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Women's Economic Empowerment and Digital Connectivity

The White Paper

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1. Introduction

Throughout human history some of the most important technological advances have been those that reduce information and communication costs. From the invention of writing and much later the printing press transforming how information is recorded, stored, and disseminated; to the telegraph and telephone accelerating the speed of long-distance communication; to the radio and television enabling the mass broadcasting of audio; and then video; each of these innovations produced profound changes in human capital, social networks and identity, and markets, trade, and political organization. The digital technology revolution that took off in the second-half of the 20th century is no exception, and in many ways marks the most significant transformation yet in terms of the speed, scale, and scope of the evolution of information and communication technologies.

Underpinned by breakthroughs in the digitization of information (i.e., its conversion from analog forms such as paper documents, photographs, and tape recordings into binary digital code) and, as importantly, its transmission and readability using computers, digital networks, and mobile phones, the digital technology revolution has ushered in an interconnected world. Such digital connectivity has enabled end-users' immediate access to vast amounts of information over the internet, real-time communication from nearly anywhere, and opened the door to digital-based systems, including finance, healthcare, agricultural extension services, learning platforms, job training, and countless others. While the digital technology revolution has had far-reaching consequences the world over, low- and middle-income countries (LMICs) in many ways had the most to gain, given historically underdeveloped information systems (e.g., scarcity of public libraries, newspapers in circulation, and public information services), communications infrastructure (e.g., sparseness of fixed telephone lines, post offices, and transportation networks), and public services (e.g., low density of healthcare facilities, banks, schools, and agricultural extension offices). And within LMICs, the ICT revolution may be especially beneficial for women given the foundational social constraints they face—including limited mobility, information asymmetries, social isolation, and lower-levels of literacy—that hinder their access to what services are available, to economic opportunities, and to social and political mobilization.

In this White Paper we propose a framework to study the impact of the digital technology revolution on women's economic empowerment in LMICs. Among the broader ICT changes that have transformed the world over the past half-century, we focus on the impact of *digital connectivity*—that is, the ability of individuals to access and effectively use mobile and internet-abled devices to search for information, communicate in real-time over long-distances, and access

digitized networks, systems, platforms, and services provided by governments, private companies, non-governmental organizations, and local communities. Given the high relative costs of computers in LMICs, the gateway to digital connectivity for the average end-user is the smartphone. Smartphone penetration rates in LMICs have increased substantially over the past decade. Nonetheless, they remain significantly lower than in high-income countries. Rates of *meaningful connectivity* lag even further behind—in which end-users not only have internet access, but are able to effectively use the internet and internet-enabled services through high-quality, affordable, and sufficiently fast connections and reliable devices, as well as possessing the digital skills to do so (Alliance for Affordable Internet 2020). Although the gender gap in basic phone ownership and access to critical mobile-based services, such as mobile money, continues to narrow, significant gender disparities persist in smartphone ownership, mobile internet usage, and meaningful connectivity (Jeffrie et al. 2023).

Our theoretical framework, developed in Section 2, focuses on three channels by which digital connectivity is leading to socio-economic change in LMICs: 1) reducing information frictions; 2) lowering communication costs and changing the structure of communication networks; and 3) enhancing access to public services, especially digitized ones.

We conceive that women's access to digital connectivity, especially meaningful connectivity, will enable them to leverage these benefits—and help mitigate structural inequalities women face—with important individual, market, societal, and economy-level effects. However, as these channels of impact are contingent on women's access to and use of mobile phones and mobile broadband internet, dynamics of technology adoption cannot be assumed away and remain integral to our framework. In Section 3, we analyze the most important drivers of adoption—affordability, availability, accessibility, literacy, relevance, risk/security, network effects, and social norms—drawing from existing scholarly and policy research on each dimension. We also acknowledge that the dynamic relationship between adoption and connectivity implies that the social and economic consequences of access to the internet and internet-enabled services will, in turn, shape women's preferences for smartphones and the slope of demand curves.

In Section 4, we survey existing scholarship on the impacts of digital connectivity in LMICs. We begin by focusing on individual or household-level effects across different sectors: labor force participation and income generation; agricultural productivity; education; healthcare; and digital financial services. Large literatures exist for each of these research programs. In line with our theory of change, as we survey the evidence, we pay special attention to studies that differentiate effects by gender, specifically focus on women, or test interventions designed for women. On the whole, however, despite the gender digital divide, the evidence base on women is thin. In Sections 5 and 6, we consider research on societal impacts and general equilibrium effects.

We conclude by proposing a series of questions to guide future research. One overarching frame is that the substantial and growing body of evidence illuminating the developmental dividends that digital connectivity brings in LMICs points to a significant opportunity to strengthen women's economic empowerment by expanding access to meaningful connectivity. However, among the literature reviewed above only a handful of studies were intentionally designed to explore gender differences or evaluated interventions intentionally designed around the barriers faced by women. This dearth of evidence begs for additional research centered squarely at the intersection of connectivity and gender.

2. Theory of Change: The Impact of Digital Connectivity on Women's Economic Empowerment

Channels of Impacts

In this section we delineate some of the key channels through which digital connectivity is driving economic change in LMICs. Building from Goldfarb and Tucker (2019), who argue that the transformative potential of digitization stems from its impact on lowering fundamental economic costs (see also Aker and Cariolle 2023), we focus on those pathways most likely affected by connectivity: lower information and communication costs and increased accessibility of services. These are by no means the only mechanisms, but we focus on them because they are likely to be especially consequential for loosening the foundational constraints that affect women's economic empowerment in emerging economies.

Information costs: Traditionally in emerging economies with underdeveloped communication networks, transportation infrastructure, and government services, individuals, firms, and organizations faced formidable barriers to acquiring information. To do so incurred substantial opportunity costs in terms of time and effort (e.g., walking to markets to determine commodity prices, waiting by the road to find piece-work, or traveling to the capital to learn about governmental policies), which diverted resources away from productive activities and reduced economic efficiency. However, the advent of wireless networks and digital connectivity has ushered in an era of increased information availability, searchability, and accessibility. In a seminal early contribution, Jensen (2007) illuminates the benefits of mobile phones as a "search technology" among fishermen in Kerala, India. With cellular network coverage extending offshore, fishermen no longer were constrained to selling only in one's local market (as was traditionally the case due to lack of communication and high transportation costs both on sea and land), but could use their mobile phones to market their catch across multiple buyers in different fishing villages. This transformed the fisheries sector from "a collection of essentially autarkic fishing markets to a state of nearly perfect spatial arbitrage," increasing consumer and producer welfare. Aker (2010) finds similar impacts on search costs and trading efficiency among grain traders in Niger, particularly in remote and unpaved regions.

The internet and the informational innovations it has enabled (e.g., search engines, free-content online encyclopedias, message communities, online health information repositories) have significantly amplified the accessibility and searchability of information. It also has given rise to online platforms that further drive down search costs and facilitate matching between buyers and sellers (Kroft and Pope 2014; Goldfarb and Tucker 2019).

Communication costs and changing structures of communication networks: Integral to the impact of mobile phones on the improved efficiency of Kerala's fishing markets and Niger's grain markets was real-time remote communication. This represents another fundamental dimension of the digital connectivity revolution. Similar to the access of information, traditional modes of communication were generally slow and costly (such as face-to-face meetings or by courier or postal services). Landline telephones enabled significant cost savings in long-distance communication, but access to the service was sparse. For example, in Kenya in 1997, the year the first mobile operator was licensed in the country, its landline network reached less than 1% teledensity (telephone connections for every hundred individuals) (Waema 2007). Radio was much more prevalent, increasing exposure to information from those who controlled the media (broadcasting companies, government officials, and elites), yet with limited applications for supporting peer-to-peer communication.

Innovations in wireless networks and mobile phones thus represented an opportunity for LMICs to 'leapfrog' ahead of their prevailing limited ICT infrastructure (Aker and Mbiti 2010). In the first decade of the launch of cellular service in Kenya, the mobile network reached more than 20 times the size of the landline network (Waema 2007), continuing to grow exponentially in the subsequent decade. In many LMICs, this technological change had the potential to significantly reduce the costs of long-distance communication, improve market coordination, increase economic integration (including of remote, underserved regions), and foster social connectivity.

The emergence of social media has further transformed communication, not only in continuing to lower costs, but also in revolutionizing its structure—leading to a shift from one-to-many communication to many-to-many networks (Tufekci 2017; Tucker et al. 2017). This transformation has increased individuals' weak ties-network and qualitatively reduced the costs of acquiring information from them. In an experimental study using LinkedIn, Rajkumar et al. (2022) provide causal evidence on the power of social media to expand individuals' weak ties and increase their job mobility. Moreover, social media may serve to uncover and possibly transform collective beliefs, or norms, by enabling widespread, simultaneous expression, sharing, and updating of ideas. At the same time, however, social media has been found to accelerate the spread of misinformation and outrage. Messages that engender out-group animosity (Rathje, Van Bavel, and van der Linden 2021) or spread fabricated content that invoke "fear, disgust,

and surprise in replies" tend to be more likely to go viral on social media than factually correct stories (Vosoughi, Roy and Aral 2018).

Access to services: The third key channel of change arising from digitization is on service delivery and access. Compounded by prevailing limitations in ICT infrastructure as well as underlying weaknesses in state capacity (leading to inefficient bureaucratic administration and the undersupply of public goods), governments in LMICs struggled to build ecosystems that would enable citizens' access to basic services, such as healthcare, education, and banking. With the leapfrogging of communications infrastructure, the digitization of information, and the proliferation of connected devices, governments, firms, and individuals gained new, often cheaper, ways to disseminate content, collect information, and transact with each other. This facilitated the development of innovative and more accessible services, such as enabling the sending and receiving of money using USSD codes on basic handsets or the digitization of agricultural extension services. It enhanced real-time communication and geolocated tracking to improve targeting and service delivery, such as the use of mobile technology by the World Food Programme to collect food security data using SMS, live phone interviews, and an Interactive Voice Response (IVR) system. It also has lowered barriers for citizens to access information about government programs and provide feedback through SMS, online portals, and social media platforms (Grossman, Humphreys, and Sacramone-Lutz 2014; Chen, Pan, and Xu 2016).

In significantly driving down the costs of developing, replicating, and transporting content to connected users, digitization of services enables near-zero marginal cost and significant economies of scale (Goldfarb and Tucker 2019; Aker and Cariolle 2023). For example, in Nepal the digitization of agricultural extension services has been found to be 0.05% of the cost of traditional in-person training per adopter (Giulivi et al. 2023).

At the same time, however, the digitization of services introduces its own set of complexities, challenges, and costs in system design, implementation, security, administration, and sustainability.[1] And we would expect the effectiveness of digital initiatives to be endogenous to institutional capacity and political will to adopt and maintain them. For example, Shonchoy and Wahhaj (2023) find that the efficacy of Bangladesh's initiative to increase birth registration using local, government-run digital centers linked to a national database varied significantly due to subnational differences in administrative capacity.

Digital Connectivity for Women: By driving down information and communication costs and increasing the accessibility of services, connectivity-enabled digitization has the potential to transform economic development in LMICs. This may be especially consequential for women

[1] See Aker and Cariolle (2023) for a constructive discussion of some of the inherent limitations and common design flaws of ICT4D programming and policies.

given the structural barriers that hinder their economic attainment and empowerment. These channels of impact for women are directly mediated by their access to and use of mobile phones and mobile broadband internet. Therefore, we propose that development policy and practice would benefit from greater evidence both on drivers of women's phones and internet adoption – the causes – and on the impacts of expanded connectivity – the consequences. We begin with the consequences, providing a theoretical framework for why expanded availability and usage of mobile phones and the internet in LMICs—and the gains in access to information, communication, and services they help bring—are likely to affect women's empowerment, economic growth, and development more broadly. We organize our discussion at different levels of analysis.

Impacts at the Individual/Household Level: We expect commercially driven digital connectivity, much like the prior ICT revolutions, will drive substantial productivity and welfare gains for women and men alike in LMIC low-income communities. However, phones and the internet hold particular promise for driving *women's* self-realization given the foundational constraints women, in particular, face as a result of structural gender inequalities across commercial, political, and cultural institutions. Ample evidence demonstrates that women in LMICs are disadvantaged compared to men due to what we label as "foundational constraints" from, *inter alia*, limited mobility, lower literacy, physical insecurity, less information on labor market and trade opportunities, and greater social isolation due in part to more limited social networks (Moore 1990; Egbo 2000; True 2012; Jayachandran 2015; Muralidharan and Prakash 2017; Jayachandran 2021). This list is hardly comprehensive and the foundational constraints that inhibit women's short and long-term economic empowerment, physical and mental health, and self-realization more broadly interact.

We highlight the five foundational social constraints above, in particular, because meaningful connectivity via phones and internet is especially promising for helping to mitigate or circumvent these constraints. For example, among women that are discouraged from traveling alone to markets or health clinics or financial institutions due to prevailing social norms, controlling behavior from spouses, or threats to physical safety, phones can enable virtual commerce, remote health consultations, and digital financial transactions. Even women that may be empowered to travel may have more limited access to agronomic information, market prices, or job opportunities due to more limited social networks and gender-based segregation in occupational sectors. For these women, new connectivity-enabled information sources may be empowering particularly when accessible in local languages via voice-based technologies. Examples of this first category of causal impacts on individual women and their households suggests a second category that operates at the level of markets more broadly.

Impacts at the Market Level: Expanding the population of women with access to and use of meaningful connectivity can encourage improvements in the design of existing commercial, public, and social services and the provision of new services. In economic terms, we can think of the expansion of connectivity for women in a couple different ways that can be interpreted as means of solving market failures, improving market efficiencies, or expanding the production possibility frontier, depending on the context.

First, including more marginal users of connectivity-enabled services provides a positive demand shock expanding the market and encouraging supply-side investment in services relevant for women. For example, it may only make sense to invest in the digitization of government services, utility payments, public sector job applications, MSME licensing, vaccine SMS reminders, etc. when a sufficient share of the population has access to phones and the internet.

Second, among existing analog users of commercial and public services, such as female entrepreneurs that procure goods, female farmers that purchase agricultural inputs, and women in need of health services, the ability to engage women digitally may reduce the marginal cost of supplying services, effectively changing the slope of the supply curve. Seed companies may target women farmer-dominated crops for research if it is easier to reach female farmers. Banks may more actively promote credit among women if phones reduce the cost of marketing and lending to women who may be less likely to otherwise visit physical bank branches. Digitization may also enable service providers to better target segments of women with more tailored messages and services. Services may not only be more accessible for women, but can also be made more relevant.

These potential supply-side responses to expanded demand among women reflect the rational response of service providers to a growing market that can be served at reduced marginal cost. Of course, digitizing services, whether loan underwriting or remote health consultations, will require investment. And, the ability for providers to target and tailor services to sub-populations can both benefit women that were otherwise underserved or can hurt women that may face more effective price discrimination.

Impacts at the Level of the Economy and Society: Beyond its individual/household impacts and market level effects, expanding connectivity for women may also impact the economy and society in which the economy is embedded. Expanding women's connectivity can increase the marginal benefits of investing in public goods and private goods that have positive externalities. Building out and upgrading telecom infrastructure in response to expansion in women's demand can improve the productivity of the economy. Investment in local language corpora and related technology to deliver services via voice or text in local languages can yield diverse benefits across sectors and services. The ability to more cost-effectively monitor public program

implementation and to supervise commercial markets as transactions and programs are digitized can improve the provision of public services and governance across sectors. And, the ability to survey via phone more broadly representative and less gender-biased samples of the population more frequently can enable more accurate insights and impactful innovations whether pursued by public or private institutions.

In addition to improving the abundance and accuracy of information about women, expanded connectivity may enable women to communicate and engage one another in ways that enable their political agency and representation, and more generally evolve social norms about gender. Norms about women's rights and roles may evolve as women gain access to information about themselves and the economy, and as men witness and learn about the benefits of expanding women's connectivity.

Of course, impacts on the level of public goods, women's representation and power, and social norms reflect society-wide outcomes, which emerge through the mechanisms of individual, households, and market impacts. And, expanded women's connectivity may not automatically guarantee political and cultural empowerment for women. Technology-enabled harassment and abuse could discourage women in leadership, in particular, and technology can catalyze political disinformation to the detriment of women. Digitizing public goods without proper monitoring and redress systems can exclude the most vulnerable and private data trails can be abused by malicious commercial and public actors.

Endogeneity and Simultaneity of Cause and Consequence: Having laid out these various theories of change on the consequences of expanded women's connectivity, i.e. how women may be impacted at the levels of individual, household, market, economy, and society in a causal sense, we next turn to the question of the causes. Specifically, we explore how women might achieve improved access and use of meaningful connectivity by interrogating the current barriers to adoption of phones and the internet. Before focusing on this "first stage" of adoption, however, we should acknowledge that the consequences may themselves become causes. Increased income through access to new connectivity-enabled marketplaces may render smartphones more affordable. The availability of remote health services provided via phone may encourage adoption of mobile broadband internet services. And, the relaxing of general social norms stigmatizing the use of the internet by young women may encourage the personal ownership of phones among women within more traditional households. As these examples illustrate, new adoption of phones and the internet and the general expansion of demand is endogenous to the dynamic evolution of preferences, the fast-changing shape of supply curves, and the expanding production possibilities. This dynamic reality of simultaneous and opposite channels of causal effects is complex. However, in the following section we provide some

simplifying theory on women's adoption of phones and the internet as scaffolding around which we may make progress towards a coherent research agenda.

3. Drivers of Digital Connectivity Adoption

As noted, there is a dynamic relationship between digital connectivity adoption and impact. Here we consider the exogenous and endogenous drivers of connectivity. As a large body of evidence indicates, significant disparities in internet access persist across the globe, but especially in LMICs. To take one example, despite gains in 3G and 4G mobile network coverage, it is likely that upwards of 2.6 billion people do not use the internet (World Economic Forum, 2024). Among the digitally excluded, women tend to be disproportionately represented. According to GSMA, the gender gap in mobile internet adoption (as measured by access to the internet on a mobile phone at least once in the last three months) is around 19% across LMICs—and as high as 36% and 41% across sub-Saharan Africa and South Asia, respectively (Jeffrie et. al., 2023).

Among practitioners there are a variety of frameworks used to classify the barriers to adoption. The GSMA proposes six: affordability, accessibility, literacy, relevance, risk/security, and social norms (Jeffrie et. al., 2023). This taxonomy of barriers is informed by the portfolio of interventions practitioners consider and the list of targets towards which practitioners aim their interventions to expand women's connectivity. We consider these interrelated factors—as well as two others, availability and network effects—in the context of canonical models of technology adoption. (Note: As the smartphone represents the primary gateway by which the modal citizen of the world connects to the internet, we predominantly focus on this technology, but our framework applies more broadly to digital connectivity.)

While the language of these barriers differs from that of economic theory, they imply clear economic theoretical interpretations. By framing the gender gap in adoption as the product of barriers, practitioners are implicitly suggesting there is inefficiency in the connectivity market and/or that there are compelling reasons to intervene to metaphorically break these barriers to expand adoption among women. For researchers in economics and other social sciences, identifying if and why these barriers reflect market failures becomes a first order question. Does the current gender unequal market equilibrium truly reflect the balancing of marginal cost to suppliers and marginal utility to consumers? And, what is the magnitude and mechanism of positive externalities derived from expanding connectivity for women beyond current gender unequal adoption equilibrium?

3.1 Affordability: Affordability represents the cost of smartphones and mobile data plans relative to consumers' income, affecting elasticity of demand. Globally, the manufacturing of smartphones is highly competitive and efficient, which has significantly driven down costs of

handsets. Despite these reductions, entry-level smartphones remain out of reach for many consumers in LMICs due to lower relative income levels. For example, the World Bank (2023) finds that the prices of entry-level smartphones in Rwanda are especially low, due to the government's liberal tax and tariff policies, but nonetheless still would account, on average, more than one month of income for the poorest 20 percent of Rwandans. A similar disparity is observed in mobile data costs; in low-income economies, the expense of mobile data is 22 times higher as a percentage of income than in high-income countries, underscoring the affordability gap in digital connectivity in many low-income households. In an analysis of mobile internet adoption using household surveys across seven countries in the West African Economic and Monetary Union (WAEMU), Rodríguez-Castelán et al. (2021) find that low household consumption and high price of mobile services stand out as two key constraints. The affordability barrier is especially high for women who typically have lower income levels and less access to financial resources compared to men (Jeffrie et. al., 2023).

Another consequence of smartphones and internet representing a large share of income is that, in the face of economic downturns or shocks, households, especially lower-income ones, may turn to cutting internet subscriptions (Silva et al. 2020), selling handsets to provide short-term financial support (Roessler et al. 2021), or preferring to purchase cheaper, but less durable, second-hand devices to begin with, increasing the intermittency and unreliability of connectivity (Roessler 2018).

3.2 Availability: On the supply-side, the availability of smartphones, network coverage, and competition between mobile network operators are key factors that determine prices. One fundamental challenge in low-income countries is network coverage due to high maintenance costs and low consumer purchasing power for network services. Consequently, in many LMICs, 3G and 4G coverage remains limited in rural areas, which may be more likely to affect women because of gendered differences in urban migration.

One innovation that may boost network coverage is the increasing use of network sharing, in which MNOs share cellular signal (e.g., through roaming agreements) and also core elements of the infrastructure, such as towers, masts, and radio equipment. This has been found to reduce operators' capital expenditures, leading to lower consumer prices and improved network coverage and quality (Koutroumpis, Castells, and Bahia 2023). In a global sample, Houngbonon et al. (2023) find that such price reductions and increases in network access stemming from tower sharing (in this case via increasing reliance on independent tower companies who then rent access to the infrastructure to all operators) provide an initial boost to women-led households' access to mobile internet.

In addition to market forces, government regulation also plays a critical role in availability. Regulators face the challenge of identifying optimal policies that balance a range of diverse objectives, from fostering innovation and competition in the telecoms sector and maintaining fair market practices to broadening affordable access to handsets and enhancing consumer protection. This can pose difficult trade-offs. For example, counterfeit handsets (i.e., those not produced by original mobile phone manufacturers, and which use sub-standard components and pirated software) are prevalent in emerging economies. Though cheap, they are prone to poor, unreliable service, harming consumers and potentially reducing overall trust in the digital ecosystem. To address this problem, regulators have sought to block `fake' handsets (i.e., those without authentic international mobile equipment identity (IMEI) numbers) from using the country's wireless network (Gumbiner 2018). In 2016 the government of Tanzania disabled upward of 2 million such counterfeit handsets. In the short-run, this caused a substantial decrease in household mobile phone ownership from 77% in 2015 to 62% in 2016, which disproportionately affected women (FII 2017).

Another policy dilemma is how, if at all, to tax digital connectivity. Revenue mobilization is a perennial challenge in LMICs. Growing demand for handsets, airtime, and mobile money has led governments to levy excise taxes on mobile services—which have the benefit of being readily monitored by the state and more easily taxed than other sources, such as the income of informal workers.[2] However, in contrast to high-income countries, demand for mobile services tends to be elastic in LMICs, such that excise taxes have the potential to substantially depress usage (Matheson and Petit 2021).[3] This has been a notable effect of mobile money taxes (GSMA 2023). On mobile devices, Björkegren (2019), drawing on transaction data from nearly all of the Rwandan mobile phone network over 4.5 years, finds that during a period in which the mobile network was growing (e.g., when end-users were gaining access to mobile service for the first time) taxing usage (or airtime) rather than handsets would have been substantially welfare-enhancing for low-income users. While, as mentioned, today Rwanda administers no custom duties or VAT on smartphones, across countries in Sub-Saharan Africa these levies remain high, accounting for 33% of handset costs (GSMA 2023).

3.3 Accessibility, digital literacy, and relevance: Accessibility is a related but slightly different barrier. It refers to the ease with which consumers can use mobile devices and services within their households and public spaces. Accessibility stems from infrastructural, market, and socio-cultural factors. In terms of the former, electricity is even more limited than network coverage,

[2] One stated objective of Ghana's E-levy on mobile money and other electronic transfers was to increase revenue mobilization among the informal sector (Anyidoho et al. 2023).

[3] As would be expected, however, there is significant heterogeneity in elasticity of demand for mobile services within LMICs based on income as well. See Economides and Jeziorski (2017) on variation in demand elasticities in mobile money use in Tanzania.

and represents a significant barrier to digital connectivity (Armey and Hosman 2016). As a consequence, many low-income households have to rely on public charging stations to charge their handsets,[4] which is inefficient, increases risk of theft, and often leads to extended periods without mobile access due to drained batteries. When it comes to mobile money use, uptake is significantly shaped by consumers' access to the mobile agent network, both in terms of the distance to the nearest agent (Munyegera and Matsumoto 2016; Suri and Jack 2016) as well as quality of agent services (e.g., pricing transparency or cash float) (Balasubramanian & Drake 2015; Suri 2017). Across Bangladesh, Tanzania, and Uganda, Annan et al. (2023) find that women tend to incur significantly higher time costs than men (by 34-50 percent) in making mobile money transactions due to higher reported travel times.

In addition to infrastructural constraints, literacy (i.e., the ability to read, write, and understand digital text and numbers) and digital literacy (i.e., the ability to navigate, understand, and use information communication technologies and the internet) profoundly impact digital connectivity (Wyche and Steinfield 2016).[5] In a randomized-controlled trial of a mobile phone distribution program in Tanzania targeting women non-phone owners, Roessler et al. (2021) find that literate women were much more likely to be in possession of the program smartphone more than one year later and reported significantly higher levels of phone use, leading to a large increase in household consumption compared to control.[6] However, among low-literacy women, basic or feature phones proved more efficacious than smartphones in increasing uptake of digital financial services using a behavioral measure.

This points to the importance of relevance or "motivational access" (van Dijk 2006)—in which end-users find that the digital technology meets their specific needs and capabilities. Put differently, the most 'teched up' solution is not always best (Aker and Cariolle 2023). In the Tanzania study, most of the smartphone recipients owned a feature phone at the end of the study; this was likely due to some 'trading down' their smartphone handsets for feature phones that they found more useful (Roessler et al. 2021).[7] Similarly, in an RCT of a farmer smartphone app in Nepal compared to radio and conventional 'classroom and field' based extension training, the app proved generally as effective as traditional extension training (at a

[4] Among low-income households in Blantyre, Malawi, Roessler et al. (2023) find that more than 63% report using public charging stations to charge electronic devices.
[5] On the effects of education on internet and mobile internet adoption, see Grazzi and Vergara (2014), Rodríguez-Castelán et al. (2021).
[6] Education levels are also found to be highly correlated with mobile money uptake and use (Munyegera and Matsumoto 2016).
[7] Other sources of this transition from smartphones to feature phones included participants not retaining their handsets (due to loss, breakage, or theft) and only being able to afford to replace it with a feature phone.

fraction of the cost) and more effective than radio in increasing uptake of fertilizer use—but only for men. For female farmers, radio and in-person training increased fertilizer use but the smartphone app had no effect (Giulivi et al. 2023), pointing to the potential value of digital services that incorporate audio-based content transmission used in traditional methods.

At the same time, however, the perceived relevance of digital technologies may change through exposure, engagement, and learning. Lee et al. (2022) show that training and support in mobile banking helped reduce gender disparities in use among migrants in Bangladesh. In a follow-up study in Malawi, Roessler et al. (2023) find that smartphone adoption among non-phone owners leads to a shift in perceptions in the perceived value of mobile technology. Whereas those in the control group are as likely as the smartphone groups to report that it is important for women to have their own phones to maintain social ties and stay in touch with family, smartphone recipients are more likely to see them as a tool for using financial services, such as mobile money, and for improving their livelihoods. Nonetheless, these effects were low and many continued to prioritize phones for social connectivity.

Overall, the mobile-for-business use case remains low in LMICs.As noted in a recent Connected Women report drawing on surveys with nearly 8,000 micro-entrepreneurs in ten countries, some 35% of male micro-entrepreneurs and nearly 50% of females use a mobile phone in their personal lives but not for business (Carboni and Taghiyeva 2023).

Lack of digital content in local languages also reduces the relevance of connectivity for women. Grazzi and Vergara (2012) demonstrate that indigenous Guaraní speakers in Paraguay not only use the internet less but perceive it as less useful. Rodríguez-Castelán et al. (2021) show that in West Africa literacy in the national European language (namely French) increases mobile internet adoption by almost 15 percentage points. Gupta, Ponticelli, and Tesei (2023) find that in India areas with higher language barriers between farmers and a call center offering agricultural advice and information services reduced the volume of calls per farmer by more than 20%, reducing diffusion of agricultural technologies, such as high-yield varieties of seeds.

3.4 Risks

Consumer choices are impacted by the potential risks associated with technology adoption. These include not only the uncertainty of investment returns in new and costly technologies (Foster and Rosenzweig 2010), but also potential exposure to security risks, such as fraud and scams, loss of privacy, theft of personal data, or threat of physical harm—that may arise from the increasing interconnectedness, data-sharing capabilities, and digital use of financial services enabled by mobile phones. One of the most prevalent digital consumer protection issues in emerging economies is phishing scams that aim to lure end-users to divulge sensitive information, such as financial details or pins, or even convince them to transfer money. In one

study in Kenya, 56% of respondents reported having faced such phishing attempts via phone call or SMS (Blackmon, Mazer, and Warren 2021). Violations of consumer protection lead not only to direct costs to end-users but also can cause broader market failures as consumers' concerns about being scammed lead them to eschew legitimate transactions (Garz et al. 2021).

Moreover, digital connectivity and access to social media impose disproportionate social costs on women, who are the subject of misogyny, "gendertrolling," and sexual harassment online (Mantilla 2013; Megarry 2014). These behaviors not only cause emotional distress but are also found to contribute to the perpetuation of offline sexism by men (Fox, Cruz, and Lee 2015).

3.5 Network effects

Digital connectivity represents a classic network good, where its value increases as more people adopt the technology. Specifically, a mobile phone will grow in value to an individual as the set of other users that can be reached with that phone expands.[8] And, adopting a phone becomes more commercially desirable as more firms, suppliers, and buyers use phones for trading and other market activities. The positive externalities of the phone as a network good suggest that individual demand likely under-represents the socially efficient demand at any given market price. In other words, there may be scope for policymakers to intervene to improve natural inefficiencies in market driven phone adoption. Analysis from a phone subsidy program in Rwanda demonstrates this point.

Björkegren and Karaca (2022) analyze a 2008 program in Rwanda to subsidize the cost of more than 50,000 basic mobile phones, accounting for 8% of the total number of handsets in the country at the time. The authors estimate that in a given district directly subsidizing adoption for one percentage point of the population corresponded to a 1.88-3.31 percentage point adoption increase between 2005 and 2010, pointing to potential positive spillover effects of the subsidy program and highlighting the network properties of mobile phones. Additionally, subsidized recipients were almost five times more likely to be connected to each other than the rest of the network, underscoring the localized benefits of mobile connectivity (i.e., within one's social network), in addition to more diffuse benefits that accrue to being connected to the broader communications network. The subsidy program led to a high social rate of return for consumers (a rate of upwards of 89%) but also increased revenue for the operator, which benefited from increased usage by recipients and nonrecipients and increased adoption of mobile

[8] On the effect of telephony networks on adoption, see Kim and Kwon (2003). In addition to these indirect network effects, there is strong evidence that individuals are especially influenced by the adoption decisions of their friends and family (Birke and Swann 2007, 2010). Birke (2009, 766) underscores this, "noting the influence of other household members on mobile network choice is about 10 million times higher than that of a random extra member of a network."

handsets by non-phone owners. The latter ripple effect is estimated to account for 24% of the effect on operator revenue.

Despite its importance to technology adoption, network effects remain generally understudied.[9] Considering the gender gap in digital connectivity in LMICs, we would expect gender differences in adoption rates within one's network to influence how the technology spreads. This might exhibit direct effects on women's adoption if there are gender barriers to social learning. But it might also have significant indirect effects. With fewer women users, services and digital public infrastructure may cater more to men than women, further reducing the latter's adoption. In turn, these network effects are likely shaped by and shape social and cultural norms within society that further structure adoption dynamics.

3.6 Norms

The influence of such societal and cultural factors is a final, overarching dimension mediating digital connectivity. Expectations, norms, and biases within society can significantly constrain technology adoption, often intersecting with and influencing other determinants like relevance and digital literacy. These norms, which vary across societies, can restrict women's communication with men not in their family, limit their physical mobility, dictate their educational and work opportunities, and censor their access to content, especially related to adult themes, premarital relationships, and digital harassment.[10] Even when some barriers are lifted post-marriage, women often face new challenges tied to their expected roles as caregivers (Barboni et. al., 2018). Such societal expectations are intertwined with economic factors that affect women's technical literacy and independence in owning mobile devices, leading to a gender disparity in mobile usage.

According to Girl Effect (2023), the pervasive belief that girls are not 'tech savvy' and are less capable of navigating online safely undermines their confidence and interest in technology from a young age. This issue is compounded by the fact that, as BBC Media Action (2022) notes, women's use of mobile phones and the internet is often subject to supervision or monitoring by male family members, older relatives, or intimate partners, which can significantly curtail the potential for autonomy and empowerment that digital technology offers. Even when achieving parity with men in income, education, literacy, and employment, women in low- and middle-income countries (LMICs) still face a mobile gender gap, indicating that these disparities are not merely a product

[9] Suri (2017) raises this point with regards to research on digital financial services and Spielman et al. (2021) on digitization of agricultural extension services.

[10] There is a literature on the effect of norms on gender inequality; see Lerner (1986), Agarwal (1997), and Heise et al. (2019), among others, for important contributions. On the persistence and pervasiveness of gender biases worldwide and their consequences for women's empowerment, see UNDP (2023).

of economic or educational inequalities, but are deeply rooted in societal attitudes (GSMA, 2023). Furthermore, the norms dictating that women and girls should have restricted access to mobile technologies can be perpetuated by older generations and internalized by the young women themselves, creating a cycle of digital disempowerment. Evidence from Girl Effect (2023) reports that 82% of parents agree that mobile phones could lead to trouble for young women, compared with findings among the youth, particularly girls, who tend to disagree with these risks and hold more liberal views.

These findings beg the question of whether interventions to promote gender equity in digital connectivity should be designed to directly address constraining social norms or whether other interventions should be relied upon to indirectly impact social norms. For example, by enabling women to acquire new skills, access information, increase control over resources, and connect with supportive communities, expanding connectivity for women may contribute to a shift in the perceived roles and capabilities of women (Field et al. 2021). This, in turn, can lead to a change in gender norms as the tangible benefits of digital engagement become apparent.

4. Evidence on the Impacts of Connectivity

Mindful of the dynamic sources of digital connectivity adoption, we now turn to surveying connectivity's impacts. Consistent with our conceptual framework, we anticipate that reduction in information and communication costs and improved availability and access to services will be especially important channels through which digital connectivity affects economic development.

In line with our theory of change, as we survey the evidence, we pay special attention to identifying specific effects on women and the foundational constraints they face to economic empowerment. On the whole, however, the evidence base on this line of inquiry is limited, underscoring the value of future research in this field that we turn to in the final section of the paper.

4.1 Labor Force Participation and Income Generation: Traditionally in LMICs individuals face steep barriers to finding work for a variety of reasons. For one, there are fewer opportunities for formal employment due to the weakness of the private sector and the lower density of firms, especially large-scale enterprises (Ciani et al. 2020). Moreover, information asymmetries in labor markets can lead to inefficient matching and biased recruitment (e.g., through an employers' social network). Likewise, individuals face high transaction costs to find a job in-person due to limitations in transportation and communication infrastructure. Finally, individuals in LMICs may lack opportunities for skills development and training that can improve one's qualifications and expertise demanded by employers.

Perhaps because of these reasons most people are self-employed as contractors, freelancers, and especially farmers and subsistence entrepreneurs (i.e., those who run micro-enterprises, such as food vendors, artisans, and market traders, to meet their basic needs and those of their families relying solely on their own labor). In low-income countries, more than 88% of women in the workforce are self-employed, compared to 75% of men. In this highly competitive space, the self-employed are constrained by lack of market information, access to financial services, credit, and other inputs, and sales channels to grow their enterprises and increase their incomes (Cho, Robalino, and Watson 2016).

It is in this context that we might expect improved communication capabilities and reduced information costs enabled by digital connectivity to help address some of these longstanding challenges in labor force participation and income generation in LMICs.

A growing number of studies point to the significant impact of digital connectivity on labor markets in emerging economies. Leveraging the gradual arrival of submarine internet cables from Europe to Africa that greatly increased high-speed connectivity and capacity, Hjort and Poulsen (2019) find that access to fast internet significantly increased an individual's likelihood of employment from 6.9%-13.2% without displacing job opportunities in unconnected areas. These gains were largest among higher-skilled workers, but unskilled workers also benefited. Underpinning this employment growth was a more robust private sector as new firms came online, especially those that rely more on ICT. Productivity of existing firms also improved (perhaps given a corresponding increase in on-the-job training) and exports rose. Goldbeck and Lindlacher (2021) show that basic internet availability also is associated with economic growth across towns in parts of Africa (as measured by nighttime light satellite data) and increases in manufacturing employment.

Bahia et al. (2023) use panel household survey data and careful measures of the differential rollout of 3G wireless networks in Tanzania between 2008 and 2013 to estimate the impact of mobile internet on labor outcomes and economic well-being. Overall, 3G coverage (more than at least one year) is associated with a significant increase in household consumption, and a general decrease in farm employment.[11] But, only men realized significant increases in labor-force participation and wage employment, suggesting it is their improved labor-market outcomes that may account for rising household consumption. Likewise, the labor gains only accrued to mobile

[11] The effects of 3G coverage on employment and consumption are generally consistent in similarly designed studies on Nigeria and Senegal (Bahia et al. 2020; Masaki et al. 2020). In Nigeria, however, they find a positive and significant effect on women's labor force participation after two or three years of 3G/4G coverage.

phone owners, pointing more to individual-level effects (i.e., using a mobile phone to find and pursue a job) than market-level effects that increased labor demands in the formal sector.

Other studies, however, find more beneficial effects of digital connectivity on women's labor force participation (Dettling 2017; Watson, Corliss & Le, 2017; Bahia et al. 2020; Chiplunkar and Goldberg 2022). Klonner and Nolen (2010) estimate that access to early mobile phone coverage in rural parts of South Africa between 2005 and 2010 significantly increased labor force participation, especially among women in wage jobs. Likewise Viollaz and Winkler (2021) find that the diffusion of mobile broadband in Jordan between 2010 and 2016 boosted female labor force participation among older, educated women, particularly those who were unmarried in 2010. Online job searching appears to partly have accounted for this increase in labor force participation.

In one of the few RCTs on mobile phone ownership (also in Tanzania, between 2016 and 2017), targeting women non-phone owners, Roessler et al. (2021) find that smartphones caused significant gains in household consumption (a 20 percent increase over control)—which was driven by those women still in possession of the handset 13 months later, pointing to the benefits of use rather than selling the high-valued asset.[12] In contrast, basic phones did not lead to significant increases in household consumption. Consistent with Bahia et al. (2023), women in the smartphone condition spent less time farming. But, rather than entering the formal labor force, they reported spending more time in market trading and using their phones to communicate with customers and clients. However, this did not lead to measurable effects on women's recent income flows at the time of the endline survey; this could be due to the challenges of measuring income in the informal sector or consistent with Bahia et al. (2023), household welfare gains were more a function of husbands' use of the smartphones.[13]

Finally, evidence from the Indo-Pacific region shows that Internet usage correlates strongly with the rise in female workforce participation from 2000 to 2016, explaining 80% of the rise (Watson, Corliss & Le, 2018).

4.2 Improved Agricultural Productivity: Over the last thirty years in low-income countries, there has been a marked drop in the proportion of the labor force engaged in agriculture. Yet the sector still represents the primary occupation for most households, especially for women. Moreover, most of the world's poor live in rural areas, where they are dependent on farming for

[12] However, pointing to the importance of better understanding dynamics of connectivity adoption, only 33% of women still had the smartphone on their person at the endline survey (13 months) later. As noted above, many women in the smartphone group were in possession of a basic handset at the end of the study.

[13] The largest household consumption gains correlated with women who reported sharing their smartphones with their husbands (Roessler et al. 2021).

their livelihoods. Thus, improving agricultural productivity in emerging economies is an important channel for poverty reduction, as has been seen in China, Thailand, India, and Bangladesh (Gautam and Faruqee 2016; Jayne et al. 2021).

In many LMICs, agricultural productivity remains constrained. Imperfect market information constitutes a key friction, which hinders farmers' ability to make informed decisions about what to plant, when to harvest, and where and at what price to sell their produce for the best possible return (Aker 2011; Fafchamps and Minten 2012). Another is the low adoption of agricultural innovations that are already widely available, such as hybrid seeds, tractors and plows, fertilizers and other agrochemical inputs, and crop insurance (Fuglie et al. 2019; Suri and Udry 2022). Uptake of such inputs is found to be significantly lower among women due to their historic exclusion from extension services and dependence on informal networks or intra household information sharing (Spielman et al. 2021).

It is against this backdrop that a number of studies have sought to examine the impact of digital connectivity on helping farmers overcome these information frictions and increase their awareness and access to agricultural innovations.[14]

In line with Jensen (2007), several studies find that advances in digital connectivity (e.g., the introduction of mobile phone coverage, internet kiosks, or mobile-based information services) increased the efficiency of agricultural markets, namely by reducing spatial price dispersion (Aker 2010; Goyal 2010; Aker and Fafchamps 2015; Zant 2018). In addition to more effective marketing behavior by producers (Jensen 2007; Goyal 2010), Tack and Aker (2014) and Zant (2018), respectively, find that mobile communications helps traders more efficiently operate in multiple markets, raising their reservation prices, and driving down their transportation costs.

Improved market information realized through digital connectivity, however, does not necessarily translate into higher producer prices; here results are mixed (Aker 2010; Goyal 2010; Fafchamps and Minten 2012; Aker and Fafchamps 2015; Aker and Ksoll 2016; Mitra et al. 2018; Soldani et al. 2023). Effects tend to vary by crop type and market structure with digitally-accessed information proving more advantageous for the sale of perishable produce and more beneficial when farmers have outside options for the sale of their crops or otherwise greater bargaining power (Nakasone, Torero, and Minten 2014; Mitra et al. 2018; Soldani et al. 2023). This suggests that, in the face of broader market failures, better access to information alone is likely not sufficient to boost producer prices and welfare (Aker and Ksoll 2016; Aker and Cariolle 2023).

[14] For valuable reviews, see Aker (2011); Aker, Ghosh, and Burrell (2016); Fabregas, Kremer, and Schilbach (2019); Spielman et al. (2021); Abate et al. (2023).

Beyond its effects on producer prices, digital technologies may enable access to curated information and extension services that aid farmers to improve their agricultural productivity via greater use of inputs and more effective farming practices. In a meta-analysis, Fabregas, Kremer, and Schilbach (2019) find that digital-based informational interventions increased yields by 4% and the likelihood of adopting recommended inputs by 22%. Likewise, Fabregas et al. (2024) estimate that text messages to encourage uptake of agrochemicals in Rwanda and Kenya had a small, but extremely cost-effective impact on actual acquisition of the inputs, with no heterogeneous effects by gender or level of education. For the communication of more complex information, other studies highlight the value of mobile voice-based agricultural extension services (Cole and Fernando 2021; Fernando 2021); audiovisual messages using phones or tablets (Fu and Akter 2016; Maredia et al. 2018; Van Campenhout 2019; Van Campenhout, Spielman, and Lecoutere 2021); gamification (Tjernströma et al. 2021); and smartphone apps (Giulivi et al. 2023), including those with tailored content to specific types of farmers (Yang et al. 2024).[15] As noted by Spielman et al. 2021, within the literature on digitized extension services a number of studies consider differential effects by gender, especially as mediated by mobile connectivity, but few are designed specifically for women and to learn how they may affect social constraints that disadvantage female farmers.[16]

Bergquist and McIntosh (2021) provides the first evidence on the impact of digital agricultural platforms, finding that the platform proved successful in generating additional and significant short-distance trade—in terms of trade linkages (between 1 and 2% increase), number of traders (7 to 9%), and volume traded (2.5 to 4.3 additional tons)-–but smaller (and consistently decreasing) effects at larger distances. Usage of the platform comes almost entirely from traders and does not address gender.

A number of additional studies report spillovers from agriculture-related digital technology, but report few gender-related insights (Casaburi et al. 2019; Soldani et al. 2023; Van Campenhout 2021; Van Campenhout, Spielman, and Lecoutere 2021).

4.3 Improved Access to Education Significant educational access and quality gaps persist between low-income and high-income countries and between genders, with LMIC girls suffering from lower literary and lower educational access, for example. Connectivity enabled phones, computers, and tablets offer promising opportunities to improve educational outcomes for girls, in particular, though the existing evidence requires nuanced interpretation. Rodriguez-Sierra (2022) provides a systematic review of the evidence on educational technologies ("edtech") in

[15] In the case of Yang et al. (2024), they target grape farmers with digitally-delivered technical content using the app and leverage an objective quality measure, sweetness, to test its impact. They find the technical videos cause a 0.3 SD increase in grape quality.
[16] Notable exceptions include Mittal (2016); Lecoutere et al. (2020); and Abate et al. (2023).

LMICs, reviewing 81 core studies in 36 countries since 2002. The study differentiates between edtech interventions that enable: access to technology (e.g. evaluations focused on computer/tablets), technology-enabled behavioral interventions (SMS reminder, etc.), improvements to instruction (remote live / pre-recorded instruction), and self-led learning (adaptive software for math / language). The review finds consistent large and cost-effective impacts on learning across interventions to improve instruction to enable self-led learning. Behavioral interventions, such as SMS reminders, had small, but highly cost-effective impacts. In contrast, interventions to directly provide computers in classrooms were highly cost ineffective on their own. Unfortunately, only a handful of studies reviewed disaggregated results by gender with few differences in impacts by gender.

One notable exception is by Bianchi, Lu, and Son (2022), who analyze the long-term effects (up to a decade) of a significant 2004 educational reform in China that facilitated computer-assisted learning (CAL) for over 100 million rural primary and middle school students with top urban teachers through satellite internet technology. Leveraging the staggered implementation of the program and comparisons across cohorts and counties, they estimate the program improved students' academic achievement, labor performance, and computer usage—with women and individuals with less-educated fathers experiencing larger educational gains. Lakdawala, Nakasone, and Kho (2023) also show the positive impacts of school-based internet access on students' educational attainment in Peru, and that which increased over time—pointing to the value of longer-term benefits as teachers, students, and administrators learn to use the new technology.

However, other interventions proved less effective, such as improving access to laptops. Evaluations of the "One Laptop per Child (OLPC)" across Latin America did not find significant results on scholastic outcomes (Barrera-Osorio and Linden (2009) in Colombia; Beuermann et al. (2015), Cristia et al. (2010, 2017), in Peru; de Melo et al. (2014) in Uruguay, Meza-Cordero (2017) in Costa Rica). In contrast, Berlinski et al. (2016) provides an example of how interventions targeting behavioral changes among teachers, parents, and students have shown promise. The paper finds a high-frequency SMS texting campaign for parents in Chile, which provided updates on their children's performance, attendance, and behavior, led to substantial improvements in test scores and attendance within just four months.

Similarly, interventions directed at teachers and school officers, like those by Vakis and Farfan (2018), which employed SMS campaign with potentially useful information for teachers, such as reminders about deadlines, teacher benefits, motivational texts, and occupational wellness, although producing smaller effects, highlighted the scalability and cost-effectiveness of such digital approaches. Likewise, connectivity-enabled interventions aimed at improving accountability around the stakeholders of education seem promising, albeit more sensitive to

challenges with implementation, monitoring, and scalability. If implemented correctly, these can achieve large gains in academic outcomes such as in Duflo et al. (2012), and very high cost-benefits ratios such as in the case of Aker and Ksoll (2019). However, the support of local partners to design, deploy, and incentivize the take-up of the intervention is crucial, as best exemplified by Adelman et al. (2015).

A recent study demonstrates how connectivity-enabled self-learning interventions also can be impactful. Angrist et al. (2022) focuses on mobile-based education interventions during COVID-related school closures, particularly in low-income households in Botswana. The research involved 4,500 families divided into three groups: one receiving weekly SMS messages with numeracy problems, another receiving SMS plus phone call follow-ups, and a control group. It is observed that the combined phone and SMS intervention increased learning by 0.121 standard deviations and decreased innumeracy by 31%, while SMS alone had no effect. Notably, 92% of parents engaged with the program, demonstrating increased self-efficacy in supporting their child's learning. Importantly, the study also found no significant gender differences in the intervention's impact, suggesting girls were not disadvantaged by the digital format of the intervention. Overall, the body of evidence suggests that certain types of connectivity-enabled edtech can meaningfully and cost-effectively impact student achievement, though studies that explicitly investigate the interaction of edtech and gender remain limited.

4.4 Transformative Health Interventions: In the evolving landscape of healthcare, technological advancements have recurrently promised transformative shifts, yet the actualization of a cultural and systemic overhaul remains elusive. The journey began with the advent of e-health in the 1990s, following the widespread availability of personal computers (Eysenbach 2001), and evolved with the introduction of telemedical services as these computers connected into networks (Perednia & Allen 1995). The proliferation of social media networks further expanded the horizon to medicine 2.0 and health 2.0 (Van De Belt et al. 2010), and the widespread adoption of mobile phones and smartphones heralded the era of mobile health (Steinhubl et al., 2013).

Despite these advancements, the digital divide persists, exacerbating health inequalities by limiting access to those most in need of healthcare services. The rapid emergence of digital technologies since the 2010s, coupled with the widespread diffusion of the internet and mobile connectivity, has improved access to health information and resources, showing significant distributional and aggregate effects (Chen et al., 2017). Nevertheless, to mitigate the digital divide's impact on health inequalities, there is a pressing need for initiatives aimed at enhancing meaningful digital connectivity among the offline populations. This approach not only facilitates direct engagement through online health management, virtual consultations, and access to health information but may also lead to indirect gains by influencing other social determinants

of health. Thus, addressing digital access and proficiency emerges as a dual-pronged strategy essential for narrowing health inequalities and fostering a more inclusive digital health ecosystem.

The literature on mobile messaging and health interventions, as evidenced by several studies, highlights the significant impact of these approaches on health behaviors and outcomes. LeFevre et al. (2022) conducted a study on the Kilkari mobile messaging service in Madhya Pradesh, India, targeting pregnant women and their husbands to improve reproductive and child health outcomes. The study involved sending 72 weekly pre-recorded health messages in six languages, resulting in a 3.7% increase in the use of modern reversible contraception and a 2.8% increase in child immunizations at 10 weeks. Additionally, there was increased female involvement in childcare decisions, underlining the importance of including men in health interventions and aligning messages with existing cultural norms.

Dammert, Galdo, and Galdo (2014) evaluated a mobile intervention against dengue in Peru, showing a decrease in dengue risk and improved preventive behaviors through SMS messages. Levine et al. (2021) in Ghana found that voice call reminders and community health volunteer programs significantly improved the timeliness of neonatal vaccinations. Eze and Adeleye (2015) in Nigeria demonstrated the efficacy of SMS reminders in improving routine immunization performance, with an 8.7% increase in coverage. Similarly, Bangure et al. (2015) in Zimbabwe and Schlumberger et al. (2015) in Burkina Faso found that SMS reminders significantly improved childhood immunization rates. Ekhaguere et al. (2019) in Nigeria observed that automated phone calls and text reminders increased the completion and timeliness of children's immunizations.

Gibson et al. (2017) in Kenya combined SMS reminders with monetary incentives, resulting in increased childhood immunization coverage, especially among disadvantaged populations. This approach highlights the effectiveness of integrating financial incentives with mobile health interventions. Banerjee et al. (2021) in India assessed various nudges to increase immunization rates, finding that the combination of community information hubs and SMS reminders was the most cost-effective strategy. These studies collectively emphasize the effectiveness and broad applicability of mobile-based health interventions across different cultural and socioeconomic contexts, offering valuable insights for policy formulation and implementation.

4.5. Greater Access and Control of Financial Resources: For many low-income households one key source of poverty is financial exclusion, in which individuals and families predominantly rely on cash for savings, payments, and loans rather than formal financial services. This cash dependence limits their ability to save securely, send and receive remittances over long

distances, build credit, access affordable loans, and protect against financial shocks (Demirgüç-Kunt et al. 2018).

Like other ICT revolutions before it (e.g., Western Union's money transfer service piggybacking on its telegraph business), one of the most significant knock-on effects of the uptake and spread of digital communications has been innovations in financial services, leading to the creation and widespread adoption of internet banking, digital payment systems, and mobile money (Razi et al. 2022). The latter has been especially consequential in LICs where most households are unbanked and mobile phone users can use their SIM cards to store, save, and transfer money. Other technological advances, such as no-frills, low-cost bank accounts (such as Pradhan Mantri Jan Dhan Yojana in India), have further democratized access to banking. In addition to greater access to these basic services, the DFS revolution has also opened the door to digital payments, credit, and insurance products (Robinson, Park, and Blumenstock 2023; Cull et al. 2023).

As in the other sectors, research on this topic is growing rapidly.[17] On the whole, digital connectivity, in particular mobile-based financial innovations, has transformed access to financial services. Between 2011 and 2021, the share of adults with a financial account increased from around 40% to 70%, with a narrowing gender gap (6 percentage points in 2021). Mobile money was especially important in enhancing financial inclusion in Sub-Saharan Africa, where mobile money account ownership is three times higher than the global average, but also in Bangladesh, Brazil, and Paraguay (Demirgüç-Kunt et al. 2022).

One fundamental benefit of financial account ownership is increased access to remittances (Jack, Ray and Suri, 2013; Batista and Vicente, 2020; Lee et al., 2022). In the past, when households needed to send money over long distances, they often had to transport it themselves or depend on their social networks, bus drivers, or traditional money transfer services. However, with the advent of digital financial services, households have been able to forgo the costs, risks, and delays associated with these legacy systems, and send money instantly, more securely, and at a fraction of the price (Jack and Suri 2011). Accordingly, demand for mobile money is found to be less elastic over longer distances (Economides and Jeziorski 2017).

A number of studies find that access to mobile money has enabled more effective risk-sharing in the face of financial shocks and helped to smooth consumption, which tends to be quite volatile for low-income households (Jack and Suri 2014; Riley, 2018; Batista and Vicente, 2020; Ahmed and Cowan, 2021; Abiona and Koppensteiner, 2022; Apeti 2023). Digital financial transfers may be especially effective in the face of covariate shocks that affect large portions of a community simultaneously (such as droughts), and, thus, overwhelm local support mechanisms. Riley (2018)

[17] For useful scoping studies, see Suri (2017), Garz et al. (2020), Razi et al. (2022); Robinson, Park and Blumenstock (2023); and Suri et al. (2023).

offers compelling evidence to support this demonstrating that in Tanzania, in the face of village-wide rainfall shocks, households with mobile money access experience no decline in household consumption, in contrast to non-users living in the same village.

In addition to consumption smoothing, mobile money uptake also has been found to improve household well-being as measured by increases in consumption (Munyegera and Matsumoto, 2016; Lee et al., 2021). Likewise, Chakrabarty and Mukherjee (2021) show that increases in financial inclusion in India, driven by the PMJDY initiative, are associated with higher, more diversified, consumption. Suri and Jack (2016), leveraging the differential spatial roll-out of mobile money (as measured by density of mobile money agents) in Kenya between 2008 and 2014, estimate access to the service significantly increased household consumption and lifted 2% of Kenyan households out of poverty. As found in studies on adoption of mobile internet, one potential mechanism driving these welfare gains is via occupational change, mainly out of the farming sector (Suri and Jack, 2016; Chiara De Gasperin, Valentina and Luca, 2019; Aggarwal, Brailovskaya, and Robinson, 2020; Lee et al., 2021; Batista et al., 2023). This labor reallocation could be due to better access to capital needed for trade, retail, or small business (Suri and Jack 2016); an instrument to more efficiently save and manage one's finances (Aggarwal, Brailovskaya, and Robinson, 2020); and stronger incentives to invest in migrant labor (Lee et al. 2021; Batista and Vincente 2023).

Mobile money has been shown to have a particularly significant impact on women. In Kenya, Suri and Jack (2016) report that mobile money access had especially pronounced effects on consumption in female-headed households, which was more than double the average increase. Lee et al. (2021) observed that female migrant workers who adopted mobile money worked longer hours each day (by 12-14%), though at the cost of potentially worse health outcomes due to increased workloads and stress. Riley (2024) shows that digitizing microfinance loan disbursements and having them deposited directly into the women's designated business mobile money accounts led to a 15% increase in business profits and an 11% increase in business capital. These effects are strongest for women who at baseline reported experiencing family pressure to share money, pointing to the greater discretion and privacy mobile money affords. Additionally, digitizing microfinance transactions in the Philippines saved women 42 minutes per transaction on withdrawals (Harigaya, 2020). At the same time, however, Annan (2022) finds that in Ghana women mobile money clients are more likely to be overcharged by agents, including by female vendors (whereas male clients tended to receive preferential treatment from male vendors).[18]

[18] Gender discrimination in overcharging for mobile money withdrawals varies by context. See Annan et al. 2023.

As valuable as mobile money is in insulating households from economic shocks and inducing occupational change, especially among women in emerging economies, better capabilities to send and receive remittances do not necessarily translate into higher levels of financial flows, increased access to resources, and higher income. In their experimental study in Malawi, Roessler et al. (2023) demonstrate that smartphone ownership and training significantly increased women's access to remittances and realized financial inclusion (as measured behaviorally by one's capabilities to accept a mobile money transfer to their own account). But, generally, women received very few transfers (on average 0.25 transfers in the past month) with no effect on income. Likewise, in Tanzania among smartphone recipients mobile internet use was found to mediate a larger share of the increase in household consumption than mobile money use (Roessler et al. 2021). This underscores that access, while an essential dimension of digital connectivity, is not sufficient to lead to economic empowerment. Equally important is individuals' capacity to leverage connectivity and the available services to increase one's capabilities and unlock new economic opportunities.

One digital financial innovation that aims to elevate end-users' productive potential is digital credit. This service provides users with quick and easy access to loans (often with high interest rates) through their connected devices based on algorithms analyzing their digital footprint, and thus bypassing traditional banking hurdles such as extensive paperwork, collateral requirements, and lengthy approval processes. Research on digital credit is in the early stages.[19] Key initial findings suggest that demand for such credit is high, but consumers' understanding of the terms and conditions of the loans is low and with limited effects on borrowers' economic welfare—albeit with no evidence of significant adverse consequences either, such as over-indebtedness (Robinson, Park and Blumenstock 2023). Whether, and how, digital credit can increase economic resilience, productivity, and entrepreneurship requires more research.

5. Societal impacts

In the previous sections, we primarily focused on individual-level effects of digital connectivity and digital services on labor force participation, agricultural productivity, educational attainment, health care, and financial inclusion. Here we consider societal-level impacts, both in terms of how digital connectivity strengthens societal capabilities but also potential countervailing effects, such as the spread of misinformation, social divisions, and digital repression.

[19] For initial studies, see Suri et al. 2021; Björkegren et al. (2022); and Brailovskaya et al. (2024).

We can consider the direct and indirect societal effects of digital connectivity. In terms of the latter, the burgeoning scholarship on digital connectivity points to impacts across a range of sectors. While these gains are often modest and `average effects' mask important and significant heterogeneity (Aker and Cariolle 2023)—which represents an important area for future research and a key motivation for the WEE-Connect Initiative—in reducing fundamental economic costs, digital connectivity may lead to simultaneous widespread, cross-sector effects that cumulatively result in substantial societal impact. One potential channel is that these incremental gains in labor participation, education, health, agricultural productivity, and financial inclusion add up to a significant increase in human capital and, in turn, strengthen society's bargaining power and demands for more inclusive economic and political institutions.

Another channel stems from the direct effects of digital connectivity itself—in which citizens and civil society leverage these new information and communication technologies to more effectively organize and mobilize, as well as spread new ideas about how to govern society and reshape norms and values (Tufekci 2017). By one estimate, 2019 saw potentially the largest series of widespread, peaceful demonstrations ever documented, which some attribute to digital connectivity and social media making it easier for citizens to learn about events, amplify their messaging, coordinate mass action, and leverage social motivation and pressure to increase turnout (Chenoweth 2020). More systematically, a number of studies suggest a causal link between the availability of mobile communications and localized social mobilization in LMICs (Pierskalla and Hollenbach 2013; Manacorda and Tesei 2020; Enikolopov, Makarin, and Petrova 2020; Fergusson and Molina 2021). Leveraging the arbitrary roll out of the most popular social media network in Russia, VKontakte (VK), Enikolopov, Makarin, and Petrova (2020) show that a 10% increase in VK penetration increased the probability of a protest by 4.6% and the number of protesters by 19% during a spate of demonstrations in the wake of the 2011 election in Russia. They attribute social media's influence as operating more through the coordination channel than an information one as protest rates were lower in cities where social media users were fragmented between VK and Facebook—which should not have affected the spread of grievances about fraud in the election, but may have made it difficult for cross-network messaging and organization.

Social media campaigns may also serve as an outlet to reveal, and potentially shift, collective beliefs as they provide a mechanism for many to simultaneously express, share, and update their ideas based on the surge of new information and perspectives. Moreover, with fewer gatekeepers and lower barriers to information dissemination, it may provide opportunities for historically marginalized groups to challenge existing power structures. For example, the #MeToo social movement, which spread online and offline, exposed the prevalence of sexual violence and sexual harrassment against women and advocated for systemic, societal, and normative changes to prevent such abuses. Levy and Mattsson (2023) show that OECD countries with stronger

#MeToo movements had a significant increase in sex crimes reporting (by 10%) and an increase in arrests. They attribute this to the social movement revealing the pervasiveness of sexual assault, which increased solidarity among women in the face of this systemic violence, empowered survivors to report the crimes, and galvanized law enforcement to more proactively investigate and prosecute them.

One question is whether more curated and targeted campaigns on social media can prove as effective, especially in more socially conservative societies. Christia et al. (2023), working with the Egyptian Center for Women's Rights, used WhatsApp and Facebook to encourage women in Egypt to watch television programming from a well-known Egyptian human rights lawyer focused on gender norms and violence. The results from the RCT show that the social media outreach increased women's knowledge, hypothetical use, and reported use of available resources, but did not lead to attitudinal change supporting gender equality or against the justifiability of gender-based violence.

As mentioned earlier in the context of adoption, sexual harassment is also pervasive online. Often exacerbated by the anonymity of postings which can lead to particularly virulent and offensive behavior, this has been found to reduce women's online engagement or lead them to stop altogether (Salerno-Ferraro, Erentzen, and Schuller 2022). Among other ways in which social media may undermine societal capabilities is through the spread of misinformation, leading to cynicism and mistrust (Loomba et al. 2020), deepening of social divisions driven by the virality of messages that engender out-group animosity (Rathje, Van Bavel, and van der Linden 2021), and increasing hate crimes (Bursztyn et al. 2019; Müller & Schwarz 2023).[20] Finally, digital tools are also being deployed by authoritarian regimes to suppress social mobilization and weaken societal capabilities (see Earl, Maher, and Pan 2022 for a review.)

6. Market Equilibrium Effects

Evidence suggests that increasing digital connectivity can have market-level impacts, affecting productivity, economic growth, and poverty reduction.[21]

In particular, the literature suggests investments in connectivity in LMICs have high economic returns, enhancing market efficiencies to the advantage of both entrepreneurs and consumers. A 2023 meta-analysis by the World Bank concludes that investments in LMIC connectivity infrastructure yield greater returns compared to investments in transport or energy sectors. These investments show output elasticities ranging between 0.07 and 0.085.

[20] There is a large and growing literature on the societal impacts of social media. For recent reviews, see Zhuravskaya, Petrova, and Enikolopov (2020) and Campante, Durante, and Tesei (2022).
[21] See Hjort and Tian 2024 for a useful review.

Pioneering studies by Jensen (2007) and Aker (2010) provide concrete examples of these benefits. Jensen's research in coastal India revealed that access to feature phone connectivity significantly boosted the efficiency of the fishing sector, leading to an 8% increase in fishers' profits and a 4% decrease in consumer prices. Similarly, Aker's study in Niger's grain markets showed how connectivity reduced waste and price dispersion, benefiting both buyers and sellers.

Björkegren's 2022 study in Rwanda further reinforces these findings. The study focused on a subsidized feature phone distribution program in rural areas, discovering that the social return to the program was a remarkable 89%. This included benefits to operator revenue and consumer surplus, with a noteworthy 65% of the impact on operator revenue arising from spillovers to those who did not receive the subsidy.

Additionally, Bahia et al. (2020) found that the expansion of mobile broadband in Nigeria played a significant role in reducing poverty. This was achieved by increasing both food and non-food consumption in rural households, showcasing the broad socio-economic impacts of enhanced connectivity. Whereas Hjort and Poulsen (2019) show the arrival of fast internet to coastal Africa led to the entry of new firms, especially those using ICT, increased the productivity of existing firms, and enhanced export activity.

These studies collectively demonstrate the substantial and varied benefits of improving connectivity in LMICs, ranging from direct economic gains for specific sectors to broader societal impacts such as poverty reduction and increased consumption.

6.1 Governance and Public Services

In addition to market-level impacts through effects on commerce, connectivity can also strengthen governance through improved revenue mobilization, public service provision and greater accountability.

Apeti and Edoh (2023) show that countries with mobile money are able to significantly increase their tax revenue due to growing the economy and, thus, expanding the tax base, enhancing the quality of institutions, and simplifying the process of tax payments. In a study by Muralidharan et al. (2021), phone-based monitoring of a government transfer program to Indian farmers (by simply calling beneficiaries and informing program implementers that beneficiaries would be called) significantly increased the likelihood of farmers receiving their transfers both on time and at all. It reduced the incidence of farmers not receiving their checks on time by 7.4% and not receiving them at all by 7.6%, proving to be a highly cost-effective method, with each additional dollar delivered costing only 3.6 cents.

In another study conducted by Asim and Dee (2022), the impact of informing local school council members in Pakistan about their responsibilities was examined. These members, comprising parents and community members, received low-cost call center voice calls on their mobile phones, providing information about monitoring teacher, staff, and student attendance, among other duties. This intervention led to a 4% increase in school enrollment, with the most significant improvements observed in female primary schools.

Ojo, Janowski, and Awotwi (2013) investigated how governance can facilitate access to mobile technology for vulnerable groups, specifically 45 female head porters in Accra with mobile phones. The study identified three key governance mechanisms to help meet these women's needs: revising financial and telecom regulations to support mobile services such as microfinance, encouraging local content creation, and involving NGOs to improve government mobile service delivery and educate vulnerable groups on effective mobile use.

These studies collectively demonstrate that direct and efficient communication methods facilitated by technology can significantly enhance the efficiency and effectiveness of public service delivery and governance, leading to tangible improvements in sectors such as agriculture and education.

7. Digital Connectivity and Women's Development: A Research Agenda

When juxtaposed with the compelling evidence that connectivity can expedite development presented above, the consistent and substantial gender gaps observed across LMICs suggest low hanging fruit for driving women's development through expanded connectivity. However, among the literature reviewed above only a handful of studies were intentionally designed to explore gender differences or evaluated interventions intentionally designed around the barriers faced by women. This dearth of gender specific evidence begs for additional research centered squarely at the intersection of connectivity and gender. In this context, we propose the following questions organized around the conceptual framework introduced above to guide a future research agenda on connectivity and women's development.

A. **General Welfare Benefits of Connectivity:** What are the expected human development impacts of effectively reducing barriers to meaningful connectivity for new and existing women users (i.e., the benefit side of the cost-benefit ledger)?
    a. New Users:
        i. New Handsets Users: What are the impacts of facilitating "new access" to mobile handsets for previously unconnected women?
        ii. New Internet Users: What are the impacts of facilitating "new access" to the internet for previously unconnected women (e.g. through voice

enabled solutions, training, subsidized data, upgrading to smartphones, etc.)?

b. Existing Users:
   i. Consistent Access to Existing Users: What are the impacts of "more consistent access" (e.g. through more agency over personal handsets, improved network coverage, reduced social norms against active use) for under-connected women, including those who don't have consistent access to a phone?
   ii. More Useful Content and Services for Existing Users: What are the impacts of accessing "more useful content and services" among women with existing internet access?

B. **Measurement of Women's Connectivity:** What explains variation in connectivity measurement between demand and supply-side data sources, and what approaches can improve the accuracy and precision of measurement relevant to women's access and use of meaningful connectivity?

   a. What are effective methods for soliciting behavior around intrahousehold sharing of devices and revealing intrahousehold constraints on women's access to connectivity?

   b. What are effective methods for soliciting willingness to pay for connectivity services among women?

   c. What are measurement challenges and solutions for precisely measuring local connectivity related costs and actual connectivity related expenditures?

   d. What are practical approaches to measuring women's digital literacy in a standardized and meaningful way?

   e. What is the actual geospatial footprint of the mobile telecom networks and what populations are excluded? What data sources and methods can improve the geospatial accuracy of these estimates? Of women who do not have phones, what is the current level and estimated trajectory of the fraction of the population living under the mobile network? How does this differ for feature vs. smartphones?

<u>Barrier Specific Questions</u>

C. **Affordability Barrier:** How does affordability constrain women's meaningful connectivity, and what interventions could sustainably improve affordability at scale?

a. *Cost variation:* How does the composite cost to effectively use a mobile connectivity (service fees, electricity, handset cost, etc.) vary across urban vs. rural and poor vs. non-poor segments of women? Is this cost variation the outcome of competitive market forces or market failures that could be effectively addressed by policy or philanthropy?

b. *Demand:* How does women's demand for smartphone handsets and internet data respond to changes in price (elasticities of demand)? How does demand response differ to changes in handset vs. data costs?

c. *Enabling policy:* What is the impact of various connectivity related government policies on composite costs to female users (tariffs, taxes, price caps, subsidies, etc.)?

D. **Availability:** Improving women's agency to access and use available devices within the home:

a. *Intrahousehold Sharing and Norms:* What are effective interventions for enabling women's agency over handsets and connectivity services within the household? What is the effect of targeting women exclusively vs. targeting men and women with these interventions?

E. **Accessibility:** Understanding exclusion due to limited availability of networks and exclusion due to constraints on access within the household:

a. *Overcoming limits of mobile data coverage:*

i. What fraction of women smartphone users do not use data because of lack of local data coverage?

ii. What are promising internet access points that would be safe and accessible for low income women and girls (e.g. schools, health facilities, open air markets, telecom and mobile money agent kiosks, etc.)?

F. **Digital Literacy:** Highlighting impactful, scalable, and cost-efficient digital literacy interventions for women:

a. **Content of interventions:** What are best practices for onboarding women to smartphones and internet use that build confidence and encourage increasing depth of use?

i. Do general digital literacy interventions sufficiently drive multiple high-priority use cases (e.g. improved information on modern contraception, improved access to educational materials, adoption of formal digital financial solutions, etc.) or should interventions be sector/use-case specific?

ii. What is the relative importance of interventions to change women's technical capabilities in using phones vs. their perception of gender norms around phone use, i.e. is social norms oriented training a necessary component of digital literacy interventions for women?

b. **Targeting and achieving scale:**

i. Do digital literacy interventions have positive spillover effects on the use of meaningful connectivity within households and communities among women that are not directly targeted for the interventions?

ii. Which segments of women are most cost-effective to target for digital literacy interventions, anticipating, for example, the potential for spillovers at the household and community level and differential technological capacity of younger vs. older women?

iii. What digital literacy interventions among existing platforms, networks, and communications channels provide compelling pathways for providing digital literacy interventions at scale?

G. **Relevance:** Identifying, enabling access to, and promoting the creation of relevant content, services, and use cases of phones and internet for women:

a. Demand for content/services:

i. How does content accessed vary i) when phones are shared or personally controlled, and ii) when women have feature vs. smartphones?

ii. What are the entry use-cases to more meaningful connectivity to smartphone use and or more socially acceptable first smartphone use case for women? What are the spillover use cases that are discovered once connectivity is established?

iii. Is the digital content available, accurate, and appropriate (e.g. language, needs, framing)? What fraction of digital engagement content is accessed through search queries versus clicking through prompts that are "pushed" (e.g. through advertisements, social media, or chat apps)?

b. *Language constraints:*

i. Among women without personal device access, how many are unable to read and write in the device's language, and what interventions overcome these alphabetical/numerical literacy constraints?

ii. What products and features can effectively facilitate internet access for women with low alphabetical/numerical literacy (e.g. voice solutions, automatic local language translation, iconography, video tutorials, etc.)?

H. **Safety:** Exploring the nature and impact of technology-facilitated gender-based violence (TGBV) experienced by women, and mechanisms for prevention and redress:

a. **Measuring and monitoring TGBV:**

i. What is the scale, frequency, and nature of phone and internet-based TGBV experienced by women and how does that vary by age and multiple vulnerable group identities?

b. **Impact of risks on demand for connectivity:**

i. How is women's behavior online (directly or through gatekeepers) impacted by the incidence of online harassment?

ii. Do women and other household members' perceptions of risks under/overstate real risks? What is the impact of sharing accurate information on real risks/harms with women/household members?

c. **Preventing and redressing digital harms:**

i. What specific information (e.g., photos, phone numbers) creates risk for women and can reduce exposure to TGBV with improved privacy protections?

ii. What are key constraints for women to file complaints and access redress related to TGBV?

iii. What are best practices for onboarding new female users that better protect them online (e.g., protection from fraud, identity theft, TGBV)?

iv. What is the effect of private-sector and platform-interventions to enhance trust and improve digital safety among existing and new female users? Which are most cost-effective and scalable?

v. What is the impact of policies and practices to enhance trust and improve safety among existing and new women phone and internet users?

I. **Norms:** Impact of social norms on women's meaningful connectivity and interventions to overcome constraints and change norms:

a. *Understanding constraining norms:*

i. Which norms are most binding on women's access and use (e.g. norms related to communication with men, mobility, education, labor force participation, access to adult content, etc.)? How do these norms differ based on access to basic communication versus more advanced digital engagement?

ii. For women with access to handsets, what digital content, services, and use cases available to women in principle are most mediated by male gate-keepers (e.g., husbands, guardians)?

b. *Affecting norms that constrain connectivity:*

i. What existing platforms, networks, and communications channels provide compelling pathways for influencing norms around women's digital connectivity?

ii. Will access to more relevant and valuable use cases for women (e.g., education, health, employment, entrepreneurship, entertainment, etc.) naturally lead to relaxation of constraining connectivity norms?

c. *Understanding impacts of expanded connectivity on norms:* How are women's and other household members' perception of gender norms affected by connectivity?

Sector Specific Questions: What are the gender specific impacts of new sector specific connectivity-enabled digital interventions? Gender intentional evaluations of sector-specific

interventions will require gender intentional sampling, gender sensitive intervention design, and gender disaggregated analysis.

J. *Agriculture:*
   a. Do connectivity constraints limit women farmers in the use of digital technology to effectively source inputs and market harvests and specifically limit adoption of digital farmers services? What is the impact on farming practices and income when these constraints are overcome?
   b. What are the impacts of enabling agricultural extension workers with smartphones and better connectivity services on female farmers in particular?

K. Education:

   a. Can next generation education solutions (adaptive content, LLM-enabled, etc.) for teachers and students be effectively delivered via smartphones to drive learning impacts?

   b. What are the impacts on adoption and learning of delivering educational content to teachers and students in local vs. majority languages?

L. Health:

   a. Can/what women's LMIC health services can be effectively delivered remotely via voice, video, etc.? What are risks/frictions in remote health delivery? What aspects of phones/internet are the most limiting (picture quality, unreliable connections, etc.)? What preparation/training is needed among health providers and patients?

   b. Does expanding adoption of internet-enabled handsets encourage women to seek health related information on the internet? What are their preferred sources of information? Is this information accurate? How do women share health related information over phones and what opportunities/risks does this introduce?

   c. Does improved access to medical services and health related information provide a compelling use case to drive women's phone adoption? What is women's willingness to pay for these services?

   d. What are the impacts of enabling frontline health workers in clinics, vaccine campaigns, etc. with better connectivity solutions (smartphones, subsidized data plans, etc.)? What training/preparation is required for effective adoption and use among these health intermediaries? Can connectivity for key health

intermediaries improve efficiency and effectiveness of public health interventions? Can it affect actual health campaign outcomes?

M. Finance

a. Do interventions to expand women's smartphone use impact adoption and use of digital financial services?

b. Does demand for digital financial services provide a compelling use case/entry point for expanding women's adoption of smartphones and internet use?

c. Can the profit from mobile enabled financial services (particularly among vertically integrated mobile network operators that offer financial services) justify subsidizing handset, SMS, data costs?

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