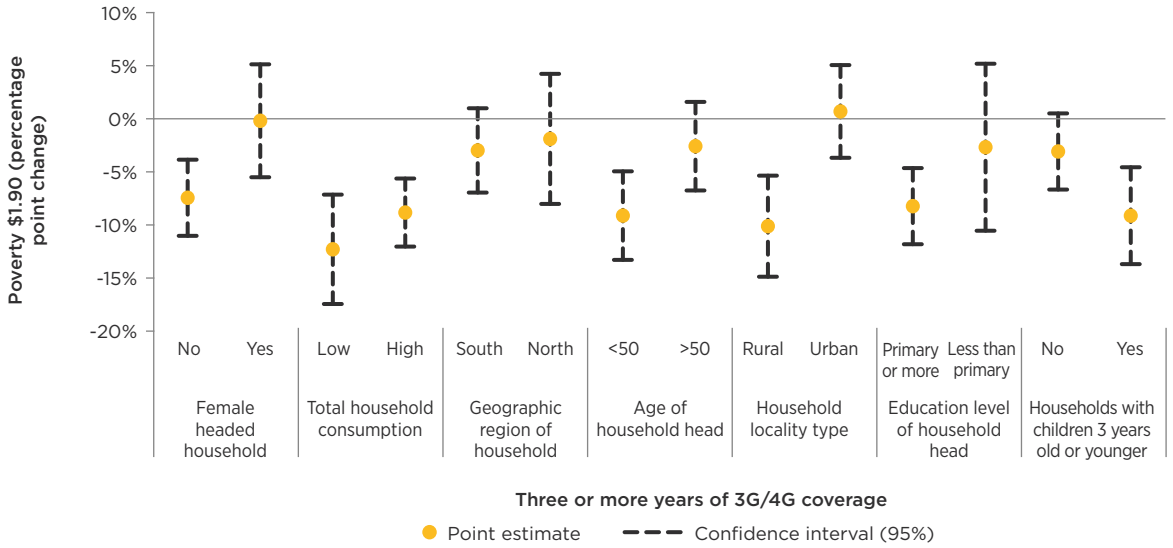


Figure 4

Impact of three or more years of 3G/4G access on poverty for different sub-samples ($1.90) (point estimates)



Source: Bahia et al. 2020
Notes: Point estimates at with 95% confidence intervals. Difference-in-difference estimators across poverty by sub-sample. Standard errors are clustered by Local Government Authorities (LGAs). Additional controls include access to electricity, ownership of dwelling, household size and a wealth index, although the coefficients for these variables are not reported to save space. Poverty measure is equal to 1 if the household per-capita consumption is less than the international extreme poverty line of $1.90 per day (measured in purchasing power parity).

The study measured the impact across all households living in areas that received mobile broadband coverage in Nigeria, independently of whether they adopted the technology or not. It is therefore plausible that the impact might be larger for those that adopted the technology than for those that did not. In addition, since most households that received mobile broadband coverage in this period already had access to basic mobile coverage (voice and text), the results of the analysis reflect mostly the impact from upgrading mobile coverage from 2G to 3G/4G, and to a lesser extent capture potential effects from providing mobile coverage to previously uncovered areas.

3 Policy implications

It is important to continue expanding the evidence base on the impacts of mobile broadband on household welfare in Sub-Saharan Africa to examine how far our findings extend beyond Nigeria. However, this study represents a solid foundation to show the significant role that expanding access to mobile broadband can have on improving the lives of the extreme poor in Africa.

According to the results of our study, three main pathways should be considered by decision makers, international organisations and other stakeholders to enhance the potential of mobile broadband to reduce poverty:

1. **Expanding broadband coverage to rural and remote areas can reduce extreme poverty**

   Globally, there are still almost 600 million people that do not live within reach of either a 3G or 4G network, around half of them in Africa. Most live in rural and remote areas. Expanding mobile broadband coverage will remain difficult; new approaches to financing coverage as well as innovations and technical solutions will be required.[22] However, this study provides a good rationale of why such investments are worth consideration since these can provide large economic and social returns for those in greater need. In the case of Nigeria, extreme poverty in rural areas fell by 8 percentage points two years after being covered by mobile broadband and by 10 percentage points three years after (see Figure 4). If these effects were of a similar magnitude elsewhere, the potential gains of extending coverage globally could be substantial, particularly if policymakers assign a greater social value to the potential welfare gains of those at the bottom of the income distribution and those that belong to excluded socioeconomic groups.

2. **Policies to address the usage gap across socioeconomic groups are necessary to ensure everyone benefits from digital technologies**

   In Nigeria, as in many other parts of the world, certain socioeconomic and demographic groups can face significant barriers to using mobile internet, which may prevent them from reaping the benefits of broadband coverage.[23] For example, in 2019 the gender gap in mobile internet usage in Nigeria was 29% (meaning women were 29% less likely than men to use mobile internet), while rural populations were 47% less likely to use mobile internet than urban residents.[24]

   Strategies to address the usage gap of those individuals living within reach of a mobile broadband network but not using it will remain important policy priorities to realise the full benefits of digital technologies. Globally, the usage gap includes 3.4 billion people, with more than 600 million living in Africa. Key barriers to bridge the usage gap include the affordability of services and devices, relevance of content, lack of digital skills, and safety/security online. The incidence of these factors is especially large for underserved groups, including women, rural populations, individuals with less education and people with disabilities.

22. See for example GSMA, Closing the Coverage Gap, 2019
23. GSMA, Mobile Gender Gap Report 2018
24. GSMA, Mobile Gender Gap Report 2020 and GSMA, The State of Mobile Internet Connectivity Report 2020

3. Complementary policies are needed to realise the social and economic benefits of digital connectivity for all

In Nigeria, we found strong evidence that increased labour force participation was one of the main benefits from mobile connectivity. Expanding access to digital connectivity can also expand labour demand by means of enabling the productive capacity of rural and non-rural firms (especially small and medium-sized enterprises) to reach more customers in non-local markets. In combination with higher labour force participation, this could allow them to expand and create new jobs for local communities.

Moreover, mobile broadband can make it easier for individuals to find jobs and for businesses to recruit qualified staff. It can also provide individuals with better access to information on health, nutrition and education, which not only improves livelihoods and well-being but can also contribute to employment and higher labour productivity.[25]

Of course, providing access to mobile broadband does not reduce poverty nor improve people's livelihoods by itself. Well-functioning markets, strong institutions and complementary investments including road infrastructure, competition in input and output markets, and high-quality public services, help the deployment of infrastructure in rural and remote areas and need to interact with mobile broadband access to maximise its potential welfare effects.

25. Other studies also show that the internet can help create new job opportunities and increase labour productivity. See Paunov and Rollo 2014; Fernandes et al. 2019; Chun and Tang 2018; Hjort and Poulsen 2019; Viollaz and Winkler 2020.

Appendix: Methodology

Calculating welfare and poverty-reduction effects of mobile broadband in Nigeria

The findings presented in this report are based on a study that evaluates the welfare and poverty-reduction effects of mobile broadband in Nigeria during 2010–2016.[26] Jointly developed by a team of researchers from the GSMA and the World Bank, the study makes use of an innovative dataset that is built from two primary sources of data:

- **Welfare and poverty** – We used the World Bank's General Household Survey (GHS) of Nigeria – a nationally representative survey that tracks around 4,000 households and 12,000 individuals over time (in 2010/11, 2012/13 and 2015/16). The GHS is a dedicated living standards survey that provides detailed information on households' consumption as well as other key demographic and socioeconomic indicators of their members including education, labour market outcomes and access to the internet.[27] The poverty status of households is calculated based on the international poverty line of $1.90 per day (measured in 2011 PPP).[28]

- **Network coverage** – We gathered data on the location of each mobile site from three of the four largest mobile operators in Nigeria[29] as part of the GSMA Mobile Coverage Maps tool.[30] This enabled us to determine with precision the time when individual households began receiving coverage. Coverage of mobile broadband is defined as the provision of 3G or 4G coverage, which enables high-speed access to the internet, and excludes 2G coverage as it only provides for limited internet browsing and applications.

By combining these two rich datasets, the analysis has several advantages over previous studies, enabling us to isolate the impact of mobile broadband on household and individual welfare and establish a clear direction of the effect. First, the precision in the coverage data means that the study is not affected by the type of measurement error that occurs when relying on other proxy measures, such as distance to the nearest mobile site. The data allows us to match the location of each household with the coverage provided by each mobile site, to determine with precision the time when individual households began receiving coverage.

Second, the granularity of the data allows us to identify households that received coverage by accident, in that they were not specifically targeted by operators but received coverage because of geographical factors outside of their control (terrain in particular). This allows us to consider two groups of households that had no broadband coverage and similar levels of poverty and consumption in 2010 and then compare them in 2016, when one group received coverage (even though operators did not intend for them to be covered) and one did not.

Finally, by using coverage data from operators rather than data reported on mobile broadband use by households, the analysis captures not only the direct impacts of individuals accessing the internet but also spillover effects.[31] The latter includes, for example, internet users sharing information with non-users and non-users benefitting from job creation and productivity gains among local firms.

To estimate the number of people lifted out of extreme poverty for the period of study (2010–2015), we first calculate the total number of households that obtained coverage for each treatment over this period as implied by the sampling weights. We then multiply that number by the weighted point estimates for each treatment to obtain estimates on the number of households lifted out of poverty. We multiply this number by the average size of households receiving coverage, which results in the total number of people lifted out of extreme poverty due to 3G/4G coverage.

26. GSMA and World Bank, The Welfare Effects of Mobile Broadband Internet: Evidence from Nigeria (2020)
27. More Information on the GHS including design, survey instruments, datasets and methodology can be found via this link: http://surveys.worldbank.org/lsms/programs/integrated-surveys-agriculture-ISA/nigeria
28. For further details on international poverty lines, see World Bank (2018).
29. We carried out a number of checks using third-party data sources to confirm that the fourth operator did not have coverage in areas outside of the other three.
30. GSMA Mobile Coverage Maps
31. Coverage is distinct from usage, which is when an individual has a SIM card that can be used in a mobile phone to access the internet.

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