The Mobile Phone Revolution and Digital Inequality: Scope, Determinants and Consequences

Background Paper

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This paper is part of a series of background papers on technological change and inclusive development, bringing together evidence, ideas and research to feed into the commission's thinking. The views and positions expressed in this paper are those of the author and do not represent the commission.

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Abstract

In the 21st century, the digital economy is one of the most important drivers of global economic growth and innovation. Infrastructure, hardware and software that enable the rapid transmission of large amounts of information between people, businesses, devices, networks and systems are increasing global economic integration, efficiency and productivity. For many, especially in low-income countries, the mobile phone serves as the gateway to the digital economy. Advances in smartphone handsets and value-added services, such as mobile money and mobile internet, have revolutionised communication, access to information and banking for even the poorest households. As global mobile phone penetration rates continue to increase, there is a tendency to assume that the first-order problem of mobile phone access is approaching obsolescence. This background paper takes a critical look at this supposition. It makes three main points. First, it is indeed the case that the mobile phone represents the most accessible information and communication technology in history. But there is also a stubborn persistence to mobile phone inequality. A core set of socio-economic factors – education, income, gender, and age – continue to constrain mobile phone ownership and, importantly, the migration to more advanced mobile phone technologies (smartphones) and services (mobile money and internet). Second, precisely measuring mobile penetration poses a number of challenges. And the true extent of mobile phone ownership is likely to be inflated. Over-counting risks inadvertently widening the digital divide: programming and services are developed that seemingly support a broad set of users but, in reality, are failing to reach an important subset on the margins of digital inclusion, leaving them further behind. Third, even as penetration rates increase, mobile phone ownership among low-income households is much more irregular than generally recognised. The issue of the prevalence of handset and SIM *turnover* – in which users are losing and then having to re-acquire mobile technology – has been neglected, but represents a critical source of digital inequality. The paper concludes by discussing potential policy solutions to mobile turnover and working within existing socio-economic constraints to increase digital inclusion.

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Overview

Digital technologies have transformed the global economy. By one estimate, digital technology – infrastructure, hardware and software that enable the rapid transmission of large amounts of information between people, businesses, devices, networks and systems – contributes US$3 trillion [£2.3 trillion] to the global economy.[1] The rise of the global digital economy has been fast and furious over the span of three decades. Integral to its penetration of low-income countries has been the mobile phone revolution. Mobile technology and wireless networks have enabled businesses and consumers in emerging markets to leapfrog underdeveloped fixed-line infrastructure and limited computer access to connect digitally. This has been a boon for billions of end-users, as the mobile phone has become the most accessible, ubiquitous and functional information and communication technology (ICT) in history.

The economic benefits of mobile technology uptake and use are far-reaching, but potentially the greatest impact holds for the poorest – those who traditionally face steep barriers to access information, financial institutions and long-distance communication. In one of the most comprehensive studies to date on the economic impact of mobile technology, Suri and Jack (2016) find that mobile money access has significant poverty-reduction effects, especially for female-headed households.[2] These findings have fuelled optimism that there may be no more potent and cost-effective poverty-alleviation tool than the mobile handset.

However, even as handset and mobile costs have dropped precipitously, this gateway to the digital economy remains closed to many.[3] Moreover, as late entrants finally get their foot in the door, they are not only failing to catch up with early adopters, but, as the digital economy accelerates, they are falling further behind – widening the gap in digital inequality. Understanding the impact of mobile phone access on digital inequality is critical to devising policy solutions to further expand the economic benefits of the digital technology revolution. This paper provides a scoping study of digital inequality through the lens of uneven mobile phone uptake and use.

Part 1 describes the state of mobile phone access and change over time. While mobile phone technology has surpassed television, radio, fixed-lines and broadband as the most far-reaching ICT, the extent of mobile phone access is difficult to measure – and is most likely inflated. The risk is that, without an accurate yardstick of access and use, it will be difficult to gauge digital inclusion and tailor interventions for those being left behind. Just as importantly, there is growing evidence that mobile phone ownership is much more fluid and erratic than generally assumed, especially for low-income populations. This unpredictability is hindering the adoption of more transformational value-added services and proving detrimental to mobile-based programming.

[1] Kosha Gada, 'The digital economy – Let's follow the money', Forbes.com, June 20, 2016. Available at https://www.forbes.com/sites/koshagada/2016/06/20/the-digital-economy-lets-follow-the-money/#3ea2e77c78cb

[2] Suri, T, and Jack, W. 'The long-run poverty and gender impacts of mobile money'. *Science* 354, no. 6317: 1288-1292, 2016.

[3] This is one reason the digital technological revolution is yielding lower economic dividends than expected. World Bank. *World Development Report 2016: Digital Dividends*. World Bank Publications, 2016.

Part 2 of this report surveys what factors account for unequal mobile phone access. It considers the demand and supply factors propelling the uptake and use of mobile technology. A core set of socio-economic factors – education, income, gender, and age – remain stubbornly persistent in constraining mobile phone ownership and the migration to more advanced mobile phone technologies (smartphones) and services (mobile money and internet). Supply factors continue to matter as well; these include the regulatory environment, infrastructure, ecosystem, structural inequalities, and household and societal constraints.

Part 3 reviews what policy solutions may be effective at addressing these usage barriers. It looks at where future attention is needed to ensure that everyone benefits from the digital technology revolution.

Part 1: Mobile technology as a gateway to the digital economy

The last half-century has witnessed the consolidation of the digital economy. At the heart of this technological revolution has been the development of infrastructure, hardware, software and networks. This has reduced the cost of storing and transmitting large volumes of information and has facilitated and intensified online connectivity between individuals, organisations and systems all over the world.[4] The digital technological revolution was initially centred in the US and Europe, where the two most important innovations driving the transformation to a digital economy – microprocessors and the internet – were invented. The spread to emerging markets was slowed by state-owned telecommunications monopolies, underdeveloped fixed-line telecom infrastructure (the backbone of initial internet connections) and the high costs of the first generations of computers.[5]

What proved revolutionary for low-income countries was the advent and spread of mobile networks. Mobile service, with substantially lower fixed installation costs than fixed-line phone services,[6] combined with the liberalisation of the telecommunications sector, disrupted traditional ICT networks, increasing phone and internet access to billions of new users.[7] Within years of adoption, mobile phone penetration rates outpaced fixed lines in leaps and bounds.[8] By the early 2000s, this great divergence was occurring in every region of the world.

Hardware and software innovations in mobile technology further advanced the digital economy's potential. Smartphones transformed handsets into 'everything devices' – enabling the use of mobile internet, global positioning systems, email, cameras, social networking, word processing, banking and access to television and radio. The development of mobile phone-based money transfer systems – mobile money – enabled users to deposit, withdraw, transfer money and pay for goods and services with even basic handsets. Mobile money has revolutionised financial services, especially for the unbanked (those without access to a bank or financial institution).[9]

The impact of the mobile digital economy on economic growth at the household and national-level has been tremendous. Consider China, the world's leader in digital payments. In the span of two decades, the contribution the digital economy makes to gross domestic product (GDP) has

[4] Tapscott, D. The Digital Economy: Promise and Peril in the Age of Networked Intelligence. Vol. 1. New York: McGraw-Hill, 1996.

[5] Williams, M, Mayer, R and Minges, M. Africa's ICT Infrastructure: Building on the Mobile Revolution. The World Bank, 2011.

[6] Henriques, I and Sadorsky, P. 'Risk and investment in the global telecommunications industry'. In Digital Economy: Impacts, Influences and Challenges, Kehal, H and Singh, V. (Eds.) Idea Group Publishing, 2005.

[7] Mobile broadband remains more affordable than fixed-line broadband. According to the International Telecommunications Union (ITU), on average, entry-level fixed-broadband subscriptions are 2.6 times more expensive than entry-level mobile-broadband subscription in least developed countries. ITU, ICT Facts and Figures in 2017, 2017. Available at: https://www.itu.int/en/ITU-D/Statistics/Documents/facts/ICTFactsFigures2017.pdf

[8] ITU, The World in 2009: ICT Facts and Figures, 2009. Available at: https://www.itu.int/net/pressoffice/backgrounders/general/pdf/3.pdf

[9] Aker, J and Mbiti, I. 'Mobile phones and economic development in Africa'. Center for Global Development Working Paper, no. 211, 2010. Jack, W and Suri, T. 'Risk sharing and transactions costs: Evidence from Kenya's mobile money revolution'. American Economic Review 104, no. 1: 183-223, 2014. Kendall, J and Voorhies, R. 'The mobile-finance revolution: How cell phones can spur development'. Foreign Affairs, 2014.

gone from virtually zero to an estimated 30% in 2016.[10] In Kenya, one of the first markets where mobile money took off, ICT businesses were estimated to have accounted for one-quarter of the country's GDP growth from 2000 to 2010. However, that has slowed recently as mobile subscriptions plateaued and growth opportunities increased in neighbouring mobile economies.[11]

Beyond these macro-level effects, the mobile digital economy is found to confer important economic benefits to individuals and households: increasing household consumption;[12] reducing search costs and improving markets;[13] more efficient allocation of labour, savings, and risk;[14] and improving health, education and agricultural productivity.[15] One of the primary ways mobile technology is improving economic well-being is through mobile money.[16]

What is especially promising about the development potential of the mobile digital economy is that mobile technology's reach is far outpacing other ICTs. While measuring mobile phone uptake and use entails a number of challenges (see next section), it is clear that, relative to television, fixed-line telephone and broadband, mobile penetration rates are on a different scale.[17] Perhaps only radio has the global reach of mobile phones, but it is a unidirectional and highly-centralised ICT that lacks the functionality and communication capabilities of mobile technology.

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[10] Hsu, S. 'China's digital economy's growth will soon see it outpace the traditional economy', Forbes, November 24, 2017. Available at: https://www.forbes.com/sites/sarahsu/2017/11/24/chinas-digital-economy-will-become-the-economy/#5b21fa5b430d

[11] Sunday, F and Kamau, M. 'Investment: Poor policy slowing Kenya's ICT sector as neighbours take lead', Standard (Kenya), November 7, 2017. Available at: https://www.standardmedia.co.ke/business/article/2001259537/poor-policy-slowing-kenya-s-ict-sector-as-neighbours-take-lead

[12] Suri, T and Jack, W. 'The long-run poverty and gender impacts of mobile money'. Science 354, no. 6317: 1288-1292, 2016; Munyegera, GK and Matsumoto, T. 'Mobile money, remittances, and household welfare: Panel evidence from rural Uganda'. World Development 79: 127-137, 2016; Roessler, P et al. 'Mobile-phone ownership increases poor women's household consumption: A field experiment in Tanzania', Evidence in Governance and Politics (EGAP) workshop in Nairobi, Kenya, EGAP meeting in Nairobi, Kenya, 8-9 June 2018.

[13] Jensen, R. 'The digital provide: Information (technology), market performance and welfare in the South Indian fisheries sector'. The Quarterly Journal of Economics 122, no. 3: 879-924, 2007; Aker, JC and Mbiti, IM. 'Mobile phones and economic development in Africa'. Journal of Economic Perspectives 24, no. 3: 207-32, 2010.

[14] Jack, W and Suri, T. 'Risk sharing and transactions costs: Evidence from Kenya's mobile money revolution'. American Economic Review 104, no. 1: 183-223, 2014; Suri, T and Jack, W. 'The long-run poverty and gender impacts of mobile money'. Science 354, no. 6317: 1288-1292, 2016; Lee, JN et al. Poverty and Migration in the Digital Age: Experimental Evidence on Mobile Banking in Bangladesh. IGC Working Paper C-89233-BGD-1, 2017.

[15] Lee, JN et al. Poverty and Migration in the Digital Age: Experimental Evidence on Mobile Banking in Bangladesh. IGC Working Paper C-89233-BGD-1, 2017.

[16] Suri, T. 'Mobile money'. Annual Review of Economics 9: 497-520, 2017.

[17] The best estimates suggest there are: 5 billion unique mobile subscriptions compared to 972 million fixed-line subscriptions; 979 million fixed-broadband subscriptions; 1.59 billion households with television; and 3.58 billion internet connections. Most statistics come from the ITU. See for example: https://www.itu.int/en/ITU-D/Statistics/Pages/stat/default.aspx [Accessed 8 November, 2018]; See also 'The state of broadband: Broadband catalyzing sustainable development'. ITU, September 2017. Available at: https://www.itu.int/dms_pub/itu-s/opb/pol/S-POL-BROADBAND.18-2017-PDF-E.pdf

While the accessibility of the mobile phone as an ICT device is unprecedented, there are significant disparities in uptake. There is also significant variation in the frequency and intensity of mobile technology use. Much has been written about the digital divide;[18] however, there have been fewer critical assessments of how we measure mobile inclusion and how the way we measure mobile inclusion affects what we know about the impact of the mobile digital economy. In the next section I turn my attention to these measurement challenges before surveying the drivers of mobile uptake and use.

The challenges and pitfalls of measuring mobile digital inclusion

Any stocktaking of the impact of the mobile digital economy has to navigate the innumerable measurement challenges in assessing the true extent of mobile phone penetration and ownership. Consider the case of India. In the latest nationally representative Financial Inclusion Insights (FII) Tracker Survey in 2017, more than 80% of respondents reported having *mobile phone access* – either owning their own phone, sharing a phone, or using a mobile phone that belongs to someone else. But if one digs deeper to try to measure *mobile phone control* – where those surveyed report owning a phone, possessing a SIM card and are somewhat or very involved in deciding how the phone is used – rates drop nearly in half to 43% of the population.[19] This points to mobile phone inclusion as a continuum rather than a binary (no phone versus own phone). Existing measurement tools tend to miss the fluidity in this continuum. From a policy perspective, the problem is that, without more nuanced information on where populations fall, it makes it difficult to tailor mobile phones for international and community development programmes. Interventions that assume all beneficiaries have full mobile phone control when they don't risks marginalizing or outright excluding a key subset. In this section, we survey critical challenges in measuring digital inclusion and inequality.

Mobile connections

One of the design features of mobile technology systems is that lack of phone ownership *need not* prohibit individuals from participating in the digital economy. Someone can purchase a SIM and insert it in to a phone when they want to use it, only paying for the services used. As the costs of SIM cards have declined dramatically,[20] this has opened the door to mobile communications

[18] See for example Norris, P. Digital Divide: Civic Engagement, Information Poverty, and the Internet Worldwide. Cambridge University Press, 2001; Van Dijk, J, and Hacker, K. 'The digital divide as a complex and dynamic phenomenon'. The Information Society 19, no. 4: 315-326, 2003; Warschauer, M. Technology and Social Inclusion: Rethinking the Digital Divide. MIT press, 2004; World Bank. World Development Report 2016: Digital Dividends. World Bank Publications, 2016. See also the various reports undertaken by the Connected Women programme cited throughout, available at: https://www.gsma.com/mobilefordevelopment/connected-women

[19] Analysis of FII Tracker Survey, India Wave 5, the Financial Inclusion Insights Program, InterMedia, 2017.

[20] The cost of a SIM card in many developing countries is less than $1. The Nigeria market is indicative of the change in accessibility that has occurred over the last 18 years. In 2001, a SIM card cost more than US$90, whereas today one costs around US$0.67. For price trends, see Nigeria Telecommunication Fact Sheet, United States Embassy in Nigeria, May 2012. Available at https://photos.state.gov/libraries/nigeria/487468/pdfs/May%20Telecommunications%20Fact%20Sheet_001.pdf

and digital financial services (DFS) to even the poorest households. Accordingly, one way to measure ICT penetration is based on SIM subscriptions. As data for the measure comes directly from mobile network operators (MNOs), the metric avoids the pitfalls and costs that arise with survey data collection. In 2015, total global mobile subscriptions surpassed the world's population – representing a near 100-fold increase in just two decades. Few statistics have done more to indicate the seeming universality of mobile phone access.

One major limitation of this measure is that it does not account for subscribers with multiple SIMs. Without accounting for individuals with more than one SIM, this figure over-counts the penetration rate by as much as up to 75%.[21] This inflated figure continues to be referenced by scholars studying mobile technology and is used by the World Bank to measure mobile phone penetration. It has also been picked up by other widely referenced sites, including Wikipedia.[22] A more accurate indicator – as recommended by the Groupe Spéciale Mobile Association (GSMA) – is the number of unique mobile subscribers.[23] In 2017, unique mobile subscribers topped the 5 billion mark, representing a staggering two-thirds of the global population and a historic level of penetration for an ICT.

Although useful for a snapshot of the spread of mobile technology access, counting unique SIM subscriptions is a crude indicator, at best, of digital inclusion. The metric provides no qualitative information about subscribers from which social patterns of digital inequality can be inferred. Nor does it offer insights into actual use. Whereas many subscribers are super-users – using their SIM cards many times a day – others rarely use their SIMs at all.

Extreme variation in actual use is evident in terms of two of the most transformational value-added services: mobile money and mobile internet. The World Bank highlighted the variation in mobile money use in its 2017 report on the Global Findex Database. Drawing on Gallup's World Poll in more than 140 countries and territories with more than 150,000 people, it estimates that 20% of users had *inactive* DFS accounts, making no deposit or withdrawal – in digital form or otherwise – in the past 12 months.[24] Disparities in mobile internet use are also high. In India, according to the 2017 FII Tracker Survey, only 15% of those with access to a mobile phone reported using mobile internet in the past week; and 77% said they never use it.[25]

Subscriber data also obscure the prevalence of SIM *turnover* and *churn*, especially among pre-paid users – the dominant subscription mode globally. Turnover entails consumers who lose or fail to retain their SIM card and have to obtain a replacement to use mobile services. Whereas

[21] As of October 2018, there were 8.9 billion mobile connections and 5.1 billion unique mobile subscribers. Thus the global average of SIM cards per subscriber is more than 1.7. See the GSMA dashboard. Available at: https://www.gsmaintelligence.com [Accessed on 8 October 2018].

[22] The number of mobile connections is the sole mobile technology indicator in the World Bank's Open Data site. See: https://data.worldbank.org/indicator/IT.CEL.SETS.P2; For Wikipedia data on mobile phone penetration, see: https://en.wikipedia.org/wiki/List_of_countries_by_number_of_mobile_phones_in_use

[23] See the GSMA primer on this topic. 'Measuring mobile penetration', GSMA Intelligence, May 2014. Available at: https://www.gsmaintelligence.com/research/?file=aafdf6d1736603f2494b61c33cf1de2f&download

[24] Demirguc-Kunt, A et al. Global Findex Database 2017: Measuring Financial Inclusion and the Fintech Revolution. The World Bank, pp. 64-65, 2018.

[25] Analysis of FII Tracker Survey, India Wave 5, the Financial Inclusion Insights Program, InterMedia, 2017.

turnover is generally involuntary, churn constitutes subscribers choosing to switch from one MNO to another to leverage market competition and to get better rates or services. Thus, if SIM churn reflects mobile savvy and digital fluency, turnover tends to indicate the opposite. It arises from SIM dormancy (lack of use), lack of phone ownership (thus no home for the SIM and greater chances of misplacement), and inability to obtain a replacement SIM (due to lack of awareness or resource constraints). For new adopters and infrequent end-users, turnover can lead to instability in access and use of value-added services, as each time they lose and then obtain a new SIM they have to start over in terms of setting up mobile money.

There is also a darker side to churn, as well. Anecdotal evidence suggests that the growing mobile loans business is contributing to churn: customers are taking on high-interest mobile loans, but when unable to pay the loan back, have money garnished from their mobile money account, and so seek a new SIM and switch MNOs.[26] More research is needed as the mobile loans business takes off.

The extent of SIM turnover and churn is difficult to assess due to the proprietary and sensitive nature of the information for MNOs. But evidence is starting to surface from individual studies. In one study in north-central Nigeria, scholars followed up with participants' self-reported mobile phone numbers in a communitybased HIV testing program and found that within the next six months 35% of the sampled numbers did not ring at all.[27] In another study in Tanzania (2016–2017) that distributed SIM cards to non-phone owners based on the strength of the MNO's service in their area, it was found that over a one-year period, 38% no longer possessed the original SIM. Of these, some 52% acquired an alternative SIM and 48% possessed no SIM at all.[28]

[26] The default rate on mobile loans is much higher than traditional bank loans. In Kenya, delinquent customers are referred to the Credit Reference Bureau (CRB) and prohibited from accessing other loans – though not from obtaining a SIM card and using mobile money – until the original loan is repaid or expired, which is a maximum of seven years from the loan start date. In Kenya, it has been reported that the number of individuals reported to the CRB has increased more than three-fold from 150,000 in 2015 to 500,000 in 2018. See for example: Lee M, 'Mobile loan crisis as 500,000 get blacklisted', Standard Digital, June 6, 2018. Available at: https://www.standardmedia.co.ke/business/article/2001283051/mobile-loans-crisis-as-500-000-blacklisted

[27] In addition to turnover and churn, some of the dead numbers were probably due to phone number misreporting (perhaps due to social desirability bias) and recording errors – another challenge for mobile based programming. Menson, WNA et al. "Reliability of self-reported mobile phone ownership in rural north-central Nigeria: cross-sectional study." JMIR mHealth and uHealth 6, no. 3: 2018.

[28] Roessler, P et al. 'Mobile phone ownership and the uptake and usage of digital financial services by women in an emerging economy: Evidence from a field experiment in Tanzania'. Report to Financial Services for the Poor Program, Bill and Melinda Gates Foundation, 2018a.

Mobile phone ownership

One of the most important determinants of SIM use is mobile phone ownership. While in theory a SIM card alone unlocks mobile communications and value-added services, opening the door to digital inclusion, the reality is far different. Not possessing one's own phone represents a significant barrier to use.[29] It restricts when and how much individuals can use a phone, as non-owners are dependent on others making their phones available. It compromises privacy, as non-owners often have to use the phone in front of those they borrow it from. It leaves borrowers vulnerable to phone gatekeepers, who may mediate information access,[30] and also leverage information asymmetries to exploit the non-owners.[31]

Initial tracking surveys did not distinguish between *ownership* – possessing one's own personal phone – and *access* – the ability to use your own, or someone else's phone.[32] This started to change with a series of groundbreaking reports by GSMA's Connected Women programme (formerly mWomen) quantifying the extent of the gender gap in mobile phone ownership and, just as importantly, the limitations of household access compared to individual ownership.[33] Connected Women's research on the gender gap catapulted the issue to the top of the policy agenda.

Measuring phone ownership, however, poses a number of challenges. Tracking surveys are vital, but are expensive and prone to imprecise measurement arising from social desirability bias[34] or framing differences in survey questions. For example, in its reporting, the Connected Women programme measures phone ownership based on SIM card ownership,[35] whereas FII, Gallup, Demographic and

[29] GSMA. Bridging the Gender Gap: Mobile Access and Usage in Low-and Middle-Income Countries, 2015. Available at: https://www.gsma.com/mobilefordevelopment/programme/connected-women/bridging-gender-gap-mobile-access-usage-low-middle-income-countries

[30] Gates, MF. 'Putting women and girls at the center of development'. Science 345, no. 6202: 1273-75, 2014.

[31] One particularly pernicious occurrence stems from non-phone owners with low-levels of digital literacy relying on mobile money agents to retrieve their money transfers from their SIMs and being over-charged for the service.

[32] The most comprehensive survey on mobile phone ownership is the World Poll by Gallup. Up until 2015, it only asked respondents about household possession of a mobile phone.

[33] "Phone sharing or borrowing allows much-needed access to voice services, but limits the ability of borrowers to gain technical literacy and use life-enhancing services like mobile money." GSMA. Bridging the Gender Gap: Mobile Access and Usage in Low-and Middle-Income Countries.,2015. Available at: https://www.gsma.com/mobilefordevelopment/programme/connected-women/bridging-gender-gap-mobile-access-usage-low-middle-income-countries

[34] Questions about mobile phone ownership may elicit a number of possible demand effects, such as the impulse to tell a surveyor that one possesses a phone to avoid the embarrassment or shame felt in not having a device that connotes high social status or economic productivity.

[35] Connected Women's justification for using SIM ownership to measure phone ownership is that there are few who own a SIM without a phone (less than 3%). FII Tracker Surveys, which draw from very large nationally representative samples, suggest otherwise. Their data show that, generally, there is a sizable gap in SIM and phone ownership: in India 25% own a SIM card but not a phone; in Bangladesh 12.7%; in Tanzania 10.5%; in Uganda 9.6%; in Kenya 8%; in Nigeria 4.2%; and in Pakistan 1.8%. Analysis of FII Tracker Surveys, the Financial Inclusion Insights Program, InterMedia, 2017.

Health Surveys and specific country-level surveys, such as FinScope in Tanzania, directly measure self-reported phone ownership. This can lead to different estimates in mobile phone ownership rates.[36]

Beyond measurement discrepancies, another limitation of phone-tracking surveys is that they only provide a static, discrete picture of ownership: respondents either report owning a phone at the time of the survey or not. Few surveys track phone ownership among the same individuals over time. These static snapshots obscure a fair amount of turnover in handset ownership, especially among low-income households. In one of the few randomised-controlled trials on mobile phone ownership, in which non-phone owners were provided cost-free basic phones and smartphones, Roessler et al. (2018) observe a high rate of turnover in mobile phone ownership. Women received or acquired mobile handsets but then subsequently lost or otherwise did not retain the handsets.[37] Among those who received cost-free phones, 13 months after the date of the phone distribution, only 50% retained the project phone, 20% obtained an alternative phone and 30% ended up with no phone at all.

In this same study, turnover in phone ownership was equally high among those who acquired phones in the control group (and in a cash placebo group – those who received an unconditional cash transfer the same value as a basic phone). This suggests that the turnover phenomenon was not an artefact of the cost-free distribution of handsets. Sources of turnover included: selling the asset to meet financial demands; transferring the asset to someone else in the household; and breaking, loss or theft of the asset. Phone loss, of course, is an inherent risk for all mobile phone owners, but the problem for low-income households is that few have insurance, and replacement costs can be prohibitive, leading to long gaps of time between ownership. Among those in the phone groups who no longer had a phone at midline, more than 75% were still without a phone at endline some six months later.[38]

It is important to note that, for some, turnover may have reflected a strategic decision to transfer the valuable asset to someone in the family who the participant deemed could make best use of the handset (for example, due to higher levels of digital literacy or a job that needed mobile access). There is evidence to suggest that both involuntary and voluntary reallocation occurred: some participants openly reported giving their phone to another household member, whereas others reported their phone "lost" – but also that the phone was used more by another family member than themselves – suggesting perhaps the phone was "lost" to another family member.

[36] Ironically, despite their championing of the mobile phone gender divide as a key policy issue, in counting ownership based on SIM possession, the Connected Women survey tends to underestimate the severity of the mobile phone gap. Using FII Tracker Surveys as a comparison, which were undertaken at a similar time in 2016, FII finds a gender gap around 25% in Bangladesh, Kenya, India, Pakistan, and Tanzania, whereas the Connected Women program finds a gender gap of 19% in those same countries. Analysis of FII Tracker Surveys, the Financial Inclusion Insights Program, InterMedia, 2017.

[37] Roessler, P et al. 'Mobile phone turnover impedes women's financial inclusion in Tanzania,' Working Paper, William & Mary, Williamsburg, VA, US, 2018c.

[38] ibid.

The phenomenon and impact of mobile phone turnover has largely been neglected in research and programming on mobile for development. However, FII Tracker Surveys suggest that it is not unique to low-income women in Tanzania, but is also a broader phenomenon. Across the seven countries in the survey, a wide range of non-phone owners (from 14% in Pakistan to 53% in Kenya)[39] reported having owned a phone previously but that it had been lost, stolen, broken, or stopped working. (This excludes those who may have owned a phone and sold it). Handset turnover and prolonged gaps in phone possession are especially a problem for low-income households, for whom purchasing a new phone accounts for a sizeable proportion of household income. In turn, this fuels demand for low-cost, second-hand mobile phones, which further exacerbates handset churn.

Mobile turnover has a number of important implications for studying and addressing digital inequality. One of the most important is that it necessitates a rethinking of how we conceive of mobile phone ownership, especially for the poor. For many, mobile phone ownership is not *continuous:* once one gains a phone and a SIM card, continued ownership is not a given. Handset and SIM turnover (due to loss, selling, strategic reallocation or other reasons) can lead to prolonged mobile-less gaps and significant setbacks in digital inclusion[40] – reinforcing the vicious cycle of digital inequality and poverty.

The perils of inflating mobile digital inclusion

Even as the mobile phone revolution transforms the global economy, measuring its reach poses a number of challenges – due to turnover in SIM subscriptions and handset ownership, and variability in the uptake and use of value-added services, such as mobile internet and DFS. Measurement error in the direction of greater access risks inadvertently widening the digital divide: programming and services are developed that seemingly support a broad set of users when, in reality, they fail to reach an important subset on the margins of digital inclusion, and leave them further behind.

Take two examples. One is in the field of mobile health (mHealth). There is growing evidence of the general efficacy and cost-effectiveness of using SMS messages to induce preventive health behaviour change.[41] The effects of digital inequality on mHealth programmes has not been extensively studied. Yet, unequal handset access is likely to have a significant impact on the

[39] Handset loss due to misplacement, theft or mechanical failure is generally high across all the seven countries in the survey. Of non-phone owners, 21% in Bangladesh report having previously had a phone but had it lost, stolen, broken, or stopped working; 24% in India; 41% in Uganda; 47% in Nigeria; and 48% in Tanzania.

[40] Individuals who lose or otherwise do not retain their phones are significantly less likely to keep an active SIM, reversing their access to mobile money and other mobile programming. Roessler, P et al. 'Mobile phone turnover impedes women's financial inclusion in Tanzania', Working Paper, William & Mary, Williamsburg, VA, US, 2018c.

[41] See for example: Cole-Lewis, H and Kershaw, T. 'Text messaging as a tool for behavior change in disease prevention and management'. *Epidemiologic Reviews* 32, no. 1: 56-69, 2010; Fjeldsoe, BS, Marshall, AL, and Miller, YD. 'Behavior change interventions delivered by mobile telephone short-message service'. *American Journal of Preventive Medicine* 36, no. 2: 165-173, 2009; Head, KJ. 'Efficacy of text messaging-based interventions for health promotion: A meta-analysis'. *Social Science & Medicine* 97: 41-48, 2013. Lee, SH et al. 'Effectiveness of mHealth interventions for maternal, newborn and child health in low- and middle–income countries: Systematic review and meta–analysis'. *Journal of Global Health* 6, no. 1, 2016; Armanasco, A et al. 'Preventive health behavior change text message interventions: A meta-analysis'. *American Journal of Preventive Medicine* 52, no. 3 (2017): 391-402.

effectiveness of SMS informational campaigns. Mobile-less participants who depend on messages being channelled through a family member, neighbour or friend have to rely on phone gatekeepers to pass on the information.[42] SIM and handset attrition likewise deprives potential beneficiaries from continued access to information.[43]

Another domain likely to be affected by imprecise tracking of mobile phone penetration is cash transfer programming. Increasingly these programmes – such as GiveDirectly, operating in Kenya, Uganda and Rwanda, or the DREAMS programme which provides cash transfers to at-risk adolescent girls and young women – are leveraging mobile money to deliver payments more efficiently.[44] Often this entails providing phones and SIM cards to ensure that those without mobile phone access are not excluded. This is an important design feature as non-phone owners are among the population these programmes are intended to help. The challenge, however, is monitoring beneficiaries' retention of their SIM and handset, especially in larger programmes with millions of participants. Turnover can lead to programme attrition, which doubly penalises beneficiaries (they lose their phone and the cash transfer), and it can also lead to waste as transfers continue to be made to programme participants who are unable to access them.

[42] Gates, MF. 'Putting women and girls at the center of development'. *Science* 345, no. 6202: 1273-75, 2014.

[43] Menson et al. find striking differential inaccessibility by gender on self-reported SIM numbers. Whereas they were able to reach 50% of male participants, they were only able to reach 19% of female participants. Menson, WNA et al. "Reliability of self-reported mobile phone ownership in rural north-central Nigeria: cross-sectional study." *JMIR mHealth and uHealth* 6, no. 3: 2018.

[44] For more on GiveDirectly's use of mobile phones, see: https://www.givedirectly.org/faq#Do%20recipients%20need%20to%20have%20a%20mobile%20phone%20to%20participate; On DREAMS see https://www.pepfar.gov/documents/organization/269309.pdf

Part 2: Mobile digital inequality and its causes

Notwithstanding the complexities of precisely measuring and tracking SIM and phone ownership and use, a consistent picture of digital inequality in the world has come into focus. In many emerging markets, the first mobile phone adopters (in the mid-2000s) were primarily male, educated, young, wealthy, and urban.[45] A decade later, mobile phone adoption has exploded, but uptake and use continue to be constrained by core socio-economic and demographic factors – income, education, urbanicity, gender, and age.[46] Among a sample of seven emerging markets in Africa and Asia in 2017, these variables continue to predict mobile phone ownership at high levels of statistical significance.[47] (See Appendix for results of statistical analysis of phone ownership.) Though the scale of inequality differs, similar patterns are evident among high-income countries. For example, within the US, smartphone ownership varies substantially by level of education, age, income, and urbanicity.[48]

This points to the stickiness of digital inequality across these core dimensions, even in the use of basic mobile products. The World Bank's Global Findex database highlights this in terms of possessing a mobile money account. Since 2011, the global gender gap in mobile money account ownership has remained unchanged at 9 percentage points. A similar trend has existed across high- and low-income groups.[49] This is also the case when it comes to the rural–urban divide. In Africa and India, urban areas have become nearly saturated in terms of unique SIM subscribers; yet, uptake in underpenetrated rural areas has plateaued.[50]

[45] Aker, JC and Mbiti, IM. 'Mobile phones and economic development in Africa'. *Journal of Economic Perspectives* 24, no. 3: 207-32, 2010.

[46] For a useful discussion of the importance of socio-demographic factors in accounting for the digital divide in the broader ICT literature, see Niehaves, B and Plattfaut, R. 'Internet adoption by the elderly: Employing IS technology acceptance theories for understanding the age-related digital divide'. *European Journal of Information Systems* 23, no. 6: 708-726, 2014.

[47] The World Bank's Global Findex database highlights this in terms of mobile money accounts. Since 2011, the gender gap in mobile money account ownership has remained unchanged at 9 percentage points. A similar trend has existed across high- and low-income groups. Demirguc-Kunt, A et al. *The Global Findex Database 2017: Measuring Financial Inclusion and the Fintech Revolution.* The World Bank, 2018. This is also the case when it comes to the rural-urban divide. In Africa and India, urban areas have become nearly saturated in terms of unique SIM subscribers, yet uptake in underpenetrated rural areas has plateaued. GSMA, 'The mobile economy Sub-Saharan Africa 2018', 2018.

[48] Based on data from early 2018, US smartphone ownership is 34 percentage points higher among college graduates than those who don't complete high school; 26 percentage points higher among those who make more than $75,000 per year than those making less than $30,000; 48 percentage points higher among individuals aged 18 to 29 to those over the age of 65 years; and 18 percentage points higher among urban dwellers than rural ones. The gender divide in smartphone ownership is only 5%. Mobile Fact Sheet, Pew Research Center, February 5, 2018. Available at: http://www.pewinternet.org/fact-sheet/mobile

[49] Demirguc-Kunt, A et al. *Findex Database 2017: Measuring Financial Inclusion and the Fintech Revolution.* The World Bank, 2018.

[50] GSMA. *The Mobile Economy Sub-Saharan Africa 2018*, 2018.

Consistent with other technology lifecycles, late mobile adopters are not just failing to catch up but they are falling further behind as the digital economy accelerates and early adopters migrate to new transformational services and products.[51] GSMA's Connected Women programme documents this dynamic in its 2018 *Mobile Gender Gap Report*. It finds that, in low- and middle-income countries, the gender gap in mobile internet access is 2.6 times the gender gap in phone ownership.[52] Digital inequality is further evident in terms of mobile financial services. In Kenya, despite the country's advanced DFS ecosystem, the rural poor are about 40% less likely to be active mobile money users compared to other populations, yet are only 27% less likely to own a phone.[53]

More difficult to measure and quantify are the impact of political, cultural and behavioural variables on digital inequality. More research is required on these dimensions. For example, political exclusion is found to significantly mediate internet access.[54] Similar political dynamics would be expected to affect the distribution of mobile wireless networks and requires further research. Likewise, cultural factors, such as rumours, myths, and other shared beliefs, may affect digital inclusion. In Tanzania, shared beliefs associating technological products and services with Freemasonry, an organisation that is viewed suspiciously by some in the country, has had discernible effects on mobile phone adoption.[55]

In the next section, we turn to explain why socio-economic factors are such powerful drivers of digital inequality and mobile adoption. We also consider how other factors may mediate adoption and use.

Supply-side factors of mobile access and use

In assessing the sources of digital inequality, it is useful to consider the drivers of demand and supply in mobile phone adoption and use. Demand drivers shape an individual's willingness and ability to own a mobile phone and consume value-added services. In turn, supply factors shape the availability and accessibility of mobile products. This section begins by discussing key supply-side factors.

[51] Van Dijk, J and Hacker, K. 'The digital divide as a complex and dynamic phenomenon'. The Information Society 19, no. 4: 315-326, 2003.

[52] Connected Women, The Mobile Gender Gap Report 2018, GSMA Intelligence, 2018. Available at: https://www.gsma.com/mobilefordevelopment/connected-women/the-mobile-gender-gap-report-2018

[53] Analysis of FII Tracker Survey, Kenya Wave 5, the Financial Inclusion Insights Program, InterMedia, 2017 Active DFS use indicates whether respondents reported making a financial transaction, such as sending or receiving money, making a payment or a banking transaction on their phone in the previous month. The phone ownership gap between rural poor and other populations is 62% to 85%; the active DFS use gap is 44% to 72%.

[54] Weidmann, NB et al. 'Digital discrimination: Political bias in internet service provision across ethnic groups'. Science 353(6304), 1151-1155, 2016. Available at: http://science.sciencemag.org/content/353/6304/1151/tab-pdf

[55] See for example the challenges Twaweza, an NGO operating in East Africa, had with distributing mobile phones to set up a nationally representative phone-based survey in Tanzania. 'Sauti za wananchi: Collecting national data using mobile phones', Twaweza, 2013. Available at: https://www.twaweza.org/uploads/files/SzW%20Approach%20Paper%20FINAL.pdf

Regulatory factors

Over the last 20 years, there have been significant changes in key supply factors that have dramatically increased the affordability and accessibility of mobile technology. One of the most important factors has been liberalisation of the telecommunications sector in many low-income countries. This has significantly driven prices down and increased mobile phone uptake. One geospatial study of mobile technology diffusion in Africa found that the economic competitiveness of the country's policy environment significantly predicted the coverage of mobile phone cell towers in 2006.[56] Another study found that, while the initial stage of market liberalisation was important, the biggest gains in digital inclusion stemmed from the addition of third and fourth mobile market players.[57]

Regulatory factors continue to play a role in the acceleration or deceleration of the digital economy. Evans and Pirchio (2015) found that countries that heavily regulate MNOs from providing DFS (often in favour of banks) have generally experienced low uptake and use of mobile money.[58] Nigeria – where mobile money access is a fraction of what it is in, say, Kenya[59] – represents a textbook case. There are calls for Nigeria to follow the lead of Ghana, which also initially opted for the bank-led model, and reform its regulatory framework to enable MNOs and their subsidiaries to receive mobile money operators' licence.[60]

[56] Buys, P et al. 'Determinants of a digital divide in Sub-Saharan Africa: A spatial econometric analysis of cell phone coverage'. World Development 37(9), 1494-1505, 2009. Available at: https://www.sciencedirect.com/science/article/pii/S0305750X09000667

[57] "Growth in subscriber numbers has generally been modest following the initial stage of market liberalization—that is, the move from monopoly to duopoly. Once a country issues its fourth mobile license, however, penetration rates increase by an average of about 4 percentage points per year." Williams, MDJ, Mayer, R and Minges, M. Africa's ICT Infrastructure: Building on the Mobile Revolution. The World Bank, 2011.

[58] Evans, DS and Pirchio, A. 'An empirical examination of why mobile money schemes ignite in some developing countries but flounder in most'. Coase-Sandor Institute for Law and Economics, University of Chicago Law School, 2015. Available at: https://chicagounbound.uchicago.edu/cgi/viewcontent.cgi?article=2413&context=law_and_economics; Staschen, S and Meagher, P. Basic Regulatory Enablers for Digital Financial Services. CGAP, 2018. Available at: http://www.cgap.org/research/publication/basic-regulatory-enablers-digital-financial-services

[59] According to the 2017 FII Tracker Surveys, active mobile money use (once a month or more) is seven times higher in Kenya: 9% in Nigeria compared to 65% in Kenya. FII Tracker Surveys, the Financial Inclusion Insights Program, InterMedia, 2017.

[60] For a useful summary see Klapper, L and Popovic, A. 'Five ways Nigeria can realize mobile technology's potential for the unbanked', Africa Can End Poverty blog, 29June, 2018. Available at: http://blogs.worldbank.org/africacan/five-ways-nigeria-can-realize-mobile-technologys-potential-for-the-unbanked.

Infrastructure

A second important supply factor is infrastructure. At the most basic level, mobile phone access is directly tied to the diffusion of cell towers. Their initial rollout generally followed traditional communication and transportation infrastructure[61] – targeting the most densely populated areas first. As access improved, uptake followed.[62] But the low fixed costs for mobile technology to supply a given area with cell service has enabled it to leapfrog older ICTs and to reach a much wider set of end users, especially in countries with sparse infrastructure networks.

Low infrastructure costs also help to account for the explosion of mobile money use in many emerging markets. MNOs were able to leverage existing wireless networks to provide the service, while the adoption of unstructured supplementary service data (USSD) communications protocol to send mobile money ensured that the service could work on the most basic mobile handsets. As a consequence, mobile money has taken off in countries where existing financial services' infrastructure is least developed.[63] Somaliland is often held up as a case study.[64] In the aftermath of civil war and its de facto secession from Somalia, the banking sector collapsed. With no formal banking system and no internationally recognised banks, money transfer systems, including mobile money, filled the void. Mobile payments are thriving in the territory.[65]

While generally low infrastructure costs have fuelled the mobile phone revolution, these costs can vary substantially within countries, contributing to digital inequality. For example, unfavourable geography, poor road networks and other barriers to penetration, such as conflict, hinder tower construction and upgrades. This can limit access, especially for those living in rural areas.[66] Infrastructure bottlenecks also constrain the adoption and spread of next-generation ICT services such as mobile and broadband internet. In low-income countries, where most of the backbone infrastructure is wireless,[67] the rollout of 3G services is critical to the uptake and use of internet. Africa, the region with the least-developed internet infrastructure, is expected to reach a tipping point over the next couple of years with the widespread adoption of 3G. Yet, for now, the majority of connections remain 2G, diminishing mobile internet use.[68]

[61] Buys, P et al. 'Determinants of a digital divide in Sub-Saharan Africa: A spatial econometric analysis of cell phone coverage'. World Development 37(9), 1494-1505, 2009. Available at: https://www.sciencedirect.com/science/article/pii/S0305750X09000667

[62] Muto, M and Yamano, T. 'The impact of mobile phone coverage expansion on market participation: Panel data evidence from Uganda'. World development 37, no. 12: 1887-1896, 2009.

[63] Evans, DS and Pirchio, A. 'An empirical examination of why mobile money schemes ignite in some developing countries but flounder in most'. Coase-Sandor Institute for Law and Economics, University of Chicago Law School, 2015. Available at: https://chicagounbound.uchicago.edu/cgi/viewcontent.cgi?article=2413&context=law_and_economics

[64] See for example: Vickery, M. 'The surprising place where cash is going extinct," BBC, 13 September, 2017. Available at: www.bbc.com/future/story/20170912-the-surprising-place-where-cash-is-going-extinct; Stevis-Gridneff, M. 'An isolated country runs on mobile money," Wall Street Journal, 6 July, 2018. Available at: https://www.wsj.com/articles/an-isolated-country-runs-on-mobile-money-1530882001

[65] Mobile money has also taken off in Somalia. See: 'Rapid growth in mobile money: Stability or vulnerability?' Somalia Economic Update No. 3, World Bank Group, August 2018. Available at: http://documents.worldbank.org/curated/en/975231536256355812/pdf/REPLACEMENT-PUBLIC-Somalia-Economic-Update-3-FINAL.pdf

[66] Central African Republic is a prime example. See country entry in ITU, Measuring the Information Society 2017. Vol. 2. ITU, 2017.

[67] Williams, M. Broadband for Africa: Developing Backbone Communications Networks. The World Bank, 2010.

[68] GSMA, The Mobile Economy Sub-Saharan Africa 2018, 2018.

Ecosystem

Broader infrastructural investments are also necessary to propel mobile money beyond a money transfer service to a digital payments platform. For example, despite Kenya serving as the birthplace of mobile money in Africa, cash transactions dominate consumer payments.[69] One challenge Kenya faces is developing a broader digital ecosystem that facilitates e-payments. One supply-side factor that is often cited as constraining greater uptake is many still get paid in cash, increasing the transaction costs of switching to digital payments.[70] Kenya's ecosystem constraints can be contrasted with China where, by one estimate, nearly half of internet users report primarily using cashless payments.[71] China's cashless economy has been driven by its three internet giants – Baidu, Alibaba, and Tencent – which invested in "a multifaceted and multi-industry digital ecosystem" that offers consumers incredible functionality and efficiency in making cashless payments.[72] Analysts also note the role of the Chinese government in facilitating the rise of a digital ecosystem. In the critical early years, Beijing was relatively hands off, allowing China's internet giants the space "to test and commercialize products and services and to gain critical mass."[73] When the Chinese government played a more active regulatory role, it adopted policies to support digitisation.

Structural inequalities and political discrimination

Another way that government policies affect the supply of mobile services is through restrictions or barriers on access. Such obstacles may reflect deeper structural inequalities and arise as an unintended consequence of greater regulation. For example, as governments have moved to adopt stricter 'know-your-customer' requirements to purchase a SIM (that is, demanding proof of identification from customers at registration) to reduce fraud and criminal activities, it risks putting mobile access out of reach for marginalised groups who lack state-issued identity cards.[74] In many low-income countries, there are significant gender differences in the possession of national identity

[69] By one estimate in early 2018, 8 out of 10 consumer payments were in cash. Flood, Z. 'Zimbabwe and Kenya lead the way in Africa's dash from cash', The Guardian, February 22, 2018. Available at: https://www.theguardian.com/world/2018/feb/22/kenya-leads-way-mobile-money-africa-shifts-towards-cash-free-living

[70] According to Financial Sector Deepening (FSD) Kenya, it is estimated that "only about 10% of people's income is born digitally." Cited in Flood, Z. Ibid.

[71] This is based on an online survey commissioned by PayPal across Asia in early 2017. Digital Payments: Thinking Beyond Transactions: APAC Research Report, PayPal, 2017. Available at: https://www.paypalobjects.com/digitalassets/c/website/marketing/global/shared/global/media-resources/documents/PayPal_Asia_Research_Report_Digital_Payments.pdf

[72] Woetzel, J et al. China's Digital Economy: A Leading Global Force, McKinsey Global Institute Report, August 2017. Available at: https://www.mckinsey.com/~/media/McKinsey/Featured%20Insights/China/Chinas%20digital%20economy%20A%20leading%20global%20force/MGI-Chinas-digital-economy-A-leading-global-force.ashx

[73] ibid.

[74] For a valuable analysis of this issue, see: GSMA, Mandatory registration of prepaid SIM cards: Addressing challenges through best practice, April 2016. Available at: https://www.gsma.com/publicpolicy/wp-content/uploads/2016/04/Mandatory-SIM-Registration.pdf

cards.[75] This form of political marginalisation can have significant consequences on digital access. One estimate suggests that in Tanzania 25% of people who are financially excluded do not have any form of identification.[76]

One potential solution to this problem is biometrically validated secure unique national identity numbers that encourage widespread adoption and seek to reduce the burden on marginalised groups to obtain an official ID. India has pioneered this with its Aadhaar unique identification system, which, among other goals, has sought to reduce fraud, ensure that poor and marginalised communities are not excluded from public benefits, and to improve access to financial and mobile services. By all indications, Aadhaar has dramatically boosted the number of Indians with bank accounts and reduced the number of 'ghost beneficiaries'.[77] In September 2018, India's Supreme Court upheld the legality of the Aadhaar programme and the government's ability to mandate its use to distribute subsidies and benefits – on the grounds that it "empowers the marginalized section of the society and gives them an identity."[78] But it has also prohibited private corporations, such as banks and MNOs, from requiring customers to have an Aadhaar ID to open an account. This latter ruling, which limits private corporations from gaining access to individuals' Aadhaar IDs, points to the trade-off between universality and privacy that arises from digital-ID programmes.[79] While it may facilitate access to government and private services, it consolidates private confidential data about users that, if breached or misused, could represent a significant threat to privacy, civil liberties, or beneficiaries' welfare. Many see the ruling of India's Supreme Court has an attempt to strike a balance between efficiency and privacy.[80]

Beyond structural inequalities that systems such as Aadhaar aim to overcome, political inequalities also affect access and use. In authoritarian regimes, there is evidence that governments are intentionally curbing mobile and internet access with the aim of weakening their citizens' mobilisational capabilities.[81] Weidmann et al. (2016) find that governments tend to undersupply internet services to ethnic groups that are politically excluded from state power to prevent them from

[75] Burjorjee, DM and Bin-Humam, Y. New Insights on Women's Mobile Phone Ownership. CGAP Working Paper, 2018.

[76] Financial Sector Deepening Trust. FinScope Tanzania 2017: Insights that Drive Innovation, p. 58. Available at: http://www.fsdt.or.tz/wp-content/uploads/2017/09/Finscope.pdf

[77] The precise effects have not been studied in detail. Most data on impact comes from the government of India. See Chandra, S. 'India's biometric identity program is rooting out corruption', Slate, 3 August, 2018. Available at: https://slate.com/technology/2018/08/aadhaar-indias-biometric-identity-program-is-working-but-privacy-concerns-remain.html

[78] Doshi, V. 'India's top court upholds world's largest biometric ID program, within limits', Washington Post, September 26, 2018. Available at: https://www.washingtonpost.com/world/asia_pacific/indias-top-court-upholds-worlds-largest-biometric-id-program-within-limits/2018/09/26/fe5a95b0-c0ba-11e8-92f2-ac26fda68341_story.html?utm_term=.b87375122f0a

[79] Goswami, S. 'India Supreme Court narrows use of Aadhaar data', BankInfoSecurity, September 26, 2018. Available at: https://www.bankinfosecurity.asia/india-supreme-court-narrows-use-aadhaar-data-a-11556

[80] See for example: Gelb, A, Mukherjee, A and Navis, K. 'What India's Supreme Court ruling on Aadhaar means for the future', Center for Global Development Blog, September 26, 2018. Available at: https://www.cgdev.org/blog/what-india-supreme-court-ruling-aadhaar-means-future

[81] On the link between mobile phone access and anti-government dissent, see: Pierskalla, JH and Hollenbach, FM. 'Technology and collective action: The effect of cell phone coverage on political violence in Africa'. American Political Science Review 107, no. 2: 207-224, 2013

using the technology to organise dissent.[82] Governments are also cutting off mobile and internet access to curtail dissent.[83] For example, in January 2017, amidst anti-government demonstrations in Anglophone Cameroon, the internet was shut down and remained blocked for a total of 230 days over 15 months,[84] costing the region millions of dollars in lost economic activities.[85]

Household and societal constraints

Beyond governmental restrictions, end users may face supply constraints within their own households as well. Family members may hinder access to mobile technology. The FII survey suggests that this is not a trivial phenomenon for both women *and* men. Across the seven countries in the survey, 15% (Nigeria) to 38% (Pakistan) of all respondents agree or strongly agree that they are not allowed to use a phone by their spouse, parents or other family members. In South Asia, women are significantly more likely to face household restrictions than men.[86] GSMA's Connected Women programme has extensively documented (through surveys and focus groups) how, in a number of low-and medium-income countries, male household members control women's phone access, significantly curtailing their use of mobile technology. For example, GSMA found that women who are secondary users of a phone (that is, they have to share someone else's phone) forfeit the privacy required for some mobile services, such as maternal health applications, and are less likely to gain technical literacy due to intermittent use.[87]

In an experimental setting, Roessler et al. (2018c) also provided some of the first direct evidence of how household supply constraints affect mobile phone adoption. Among those randomly assigned to receive cost-free phones, women from a household without any phones at baseline were significantly less likely to still possess the project phone at the endline and significantly less likely to own a phone at all.[88] This points to intra-household dynamics contributing to the gender gap in phone ownership. The next frontier in this domain is to better understand how intra-household bargaining affects phone ownership along gender lines. This bargaining is likely shaped

[82] Weidmann, NB et al. 'Digital discrimination: Political bias in Internet service provision across ethnic groups'. Science 353(6304), 1151-1155, 2016. Available at: http://science.sciencemag.org/content/353/6304/1151/tab-pdf

[83] Access Now, an advocacy group promoting the digital rights of users at risk around the world, finds that internet shut-downs are on pace to increase two-fold since 2016. See its #keepiton campaign: https://www.accessnow.org/keepiton

[84] ibid.

[85] Ritzen, Y. 'Cameroon internet shutdowns cost Anglophones millions', Aljazeera, 26 January, 2018. Available at: https://www.aljazeera.com/news/2018/01/cameroon-internet-shutdowns-cost-anglophones-millions-180123202824701.html

[86] Family restrictions of mobile phone use are significantly higher for women than men in Pakistan (14 percentage points higher restrictions for women compared to men), Bangladesh (about 7% more restrictions for women), India (about 7%), and Tanzania (3%).

[87] GSMA. Bridging the Gender Gap: Mobile Access and Usage in Low-and Middle-Income Countries, 2015. Available at: https://www.gsma.com/mobilefordevelopment/programme/connected-women/bridging-gender-gap-mobile-access-usage-low-middle-income-countries

[88] This controls for socio-economic factors that may correlate with household phone ownership. Roessler, P et al. 'Mobile phone turnover impedes women's financial inclusion in Tanzania,' Working Paper, William & Mary, Williamsburg, VA, US, 2018c.

by resource asymmetries but also cultural norms.[89] For example, in India, marriage norms related to purity and chastity may account for low uptake of mobile phones among women as girls forgo (or are prevented from) owning a phone lest they are perceived as 'promiscuous' by potential male partners.[90]

Demand-side factors of mobile access and use

On the demand side, one of the most powerful sources of digital inclusion is individuals' disposable income to buy a phone and consume value-added services. Preferences, tastes and other cognitive considerations are also important and require further discussion.

The primacy of disposable income

As noted, the costs of mobile handsets and service have dropped dramatically over the past two decades. This has exponentially increased ownership and access. But costs still represent a formidable barrier for many. Income constraints affect demand on every branch of the mobile digital economy: buying a handset; using a handset and value-added services, especially mobile money; smartphone migration; and internet use.

Across multiple surveys in low- and medium-income countries, lack of disposable income is reported as the dominant factor constraining mobile phone use. For example, in accounting for the gender gap in phone ownership, the Connected Women programme found that cost is the primary reason women report not owning a phone; this factor largely trumps other potential barriers, such as perceived value of phone use, family constraints, agent trust and access, and technical literacy.[91] Similarly in the FII surveys, most respondents (men and women) report that – more than any other factor – the high prices of smartphones keep them out of reach.[92] Income also

[89] Barboni et al. found that in India lack of women's empowerment appears to have a robust independent impact on mobile phone ownership relative to income and education. Barboni, G. et al. A tough call: Understanding barriers to and impacts of women's mobile phone adoption in India, Harvard Kennedy School, Evidence for Policy Design, October 2018. Available at: https://epod.cid.harvard.edu/sites/default/files/2018-10/A_Tough_Call.pdf

[90] Ibid. See also Schaner, S and Theys, N. 'A tough call: How can we close the gender gap in mobile phone use in India? The Evidence Base blog, 22 January, 2018. Available at: http://evidencebase.usc.edu/tough-call-can-close-gender-gap-mobile-phone-use-india

[91] GSMA. Bridging the Gender Gap: Mobile Access and Usage in Low-and Middle-Income Countries, 2015. Available at: https://www.gsma.com/mobilefordevelopment/programme/connected-women/bridging-gender-gap-mobile-access-usage-low-middle-income-countries

[92] Across the seven-country sample, on average, more than 70% of basic phone owners agree or strongly agree that the reason they do not own a smartphone is it is too expensive.

correlates with mobile money[93] and internet use.[94] Also, in high-income countries, lower-income individuals' connectivity is constrained by structural inequalities that make it difficult to maintain and use mobile technology.[95]

Spotlight: How poverty inhibits financial inclusion

Low uptake of mobile money among the poor illuminates how poverty fuels digital inequality. First, consider the direct effects. Those with low levels of disposable income are less likely to own their own handset and SIM. There is a strong association between personal phone ownership and mobile money use, especially in countries with active digital financial services (DFS) ecosystems.[96] This is seen both observationally and experimentally.[97] Moreover, many low-income individuals feel that they do not have enough money to open an account and use the service. For example, in Uganda, among those who don't use mobile money but are aware of the service, nearly 75% agree or strongly agree that not having enough money limits their use of DFS. Indirect channels also predispose the poor to turn away from mobile money. Most low-income individuals tend to work and operate in the informal economy, and lack familiarity and experience with formal financial instruments. Instead, they tend to save informally, such as "under the mattress" at home – the modal savings method in low-income countries. While risky, it avoids the transaction costs (fees and travel expenses) that come with formal banking and provides ultimate liquidity. These two factors – extreme price sensitivities to fees and liquidity concerns – constrain mobile money uptake and use among low-income individuals. One striking example of this comes from the Roessler et al. (2018a) experimental study in Tanzania on mobile phone ownership among a sample of generally low-income women. At the conclusion of the endline survey, micro-grants were offered to the participants (around $2 to $4) with varying amounts depending on if the grant was paid out in cash or via mobile money transfer. A 100% premium was offered if participants chose mobile money. Despite this very strong incentive, the majority of the sample opted for the cash payment. Liquidity concerns – needing the money for immediate use – was one of the top reasons participants said they opted for the significantly lower cash payment.[98]

[93] Demirguc-Kunt, A. The Global Findex Database 2017: Measuring Financial Inclusion and the Fintech Revolution. The World Bank, 2018.

[94] Though less stark, differences in internet use by income groups are also seen in high-income countries. See for example: Pew Research Center, Internet/Broadband Fact Sheet, 5 February, 2018. Available at: www.pewinternet.org/fact-sheet/internet-broadband

[95] Faith, B. 'Maintenance affordances and structural inequalities: Mobile phone use by low-income women in the United Kingdom'. Information Technologies & International Development, vol. 14, no. 1, 2018.

[96] In countries where mobile money is less developed, such as Pakistan, Nigeria and Mexico, there is a significant gap in phone ownership and financial inclusion. Many people in these countries own a phone yet remain unbanked. In contrast, in Africa, mobile phone ownership is more likely to be a pathway to financial inclusion. Demirguc-Kunt, A et al. The Global Findex Database 2017: Measuring Financial Inclusion and the Fintech Revolution. The World Bank, 2018.

[97] Demirguc-Kunt, A et al. The Global Findex Database 2017: Measuring Financial Inclusion and the Fintech Revolution. The World Bank, 2018; Roessler, P et al. Mobile Phone Churn Impedes Women's Financial Inclusion in Tanzania, 2018, Working Paper, William & Mary, Williamsburg, VA, US, 2018.

[98] Roessler, P et al. 'Mobile phone ownership and the uptake and usage of digital financial services by women in an emerging economy: Evidence from a field experiment in Tanzania.' 2018a. Report to Financial Services for the Poor Program, Bill and Melinda Gates Foundation.

In sum, individuals with disposable income are not only more likely to acquire mobile technology and invest in value added services, they tend to be less sensitive to mobile money transaction fees and the liquidity constraints that come with moving from cash to mobile money.

Education

Another powerful driver of demand for digital inclusion is education, even when controlling for income.[99] For example, in Tanzania, among those who have ever used mobile money, fully literate individuals are more than three times as likely to have mobile money proficiency (as measured by whether individuals think it is easy or relatively easy to complete a mobile money transaction) compared to those with no literacy. Among the rural poor, literacy increases mobile money proficiency four-fold.[100]

Education increases demand for digital inclusion through a number of channels: it increases familiarity with digital technology and its benefits; and it strengthens one's capabilities to navigate and use the technology. A growing body of research points to the design limitations of mobile handsets and software for low-literacy populations and non-English speakers.[101] In particular, the default scrolling and hierarchical navigation menus in feature phones prove challenging for individuals with low digital fluency.[102] Accessibility and accuracy seem to increase with the use of live operators or spoken-dialog user interfaces[103] but these systems are rarely available or used. Moreover, mobile user interfaces were initially built for the English language, which tends to be more compact than other languages. Thus, texting and other applications prove unwieldy in languages besides English.[104] As these barriers, arise even for basic applications such as making calls or sending an SMS, they become even more formidable as complexity increases, such as the use of mobile money. Mobile money systems rely on pin-based authentication to access an account and withdraw remittances received. Innumerate individuals – and those who infrequently use the service – are less likely to remember or know their pin.[105] To reset one's pin (which becomes

[99] Zouinar, M and Ndiaye, MA. 'Low literacy, social inclusion and the use of mobile phones'. In Wamala-Larsson, C, Scharff, C and Hellstrom, J. (Eds.), Mobile Participation: Access, Interaction and Practices (pp. 55-73). Newcastle upon Tyne: UK. Cambridge Scholars Publishing, 2015.

[100] FII Tracker Survey, Tanzania Wave 5, the Financial Inclusion Insights Program, InterMedia, 2017.

[101] Medhi, I et al. 'Designing mobile interfaces for novice and low-literacy users'. ACM Transactions on Computer-Human Interaction (TOCHI) 18, no. 1: 2, 2011; Wyche, S and Steinfield, C. 'Why don't farmers use cell phones to access market prices? Technology affordances and barriers to market information services adoption in rural Kenya'. Information Technology for Development 22, no. 2: 320-333, 2016.

[102] Medhi, I, Gautama, SN and Toyama, K. 'A comparison of mobile money-transfer UIs for non-literate and semi-literate users'. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, pp. 1741-1750. ACM, 2009.

[103] Medhi, I et al. 'Designing mobile interfaces for novice and low-literacy users'. ACM Transactions on Computer-Human Interaction (TOCHI) 18, no. 1: 2, 2011; Medhi, I, Gautama, SN and Toyama, K. 'A comparison of mobile money-transfer UIs for non-literate and semi-literate users'. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, pp. 1741-1750. ACM, 2009.

[104] Wyche, S and Steinfield, C. "Why don't farmers use cell phones to access market prices? Technology affordances and barriers to market information services adoption in rural Kenya." Information Technology for Development 22, no. 2: 320-333, 2016.

[105] Wyche, S, Simiyu, N and Othieno, ME. 'Mobile phones as amplifiers of social inequality among rural Kenyan women'. ACM Transactions on Computer-Human Interaction (TOCHI) 23, no. 3: 14, 2016.

locked after three incorrect entries), most MNOs require users to visit one of their service centres and provide proof of identity including name, birth date, ID type and number used for registration, last transaction date and amount, and available balance.[106]

Taken together, mobile technology is generally unfriendly and daunting to innumerate and illiterate individuals, reducing its adoption. Slack demand from low-literacy populations means that existing social inequalities are manifesting in digital inequalities.

Gender

Early research on the digital divide along gender lines attributed it to economic inequality, such as women's lower levels of employment, education and income.[107] But controlling for these economic factors, gender differences persist. (See Appendix). As mentioned, household and societal constraints are important supply-side factors affecting women's access to mobile technology.[108] Beyond patriarchal dominance of digital technologies and norms discouraging female adoption,[109] unequal access also rises from imbalanced labour demands in the household, which limit the amount of time women have to use their mobile phones.[110]

Demand-side factors are highly intertwined with these supply constraints. For example, if women in rural areas of low-income countries tend to gain access primarily through feature phones (and second-hand ones at that), or through borrowing, this will reduce their ability to use more advanced value-added services, such as mobile internet.[111] Similarly, norms picked up through marketing, observation of others' practices, and societal expectations may predispose women to see mobile technology primarily as a communication device rather than for the use of mobile money, internet access and other transformational services.[112]

[106] Airtel, an MNO which operates in 20 countries across South Asia and Africa, introduced a self-help PIN reset service, but it requires the registration and use of a secret word.

[107] Hilbert, M. 'Digital gender divide or technologically empowered women in developing countries? A typical case of lies, damned lies, and statistics'. Women's Studies International Forum 34(6), 479-89, 2011.

[108] Barboni, G. et al. A tough call: Understanding barriers to and impacts of women's mobile phone adoption in India, Harvard Kennedy School, Evidence for Policy Design, October 2018. Available at: https://epod.cid.harvard.edu/sites/default/files/2018-10/A_Tough_Call.pdf

[109] Croxson, H and Rowntree, O. *Triggering Mobile Internet Use Among Men and Women in South Asia.* GSMA, 2017. Available at: https://www.gsma.com/mobilefordevelopment/wp-content/uploads/2017/11/GSMA-Triggering-Mobile-Internet-Use_Web.pdf; GSMA, *Connected Women: Mapping the Mobile Money Gender Gap: Insights from Côte D'Ivoire and Mali.* April 2017. Available at: https://www.gsma.com/mobilefordevelopment/wp-content/uploads/2017/04/Mapping-the-mobile-money-gender-gap-Insights-from-Cote-d%E2%80%99Ivoire-and-Mali.pdf; Khan, I. (2016). *'Pakistan's gender gap in financial inclusion'.* CGAP Blog, 13 September, 2016. Available at: http://www.cgap.org/blog/pakistan%E2%80%99s-gender-gap-financial-inclusion; USAID. *Connecting to Opportunity: A Survey of Afghan Women's Access to Mobile Technology*, 2013. Available at: https://www.usaid.gov/sites/default/files/documents/1871/survey_afghan_women_mobile.pdf

[110] Wyche, S and Olson, J. 'Kenyan women's rural realities, mobile internet access, and "Africa Rising"'. Information Technologies & International Development 14, 33-47, 2018.

[111] Wyche, S, Simiyu, N and Othieno, ME. 'Mobile phones as amplifiers of social inequality among rural Kenyan women'. ACM Transactions on Computer-Human Interaction (TOCHI) 23, no. 3: 14, 2016.

[112] GSMA. 'Bridging the gender gap: Mobile access and usage in low- and middle-income countries', 2015. Available at: https://www.gsma.com/mobilefordevelopment/programme/connected-women/bridging-gender-gap-mobile-access-usage-low-middle-income-countries

Age

A fourth important social determinant of digital inequality is age. Across most countries in the world, smartphone and internet use is significantly lower among older generations. For example, in the US about two-thirds of Americans over the age of 65 use the internet compared to mostly all Americans between the ages of 18 and 49.[113] In addition to other factors that correlate with age, such as disposable income and employment status, the lower levels of digital connectivity among older individuals may be linked to social network size and activity, multiple users in the household, and cognitive and physical decline related to ageing – exacerbated by unfriendly design and functionality features for older users.[114] Generational cohort effects may also amplify the digital divide across age groups due to the recent mobile and internet revolutions; newer generations are coming of age with much greater exposure, access and experience to these technologies with significant technical, behavioural and socialising effects.[115] In contrast, for older generations first exposed to these technologies at an older age, unfamiliarity, technical challenges and cultural differences may depress use.[116]

In low-income countries, there is a curvilinear relationship between age and digital use. Older age groups have significantly lower digital access but so do younger ones. For example, in India mobile phone ownership is above 66% for 25- to 44-year-olds but only 55% for those aged 15 to 24 and 41% for those aged 55 and above.[117] The low penetration rate among younger cohorts is not only a function of differences in disposable income, but may also result from lower levels of agency among youth in certain countries and other cultural differences. For example, generally in East Asia (China, Japan and Korea), younger age groups have relatively greater phone ownership than in South Asia.[118] In their study in Tanzania, Roessler et al. (2018c) found that, among those who received cost-free phones, women aged 30 and under were 17% less likely to remain phone owners. This could be due to their greater mobility and higher likelihood of losing the phone, but most likely points to their lack of power over control of the phone compared to older women.[119]

[113] Pew Research Center, Internet/Broadband Fact Sheet,, 5 February, 2018. Available at: www.pewinternet.org/fact-sheet/internet-broadband

[114] Czaja, SJ and Lee, CC. 'The impact of aging on access to technology'. Universal Access in the Information Society 5, no. 4, 2007.

[115] Rama, MD, de Ridder, H and Bouma, H. 'Technology generation and age in using layered user interfaces'. Gerontechnology 1, no. 1: 25-40, 2001.

[116] Lüders, M and Bae Brandtzæg, P. '"My children tell me it's so simple": A mixed-methods approach to understand older non-users' perceptions of social networking sites'. New media & society 19, no. 2: 181-198, 2017.

[117] According to the FII data for India, phone ownership by age cohort is as follows: 15–24 (55%); 25–34 (69%); 35–44 (67%); 45–54 (58%); 55 and above (41%). FII Tracker Survey, India Wave 5, the Financial Inclusion Insights Program, InterMedia, 2017.

[118] Jacqueline Howard, 'When kids get their first cell phones around the world', CNN, 11 December, 2017. Available at: https://www.cnn.com/2017/12/11/health/cell-phones-for-kids-parenting-without-borders-explainer-intl/index.html

[119] Roessler, P et al. 'Mobile Phone Churn Impedes Women's Financial Inclusion in Tanzania,' Working Paper, William & Mary, Williamsburg, VA, US, 2018c.

Part 3: Policy implications

The mobile phone revolution is the most widespread communication technological revolution in history and is a key driver of the digital economy. This has been propelled by the combination of technological change (the advent of low fixed-cost wireless networks and innovations in mobile handsets and value-added services) and economic liberalisation in the telecommunications sector. Mobile technology has never been more affordable or more accessible. Yet, for many, mobile phone access and use continues to be out of reach or heavily restricted. The impact that mobile phone inequality has on digital inequality is firmly on the policy agenda due to the pioneering research of Connected Women, FII and Gallup as well as advocacy organisations, such as the Consultative Group to Assist the Poor (CGAP). However, one of the key points this briefing paper has sought to highlight is that, while the general contours of the digital divide are well established, the nuances of ownership and use necessitate more in-depth research. As the digital economy and mobile phone use for development programmes rapidly scales, more precise analysis of the true extent and nature of access and use is tremendously important to help us understand who is being left behind.

Mitigating turnover

One significant constraint in access and usage is the degree of turnover in SIM registration and handset ownership. Large tracking surveys have done a great service in exposing the large and important gaps in ownership, but, as they generally only provide a static, discrete picture of phone ownership and use, they have failed to spotlight the problem of turnover. This phenomenon points to the importance of more rigorous and dynamic methodologies in tracking the pathway from mobile phone access to ownership to usage – an important policy implication itself.

SIM attrition and irregular mobile phone ownership represent a major policy problem as it hinders individual use and also dents the efficacy of mobile for development programming. For example, SIM and phone turnover among participants enrolled in mobile money-based cash transfer programmes not only hurts beneficiaries who fail to receive their cash infusions, but it leads to waste as transfers continue to be sent, even though they are not being received. The scale of this problem is unknown but surely represents tens of millions of dollars in lost cash transfers.

It is important to note, as discussed, that churn *can* be beneficial for consumers as they exploit market forces to exchange or acquire a SIM or phone that they feel best suits their needs. Any policy response should not deny consumers this flexibility. At the same time, however, it is also clear that, for many, turnover is not a choice but a hazard. There is no easy fix to involuntary turnover. It stems from deeper structural issues, such as poverty and power asymmetries within the household.

One potential solution to turnover by loss, theft or breakage is micro-insurance. Mobile phone insurance poses a number of challenges. The diffuse market and the relative high risk of mobile phone insurance fraud[120] confronts suppliers with significant monitoring and administrative costs, whereas for the poorest even the smallest premiums and deductibles may put the product out of reach.[121] Nonetheless it is a product worth testing. Remote blocking of International Mobile Equipment Identities (IMEIs) from phones reported lost or stolen provides insurance companies with a powerful enforcement mechanism to reduce fraud. The offer of insurance, while increasing consumer costs, may encourage some to move away from unreliable second-hand phone markets to purchase phones and ensure more stable access. It may also increase consumer awareness that phone loss need not require them to 'start over' and replace their existing subscription with a new SIM card.

Increasing uptake of MNO's SIM replacement policies represents another solution to turnover. For many low-income users, turnover is debilitating because it leads to large gaps and setbacks in use. Once individuals lose their SIMs, it often takes months to acquire a new one; and when they do, it requires setting up a new mobile money account and other value-added services. This often leads individuals to forgo any airtime or money they had on their mobile money account. Consumers may not know that, if they lose their SIM, they can replace it and maintain their account. Or they may find the requirements for obtaining a new SIM too onerous, especially for individuals with low literacy and numeracy.[122] Informational campaigns targeted at poorer and less educated end-users on how they can manage SIM card loss are needed, as well as greater support for these customers. This type of training and awareness should be built into all mobile for development programming, especially cash transfer systems.

Digital literacy training to overcome socio-economic inequalities

The problem of churn and SIM replacements points to probably one of the biggest challenges in improving mobile phone access and use as a way to address digital inequality: how to overcome the stubbornly persistent socio-economic factors that constrain mobile phone ownership and the migration to more advanced mobile phone technologies (smartphones) and services (mobile money and internet). As noted, one of the most robust indicators of mobile uptake and use is education – especially literacy and numeracy. Improving educational attainment does not happen overnight. Instead mobile programming needs to think about how to improve digital literacy working under

[120] There are some indications that mobile phone insurance fraud is higher than for other consumer goods. See: 'Mobile phone insurance fraud soars', Financial Times, 8 May, 2012. Available at: https://www.ft.com/content/9ba2857c-9619-11e1-9d9d-00144feab49a

[121] Dercon, S, Bold, T and Calvo, C. 'Insurance for the Poor?' In Social Protection for the Poor and Poorest. London: Palgrave Macmillan, pp. 47-63, 2008.

[122] The stringent requirements needed to replace a SIM – including presenting an ID card, the SIM PIN, recent transactions, as well as the last numbers the subscriber dialed or received calls from – are intended to avoid 'SIM swapping' fraud, which is on the rise.

these societal constraints. As the Connected Women program laid out in a call to action: "a multi-stakeholder approach is required to improve women's digital literacy and mobile internet skills."[123] This applies to men as well as women. It emphasises the importance of: leveraging social networks to transmit knowledge and learning; increasing the availability of community resource personnel, including mobile phone and network agents; improving digital education in schools; redesigning mobile interfaces; and deepening our understanding of how women learn to use mobile internet.[124] A number of innovative initiatives are being piloted on this front, including:

- Digital Opportunity Trust (DOT) is introducing a Digital Ambassadors programme in Rwanda to recruit digitally-savvy young women and men to deliver digital literacy training to increase mobile uptake and use;[125]

- Next 3B, in partnership with Tata Communications, Tone, Trickle Up, and Brightstar, is piloting a programme in Odisha, India to introduce specially designed software and apps to increase functionality of smartphones for individuals with limited literacy and numeracy;[126]

- My Oral Village designs training and tools, such as a cash calculator and planner and financial numeracy and mobile wallet game, to increase financial inclusion among innumerate and semi-numerate people;[127]

- Fundación Capital innovates tablet-based self-learning systems to improve the financial and mobile capabilities of those living in poverty.[128]

Overcoming literacy and numeracy constraints represents one of the most important solutions to overcome the widening gap between digital access and usage. As the flagship Pathways for Prosperity report, *Digital Lives: Meaningful Connections for the Next 3 Billion*, convincingly shows, this is the critical link to ensure that everyone has an effective and fulfilling digital life.[129]

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123 Connected Women. *Accelerating Digital Literacy: Empowering Women to Use the Mobile Internet*, GSMA, 2015. Available at www.gsma.com/mobilefordevelopment/wp-content/uploads/2015/06/DigitalLiteracy_v6_WEB_Singles.pdf

124 ibid.

125 For more information, see: Digital Opportunity Trust (DOT) Rwanda: https://rwanda.dotrust.org/what-we-do

126 For more information, see: Next 3B, Odisha Pilot: One step towards financial empowerment: http://next3b.com/odisha-india-one-step-towards-financial-empowerment/

127 For more information, see My Oral Village: http://myoralvillage.org/

128 For more information, see Fundación Capital: http://fundacioncapital.org/

129 Pathways for Prosperity Commission on Technology and Inclusive Development. *Digital Lives: Meaningful Connections for the Next 3 Billion,* 2018. Available at https://pathwayscommission.bsg.ox.ac.uk/digital-lives-report

Appendix

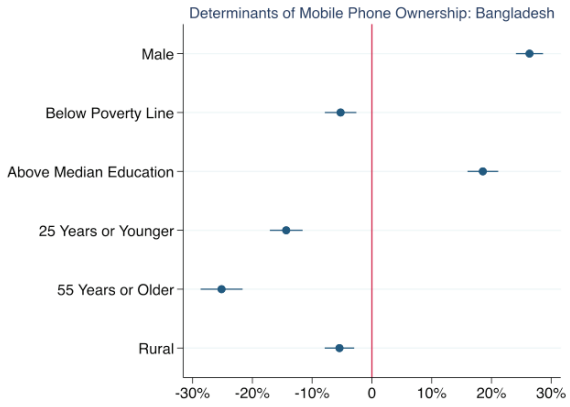
The socio-economic determinants of mobile phone inequality have remained stubbornly persistent as the mobile phone revolution has spread throughout the world. This appendix leverages the remarkable data collected by InterMedia's Financial Inclusion Insights (FII) Tracker Surveys, Wave 5, in Bangladesh, Kenya, India, Nigeria, Pakistan, Tanzania and Uganda in 2017 to estimate the relative effects of income, education, urbanicity, gender, and age on *mobile phone ownership* (whether a respondent reports owning a phone) and *mobile internet proficiency* (whether a respondent reports having some or complete ability to use the internet on a mobile phone). Each figure visualises the results of a survey-weighted ordinary least squares (OLS) regression (nationally representative among each country's population 15 years and older), in which mobile phone ownership and mobile internet proficiency are, respectively, regressed on a set of socio-economic variables. For ease of interpretation, the results indicate the percentage of change in mobile phone ownership and mobile internet proficiency for each given socio-economic determinant.

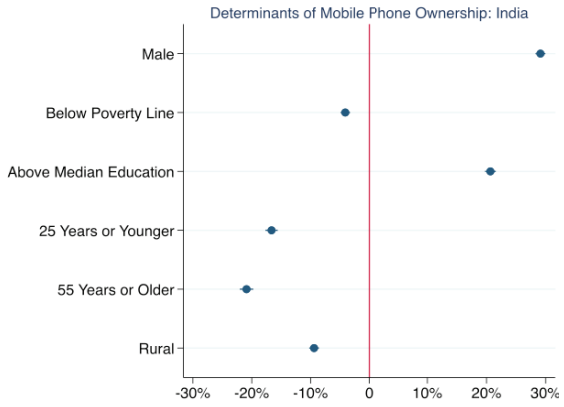
Overall, the results confirm the importance of these socio-economic determinants. More specifically on mobile phone ownership, we see that:

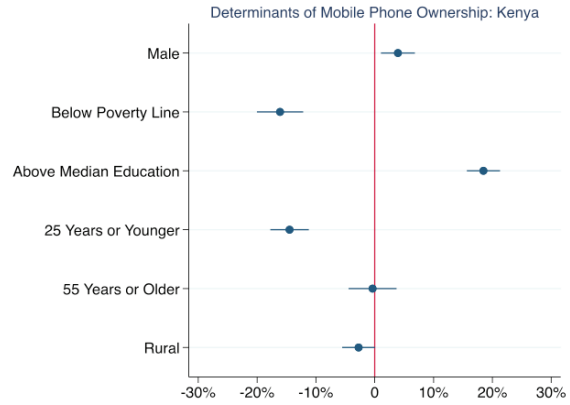
- gender is an especially powerful predictor in South Asia;
- poverty is a larger constraint on mobile phone ownership among the African countries in the sample; and
- younger and older individuals are significantly less likely to own phones.

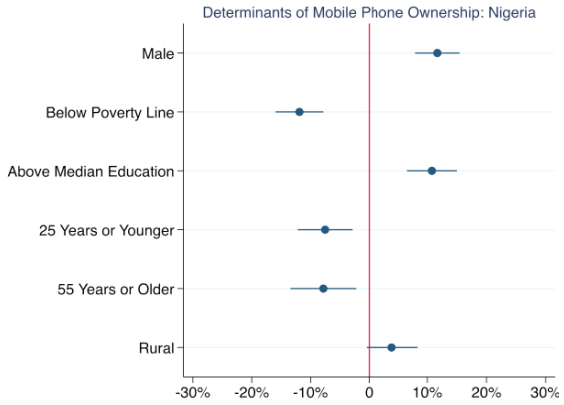
On mobile internet proficiency, education level is the most powerful determinant; moving from below median to above median education increases mobile internet proficiency by some 20–40%. Unsurprisingly, the results also confirm that younger people are significantly more likely to demonstrate internet proficiency.

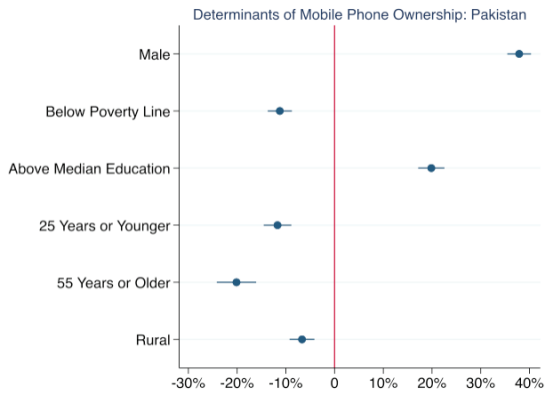
The socio-economic determinants of mobile phone ownership

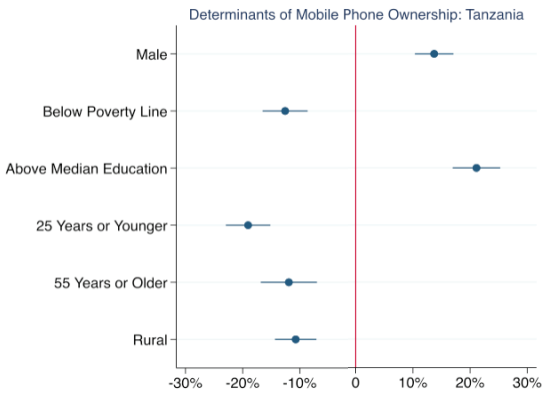


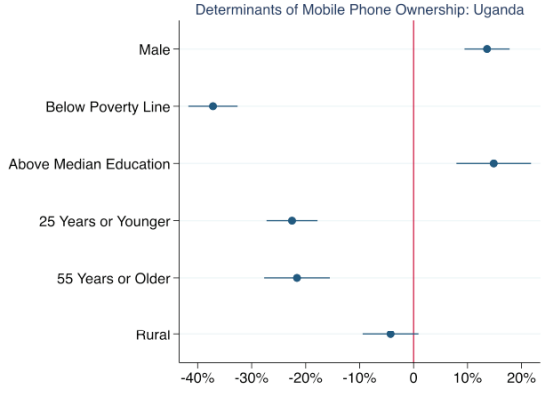






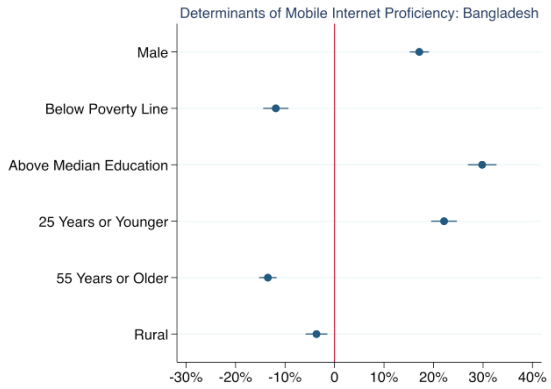


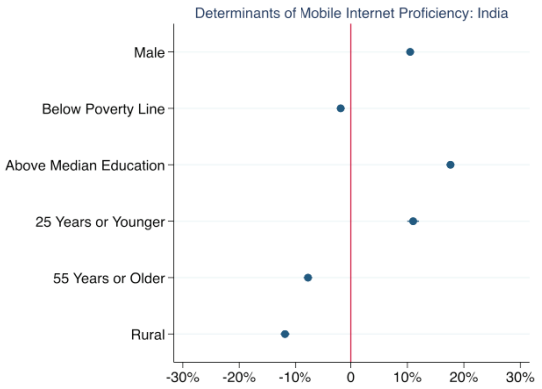


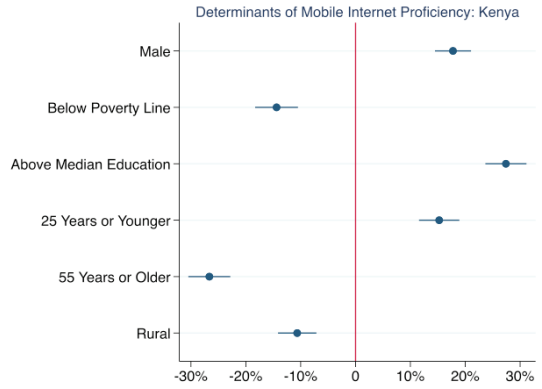


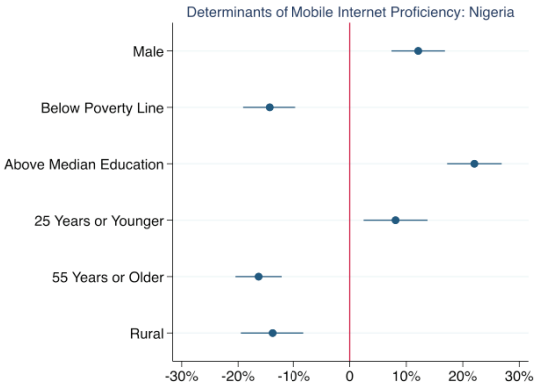
Source: InterMedia, FII Tracker Survey, 2017. Notes: Each figure represents the results of a single survey-weighted, country-level OLS regression of mobile phone ownership on key socio-economic variables. Controlling for all other variables, each variable indicates the percent change in mobile phone ownership: between male and female participants; below poverty line and above poverty line; above median education and below median education; 25 years or younger and 26-55 years; 55 years or older and 26-55 years; and rural and urban. The line around each point estimate indicates 95% confidence intervals. Total observations for each regression are as follows: Bangladesh, *N*=6,000; India, *N*=47,132; Kenya, *N*=3,129; Nigeria, *N*=6,042, Pakistan, *N*=6,000; Tanzania, *N*=3,060; Uganda, *N*=3,001.

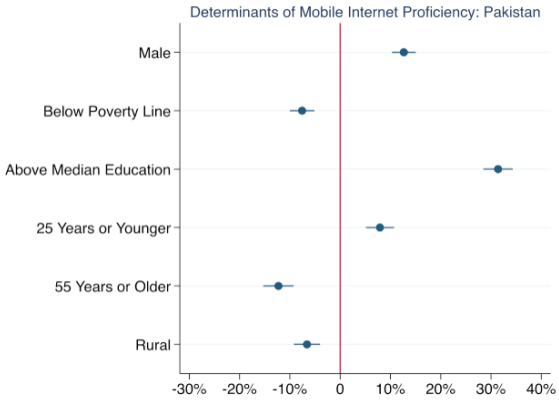
The socio-economic determinants of mobile internet proficiency

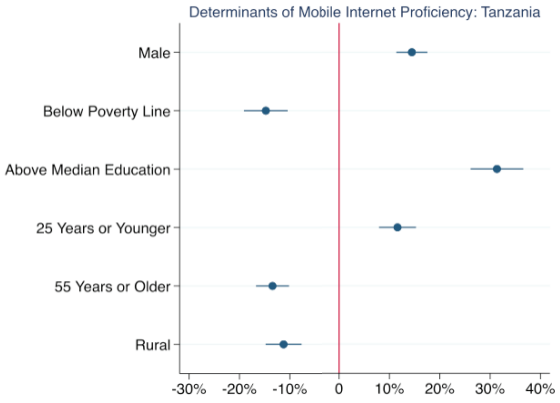


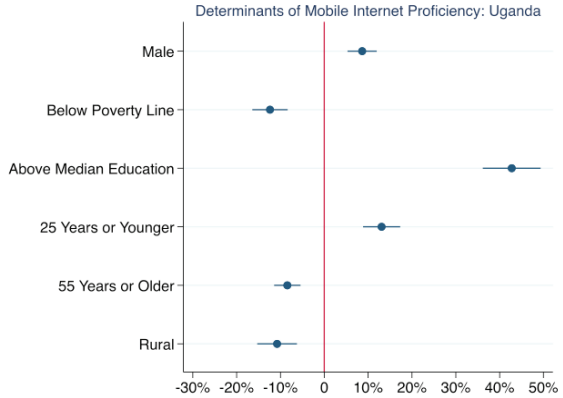












Source: InterMedia, FII Tracker Survey, 2017. Notes: Each figure represents the results of a single survey-weighted, country-level OLS regression of mobile internet proficiency on key socio-economic variables. Controlling for all other variables, each variable indicates the percent change in mobile phone ownership: between male and female participants; below poverty line and above poverty line; above median education and below median education; 25 years or younger and 26-55 years; 55 years or older and 26-55 years; and rural and urban. The line around each point estimate indicates 95% confidence intervals. Total observations for each regression are as follows: Bangladesh, *N*=6,000; India, *N*=47,132;
Kenya, *N*=3,129; Nigeria, *N*=6,042, Pakistan, *N*=6,000; Tanzania, *N*=3,060; Uganda, *N*=3,001.

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