A Tough Call:

Understanding barriers to and impacts of women's mobile phone adoption in India

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Cover image: Women watch as a community health worker uses an interactive audio-visual mobile phone-based health application in Bahraich District, India. © 2013 DS Panwar/India, Courtesy of Photoshare.

Executive Summary

Today in India, 67% percent of men own mobile phones, but only 33% percent of women do. South Asian countries in general are clear outliers among countries of similar levels of development, with India, Pakistan, and Bangladesh exhibiting some of the world's highest gender gaps in access to technology. While the mobile gender gap matters in its own right, it is particularly problematic because it can exacerbate other important forms of inequality — in earnings, networking opportunities, and access to information.

This report uses a range of sources — 125 original qualitative interviews, a literature review, and analysis of secondary quantitative data — to identify leading barriers to Indian women's use of mobile phones, assess the importance of these barriers, and propose directions for further research into how to reduce them.

Throughout the report, we examine two broad, intersecting classes of barriers: economic and normative. Economic barriers refer to factors directly related to the financial and human capital needed to own and operate mobile phones, as well as the economic "pull factors" that increase use, such as needing a phone for work. Normative barriers include the social norms, customs, and individual beliefs that shape and constrain men's and women's roles in the household and society.

Notable findings include:

- Men are 33 percentage points more likely to own a phone than women, on average.

- The mobile gap exists across Indian society. We disaggregate data by a range of demographic characteristics including age group, state of residence, marital status, educational attainment, urbanicity, and poverty status. While there is substantial variation in the gap, it is always 10 percentage points or higher.

- A woman's level of empowerment is as important a determinate of mobile use as her income. We used survey data to create a women's "empowerment" ranking, and asked whether this ranking or household income is a better predictor of the mobile gender gap, holding other background characteristics constant. Income and empowerment have similar explanatory power, which suggests normative and economic barriers are both important drivers of the mobile gender gap.

- Women's mobile phone usage challenges traditional gender norms. Interviews reveal that phone usage can stir questions about girls' "purity" prior to marriage and worries that women will be subject to digital harassment as reported in the media. After marriage, norms dictate that a woman's primary responsibility is to take care of her family and household. This home-centric role leaves women with few opportunities to use the phone for socially-acceptable, "productive" purposes.

To date, no research has causally identified the strongest drivers of women's lagging phone ownership in India. While preliminary evidence suggests normative barriers have some role to play, it is not clear which barriers are most constraining or in which direction the causal relationship flows. Will lifting economic constraints subsequently change social norms? Or will changing social norms cause women to own more phones?

The findings of this report will inform upcoming research aimed at causally identifying what interventions increase women's mobile engagement. With evidence on the nature and strength of economic and normative barriers, it may be possible to design policies to reduce the cost of phones or work to change the customs surrounding their use.

1 Introduction

Despite recent progress, too many women and girls in developing countries fail to benefit from their talents due to poor access to markets, information, and financial services (Klugman and Tyson, 2016). The gender gap in socio-economic outcomes is particularly stark in India, where traditional gender norms emphasize the role of women as caretakers of the household, while men are expected to be the main economic providers (Dyson and Moore, 1983). Consequently, women are 52 percentage points less likely to work than men (ILO, 2014), 20 percentage points less likely to have formal savings (Global Findex, 2014), and often require permission from family members to travel outside their home village (IHDS, 2011).

In contexts like India where women are physically and economically isolated, the rise of low-cost mobile phones holds the promise of connecting women to social contacts, markets, information, and a growing range of value-added services like mobile banking and digital payments (see Box 1 for a summary of the benefits of mobile phones).

BOX 1 — THE BENEFITS OF MOBILE PHONES: HIGHLIGHTS FROM THE LITERATURE

We conducted a systematic review of academic literature studying the impact of mobile phones on economic outcomes. This covered papers in economics, anthropology, sociology, and policy reports (for additional detail see Appendix B). While the literature finds that mobile phones have meaningful benefits, there are also important gaps in the evidence, especially with respect to gender:

What Do We Know?

Mobile phones have a wide spectrum of benefits. Phones help producers and consumers access the best price for market goods (Aker, 2010; Aker and Fafchamps, 2014; Jensen, 2007; Jensen and Miller, 2018) and learn about job opportunities (Dammert, Galdo, and Galdo, 2015). In Kenya mobile money has both reduced households' vulnerability to economic shocks (Jack and Suri, 2014) and lifted poor women out of poverty (Suri and Jack, 2016). Behavioral messaging[a] through SMS and voice calls has improved behavior in domains like finance (Cadena and Schoar, 2011; Karlan et al., 2016; Kast, Meier, and Pomeranz, 2012), health (Dammert, Galdo, and Galdo, 2014; Flax et al., 2014; Zurovac et al., 2011), and education (Aker, Ksoll, and Lybbert, 2012).

What is Missing?

Despite empirical evidence of large gender gaps especially in South Asia — little research to date has focused specifically on women and mobile phone ownership.[b] Only 18% of 49 papers included in our literature review included any meaningful discussion of gender. This significant gap in evidence positions our work to contribute substantially to the understanding of the unique benefits mobile phones provide to women.

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a Behavioral messaging is a technique where in order to promote a certain behavior change, a particular message is communicated to people through fliers, SMS, or other low-cost communication methods.

b One exception is Suri and Jack (2016).

Yet for women to reap these digital dividends, they must have access to phones and the ability to use them independently. Moreover, if women are systematically denied access to mobile phones, the promises alluded to above may become pitfalls: as regular use of a phone is increasingly necessary to fully participate in the modern economy, the mobile gender gap may exacerbate gender gaps in other areas rather than ameliorate them.

Unfortunately, India—and South Asia more broadly—have some of the largest gender gaps in phone ownership in the world (Figure 1).[1]
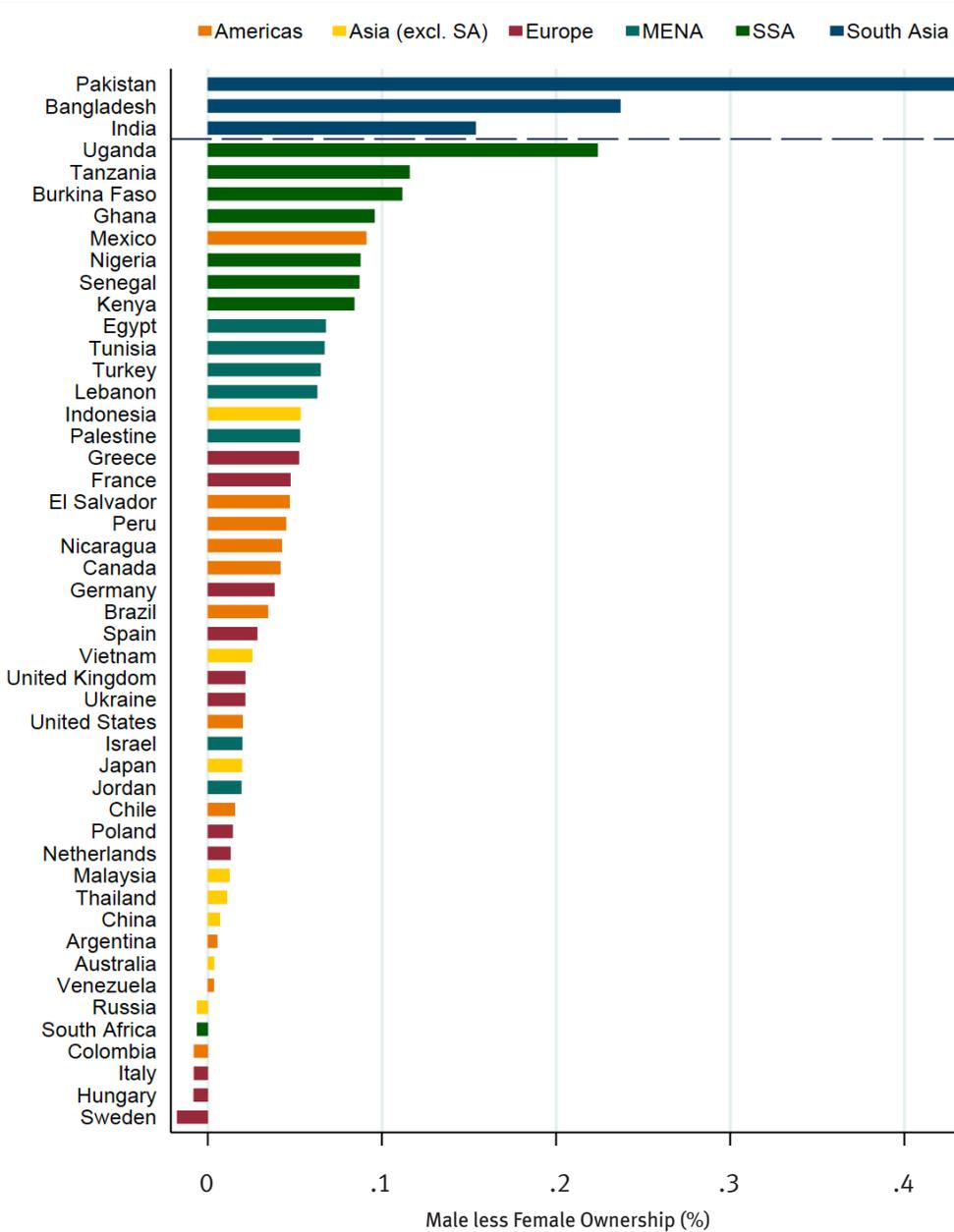
For both males and females, ownership was calculated by averaging across 2014, 2015, and 2016. Data are from the Pew Global Attitudes Survey.

Sample is restricted to countries in which male ownership of mobile phones is within +/- 15% of the three year average (2014–2016) of male mobile phone ownership in India.

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1 India's gender gap as illustrated in Figure 1 is a conservative estimate. Another nationally representative dataset, Financial Inclusions Insights, puts India's mobile phone gender gap at 33 percentage points for a similar set of years (2015–2016).

This is not simply a symptom of low levels of income or high costs of mobile phone ownership. Although gender gaps are correlated with both these factors at the cross-country level, gaps in South Asia outstrip those in other countries with similar levels of income per capita (Figure 2) and costs of mobile phone ownership (Figure 3).

Another possible explanation is that gender norms in South Asia are more restrictive than in other countries, and this constrains women's access to mobile phones even further. Indeed, from Figure 4 we see that the Gender Inequality Index, which is arguably correlated with gender norms, is positively related to the ownership gap, though South Asian countries are still outliers.[2] These basic correlations suggest that drivers of the gender gap in mobile

phone access are likely complex and multifaceted. In this report we therefore employ a multidisciplinary approach to paint a nuanced picture of drivers of India's mobile gender gap, while assessing the quantitative importance of these drivers. Our analysis combines the results of a detailed literature review, qualitative interviews with potential and current phone users (female and male), and quantitative analysis of secondary data (See Box 2: An Overview).

FIGURE 2 — ECONOMIC DEVELOPMENT AND PHONE OWNERSHIP BY GENDER
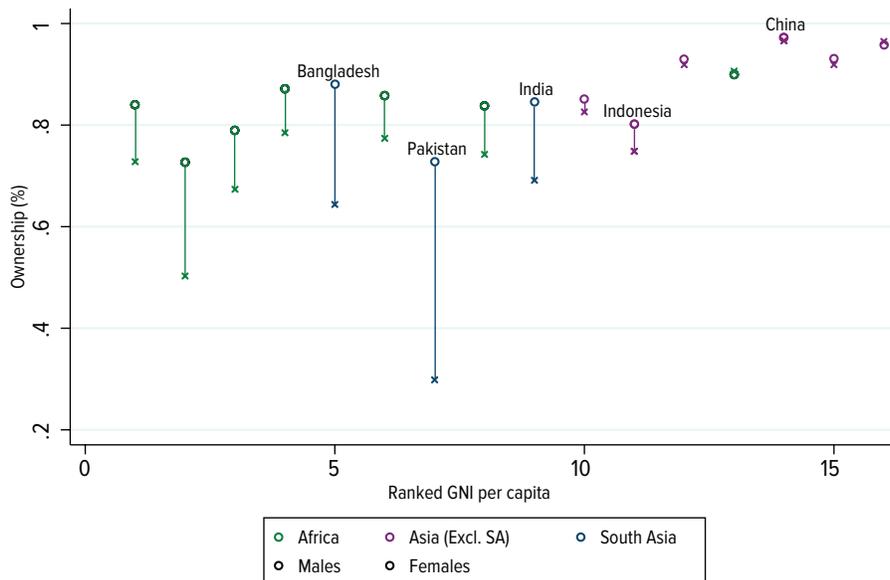
GNI data are calculated using the Atlas Method, averaged across 2014, 2015, 2016, and from the World Bank. GNI ranked amongst included countries. Ownership data for both male and females are on the y–axis, are averaged across 2014, 2015, 2016 and are from the Pew Global Attitudes Survey. Sample is restricted to countries in which male mobile phone ownership is within +/− 15% of the three year average (2014–2016) of male mobile phone ownership in India.

2 This is true even when excluding South Asian countries which are extreme cases.

FIGURE 3 — THE GENDER GAP AND THE COST OF A MOBILE PHONE
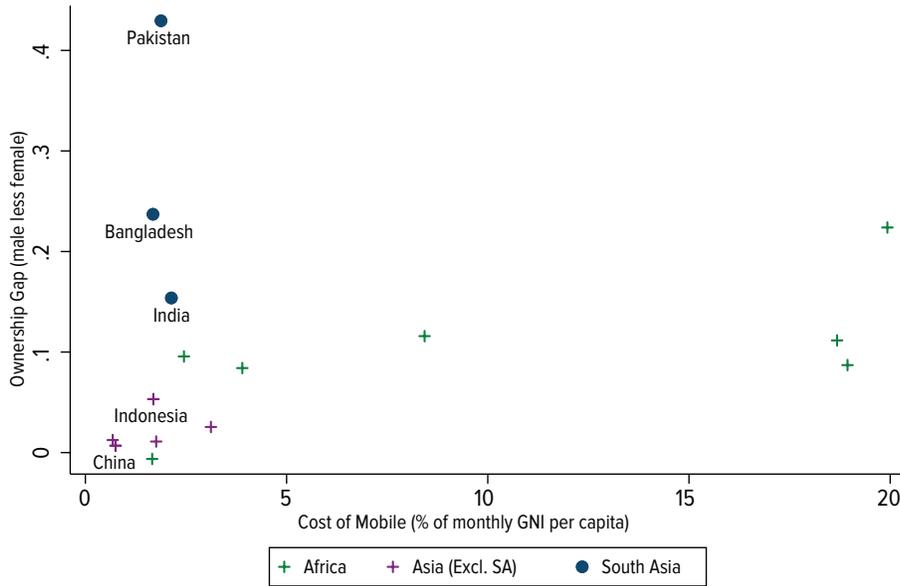
Ownership cost data are from 2014 and the International Telecommunication Union (ITU). GNI calculated using the Atlas method.

Ownership gap data are averaged across 2014, 2015, 2016 and are from the Pew Global Attitudes Survey. Sample is restricted to countries in which male ownership of mobile phones is within +/− 15% of the three year average (2014−2016) of male mobile phone ownership in India.

FIGURE 4 — THE GENDER GAP AND THE GENDER INEQUALITY INDEX
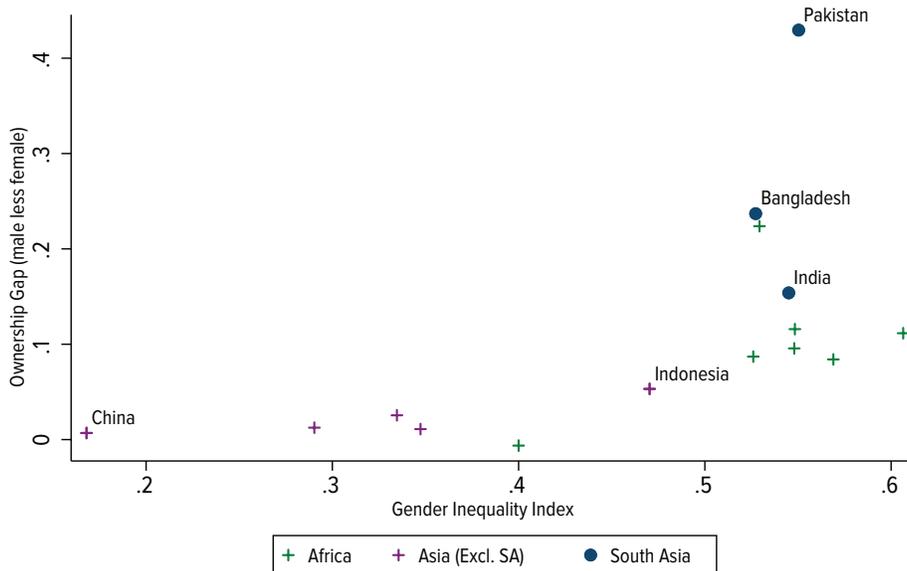
Gender Inequality Index (GII) is a measure of lost potential human development due to gender disparities; a high score indicates women are highly disadvantaged in the realms of health, empowerment, and economic status. Data are an average of the GII score across 2014, 2015, and 2016 and are calculated by the UNDP. Ownership gap data are averaged across 2014, 2015, 2016 and are from the Pew Global Attitudes Survey. Sample is restricted to countries in which male ownership of mobile phones is within +/− 15% of the three year average (2014−2016) of male mobile phone ownership in India.

BOX 2 — AN OVERVIEW

This report had three objectives: (1) to document the status quo of Indian women's access to mobile phones, (2) to diagnose the access barriers women face, and (3) to develop a theory of change and identify potential testable solutions for future research. The chart below summarizes the main tasks and subsequent outputs. This report synthesizes the main findings; please see the Appendix for a more detailed discussion on select outputs.

TASK	DESCRIPTION	RELEVANT OUTPUT(S)	RELEVANT APPENDIX SECTION (IF APPLICABLE)
Literature Review	Reviewed literature on the benefits of mobile phones and the barriers to mobile phone access for women in India	Synthesis document of findings	B
Secondary Data Analysis (Quantitative)	Accessed and analyzed data on women's mobile phone access from three sources: the Pew Global Attitudes Survey, Financial Inclusion Insights (FII), and the India Human Development Survey (IHDS)	FII and IHDS analysis	N/A
Primary Data Analysis (Qualitative)	Conducted, transcribed, and analyzed semi-structured interviews and focus groups from men and women across 5 states in India: Delhi, Madhya Pradesh, Maharashtra, West Bengal and Tamil Nadu	Site description and broad summary	C
Stakeholder Engagement	Identified, contacted, and conducted interviews with stakeholders to women's mobile engagement (e.g. telecom companies, content providers, policymakers, NGOs)	Stakeholder map	E

1.1 Our Approach

Informed by existing literature, our analysis focuses on two intersecting classes of barriers: economic and normative. **Economic barriers** refer to factors directly related to the financial and human capital needed to own and operate mobile phones, as well as the economic pull factors that drive use (such as needing a phone for work).[3] **Normative barriers** refer to the social norms, customs, and individual beliefs that shape and constrain men's and women's roles in the household and society (see Box 3 for more details). We emphasize that these barriers are often interlinked. For example, technical literacy is a commonly cited barrier to women's information and communications technology (ICT) use in India and elsewhere (Best and Maier, 2007; Huyer and Sikoska, 2003; Intel, 2012; Rashid, 2016). While superficially an economic problem, the gender gap in technical skills may reflect norms that propagate underinvestment in girls' human capital.[4] Arguably, norms that define a woman's role as caretaker of the household also could provide little rationale for girls to develop technology-related skills, which are typically rewarded on the labor market (Bornman, 2016).[5]

BOX 3 — THE BARRIERS TO MOBILE PHONE USE: FINDINGS FROM LITERATURE

Indian women face economic and normative barriers to mobile phone access and use (GSMA, 2015). (Please see Appendix B for the full literature review.)

Economic Barriers

Women are disproportionately constrained by mobile handset and credit cost (Hafkin and Taggart, 2001; Intel, 2012; Potnis, 2016). Additionally, women are more likely to cite technical literacy and confidence as a barrier to mobile phone use. (Kumar and Prakash, 2016; Seshagiri, Aman, and Joshi, 2007).

Normative Barriers

Qualitative evidence suggests many fear that women's mobile phone use will enable promiscuous behavior or facilitate the breakdown of traditional Indian courtship norms (Allendorf, 2013; Arora and Scheiber, 2017; Bell, 2006). These purity and courtship norms may lead to supervision of women's phone use or other limitations (WWWF, 2015).

What is Missing?

While this gap in mobile phone ownership between men and women in India is well-documented, there is not much rigorous, causal research on why it exists. With a few exceptions, the literature also fails to address gaps in other aspects of mobile engagement, such as phone use. Furthermore, there is no research that teases out the relative importance and interdependence of economic and normative barriers. One objective of this research project is to fill these gaps in the literature in order to better support policies designed to address women's lagging mobile engagement.

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3 Human capital is typically an important input to economic activity (Becker, 1962), which is why we classify education-related barriers as economic.

4 Indeed, quasi-experimental research by Muralidharan and Prakash (2017) suggests that the past school enrollment gender gap in India is tied to patriarchal norms that constrain girls' ability to attend school outside of their village. Specifically, Muralidharan and Prakash (2017) find some evidence that the secondary school enrollment gap in 2006–2008 could be attributed to norms that hinder girls' mobility and independence. Although the school enrollment gap has closed in recent years (Office of the Statistics Division of the Ministry, 2016), this still might be relevant for older women who were of school age when the gap was prevalent.

5 On the other hand, it is also possible that dowry norms incentivize parents to invest in girls' education in order to reap returns on the marriage market. For example, an educated girl might match with a higher quality husband or the husband's family might demand a smaller dowry (Jayachandran, 2015). In other words, different gender norms could have competing effects.

The interlinked nature of economic and normative barriers makes it difficult to identify which barriers to target with policy. On the one hand, lifting economic barriers could subsequently change norms; on the other hand, addressing economic barriers could have little effect if phone use is dictated by norms and norms are persistent. For this reason, disentangling the causal relationships among economic barriers, normative barriers, and mobile phone ownership is critical for crafting effective policy to narrow the mobile phone gender gap. Identifying these causal pathways is difficult and beyond the scope of this report; rather, our Phase I analysis is designed to set the stage for targeted Phase II research studies that will be explicitly designed to provide causal evidence. (See Box 4 for more details.)

BOX 4 — WHAT IS CAUSAL INFERENCE AND WHY DO WE NEED IT?

Causal inference is a set of rigorous methods in empirical research that allows researchers to identify cause-and-effect relationships. These methods include either natural or controlled experiments, both of which entail random variation in a policy intervention, or treatment, among a group of people. This allows the researcher to attribute observed differences between the treatment and control group to the treatment itself, and not a confounding factor. In our project, causal inference will serve two main purposes:

To Disentangle Interlinked Barriers to Mobile Phone Access for Women

Our framework identifies three categories of barriers to women's mobile phone access: norms that directly impact mobile phone ownership, norms that indirectly impact mobile phone ownership, and economic factors. Identifying barriers is of considerable policy interest, especially in the case where lifting one barrier has a positive spillover on other barrier(s). Causal inference methods are well-equipped to do this in a rigorous way. Without such analysis, the relative effects of different policies that aim to increase women's mobile phone access will remain unknown.

To Identify the Ways that Women Benefit from Mobile Phones

While it is likely that mobile phones would benefit women, all rigorous evidence to date focuses on effects of mobile phones for men or uses majority male samples. Key unexplored benefits include access to social networks, labor market opportunities, and education. Understanding these benefits will help guide the design of future policies that intend to use mobile phones in order to make women's lives better.

In this report we begin our analysis by describing the spectrum of mobile engagement, characterizing gender gaps across the spectrum, and quantifying gaps across demographic groups in India. We then turn to our qualitative data to paint a rich picture of the key economic and normative barriers identified by Indian women and men. Next, we analyze existing secondary data to quantify the relationship between barriers and gender gaps. Finally, we discuss how the analysis from this report and our future impact evaluation(s) can inform policy.

2 Minding the Gaps

There are many ways in which individuals engage with mobile phones, and thus many ways in which women can fall behind. Recognizing this, we begin by using the Intermedia Financial Inclusion Insights (FII) data from 2015–2016 to map gender gaps across the spectrum of mobile phone engagement and across subpopulations.[6] Each wave of the FII dataset is a nationally representative sample of over 45,000 individuals and contains data on mobile phone ownership (including phone type), access, use, as well as a rich set of demographic variables.[7] Our analysis reveals that women lag behind men in almost every dimension of mobile phone engagement. Furthermore, we find that although there is important variation, the gender gap persists across demographic groups.

FIGURE 5 — TAXONOMY OF MOBILE PHONE ENGAGEMENT
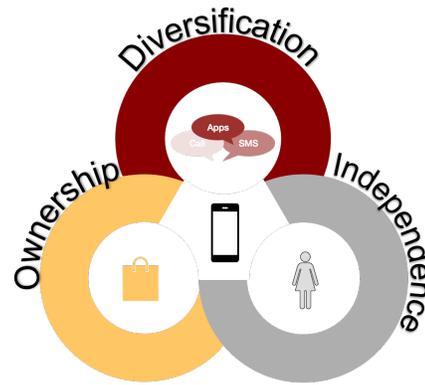
2.1 The Gender Gap and the Taxonomy of Mobile Phone Engagement

Figure 5 displays three interlocking factors that collectively determine the level of women's engagement with mobile phones. The first and second pillars of engagement capture the degree of autonomy a woman has when performing phone based tasks — first whether a woman *owns* her own phone (which will influence how frequently she can perform tasks) and whether she is able to perform these tasks *independently* (which may matter for both task frequency and the content of tasks like SMS and social media use). The third pillar of engagement is measured by the extent of *diversification* of the portfolio of tasks a woman typically performs on the phone. Tasks range from very basic operations like picking up or making calls through sophisticated tasks typically performed on smart phones, like using the internet and interacting with apps. In what follows, we explore women's mobile phone engagement along these dimensions pulling mainly from the FII data along with selected insights from our qualitative work.

Figure 6 summarizes gender gaps across a variety of aspects of mobile engagement, with the left bar graph showing male and female rates of engagement and the right bar graph showing relative gaps: the gender gap in engagement as a fraction of male engagement. The first two bars show that Indian women are much less likely to own or, more broadly, access a phone than men.[8] At 33 percentage points, the gender difference in mobile phone ownership constitutes nearly half of the level of male phone ownership.[9] In comparison, the phone access gap is 12 percentage points. Seen alone, the access gap estimate

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6   The full FII dataset contains repeated cross-sections for years 2013–2016. For data comparability reasons we constrain our analysis to pooled years 2015–2016. See Appendix A for more details.

7   The FII covers all states except Jammu and Kashmir.

8   We define phone access as either phone ownership or access to someone else's phone by borrowing or paying for its use.

9   As mentioned in Footnote 1, this estimate is twice as large as the estimate from the Pew Global Attitudes Survey. One reason for this may be that the Pew Survey asks "Do you own a cell phone?' while FII asks "Do you personally own a mobile phone? By personally I mean that you use it the most and control how to use this phone?' This underscores the difficulty of measuring ownership in contexts where women have weak control over household resources. Also, note that while both surveys are nationally representative, the FII dataset includes a richer set of variables about phone ownership and use. Moreover, the sample size is nearly seven times as large, which allows us to parse the data more finely in our analysis. Thus we use the Pew Global Attitudes Survey for broad, cross-country comparisons and otherwise rely on the FII dataset.

could suggest an overly optimistic picture of women's mobile phone engagement to see this, it is necessary to consider the two other pillars in Figure 5. First, 47% of the women who access a phone in the FII sample are phone borrowers rather than owners, as compared to 16% of men. For obvious reasons, borrowing a phone rather than owning one imposes practical limitations on diversification and independence. Moreover, results from our qualitative work suggest that diversification and independence constraints are especially binding given most women borrow from their husbands. The FII 2016 data are in line with this: 52% of female phone borrowers report borrowing their phone from their husband, while male borrowers are most likely to access a phone through their children.

The remainder of Figure 6 displays gender gaps in recent[10] use of various phone features, such as making calls or entertainment-based applications (e.g. watching videos). (Henceforth, apps is shorthand for applications.) We see that across Figure 6, women lag behind men with relative gaps growing with task sophistication: while the relative gap is between 15–20% for making and receiving calls, the gender gap jumps to 51% for a feature as simple as SMS and remains above 60% for other more complex activities such as social media. Overall, Figure 6 displays a clear gradient in the gender gap of mobile phone use, as activities range from basic to more complex.

Why does the gender gap grow with task complexity? Our qualitative discussions with phone users offer several potential explanations. Some women felt that they did not have the technical ability to perform complex tasks, or that they did not see a need to perform certain tasks (social media and YouTube, for example, were often seen as wasting time and a distraction from more pressing responsibilities). However, complex tasks were not just seen as a waste of time, they were also described in terms of propriety and decency vis-à-vis normative prescriptions of gender roles. In one respondent's words, whether or not a phone activity is *"good or bad depends on the way we are using our phone."* We find that there are three dimensions along which communities classify these activities as proper or improper, which could drive the gradient in Figure 6.

FIGURE 6 — GENDER GAP IN BASIC AND SMART PHONE FEATURES
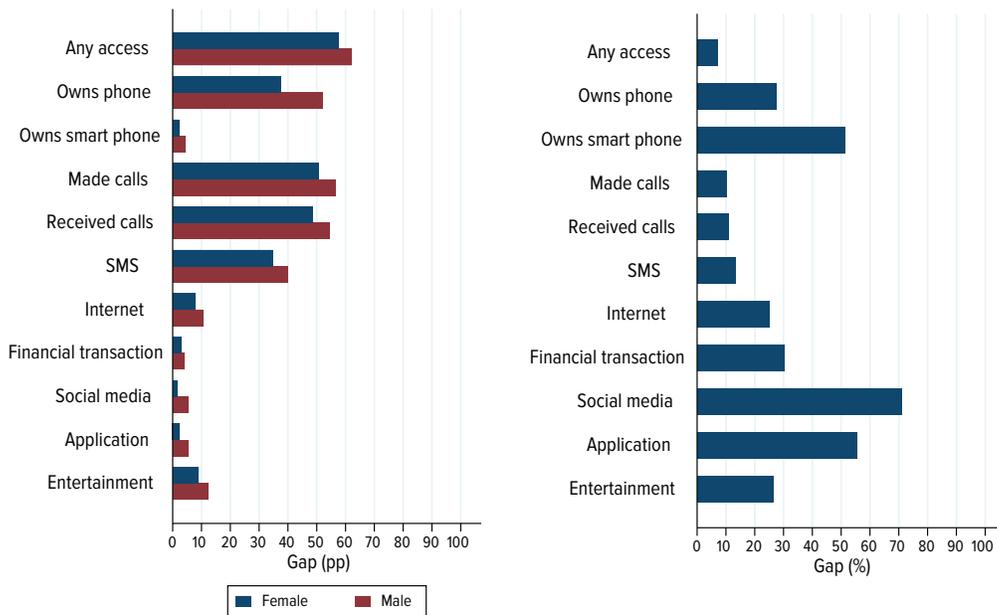
Source: 2016 and 2015 FII India data. Estimates pool years. Left panel displays the male–female gender gap in absolute terms (percentage points). To benchmark the estimates, the right panel displays the gap as a percentage of the level of mens' mobile phone engagement.

10 Meaning in the week prior to when respondent participated in the survey.

Purpose and Duration of Use. Our findings indicate that purpose of phone use and duration of phone use are gendered in the Indian context, with rules and expectations applying differently for females and males. Several respondents suggested that women should limit the amount of time they spend on their phones as well as limit their conversations to their specific needs. Even in our more conservative samples, it was considered appropriate to talk if the matter was urgent, related to work/school, and was limited to this specific purpose. Talking to family, using phones during a commute, using phones to discuss work or studies were thus considered appropriate uses of mobile phones for women. Importantly, these parameters seemed to be set and enforced by the community. For instance, if a girl chatted on the phone with a boy for a long period of time or in a light-hearted manner, the community might become suspicious that they will develop a relationship.

Location of Use. Across our sample, women were encouraged to use their phones inside the house. Especially in Madhya Pradesh and Maharashtra, there was a strong preference for women to use their phones inside the house as a measure to avoid community suspicion about what they were using their phones for. This is true even if they were speaking with their family members or if they had a good reputation: *"If she is on the phone [for 1-2 hours], then people will wonder what she is doing, and that reflects on her character. If she is not that type, then also they will think like this."* At the same time, we found a strong preference for women using their phones in front of family members while within the household. In a focus group discussion with college students in Maharashtra, for example, respondents suggested that women had to share their passcodes and could not hide their phones from their families. This suggests a preference for women's use to be supervised, and at the same time, not public.

Content Visibility. In our discussions of social media, women expressed a strong preference for relationship-driven services like WhatsApp, instead of more open access services like Facebook, which open women up to being contacted by a network of friends-of-friends and strangers. For this reason, most female respondents who owned a smart phone were active WhatsApp users, but did not use or upload pictures onto Facebook. A 20-year-old respondent from West Bengal expressed her preference for WhatsApp over Facebook because: *"many unknown people send friend requests on Facebook; they post bad comments on my post [and] send bad photos. That doesn't happen with WhatsApp."* A young, married female respondent from Madhya Pradesh justified her use of Facebook by telling us that she is only friends with some of her relatives — when we asked her if she has added her childhood friends, she said *"I have children, and a family. If I talk to [my childhood friends,] there may be an unnecessary argument in the family."* These fears were echoed by older respondents, who also pointed out that the access to inappropriate content on social media creates an unsafe environment for young female users who must be careful that their phone use doesn't harm their reputation or purity. For instance, an older female respondent from West Bengal claimed that *"everyone is using Facebook"* but not everyone is *"doing bad things."* Nevertheless, the environment exposes women to others' inappropriate actions: *"they will watch all those dirty photos."*

This discussion suggests that normative barriers may be especially important for limiting women's mobile use conditional on technical ability or other economic barriers such as cost. We return to this idea in Section 3, after discussing how the gap varies across geographies and demographic segments.

2.2 The Gender Gap Landscape

India is a remarkably diverse country — average gender gap estimates therefore obscure important heterogeneity across space and demographic groups. Exploring this heterogeneity may help illuminate barriers to women's phone use. In order to study different demographic sub-populations, we identified a key set of socio-demographic characteristics that commonly predict variation in women's well-being relative to men's: poverty status, urbanicity, marital status, education level, and age.[11] In this section, we focus attention on phone ownership, a fundamental aspect of mobile phone engagement. Figure 7 graphs the phone ownership gap across demographic segments. Each bar represents the difference in percentage points between male and female rates of ownership for the relevant subpopulation.[12]

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11 We define an individual's poverty status as either above the poverty line or below the poverty line. In order to do this, we use the Grameen Foundation's Progress Out of Poverty Index already calculated by the FII team and included in the dataset. Note that the poverty line is defined as $2.50/day, PPP.

12 For the sake of brevity, we included only a few key combinations based on which produced the most variation.

FIGURE 7 — SEGMENTATION ANALYSIS OF GENDER GAP IN PHONE OWNERSHIP

Segmented by Poverty, Urbanicity, Marital Status, Education, and Age
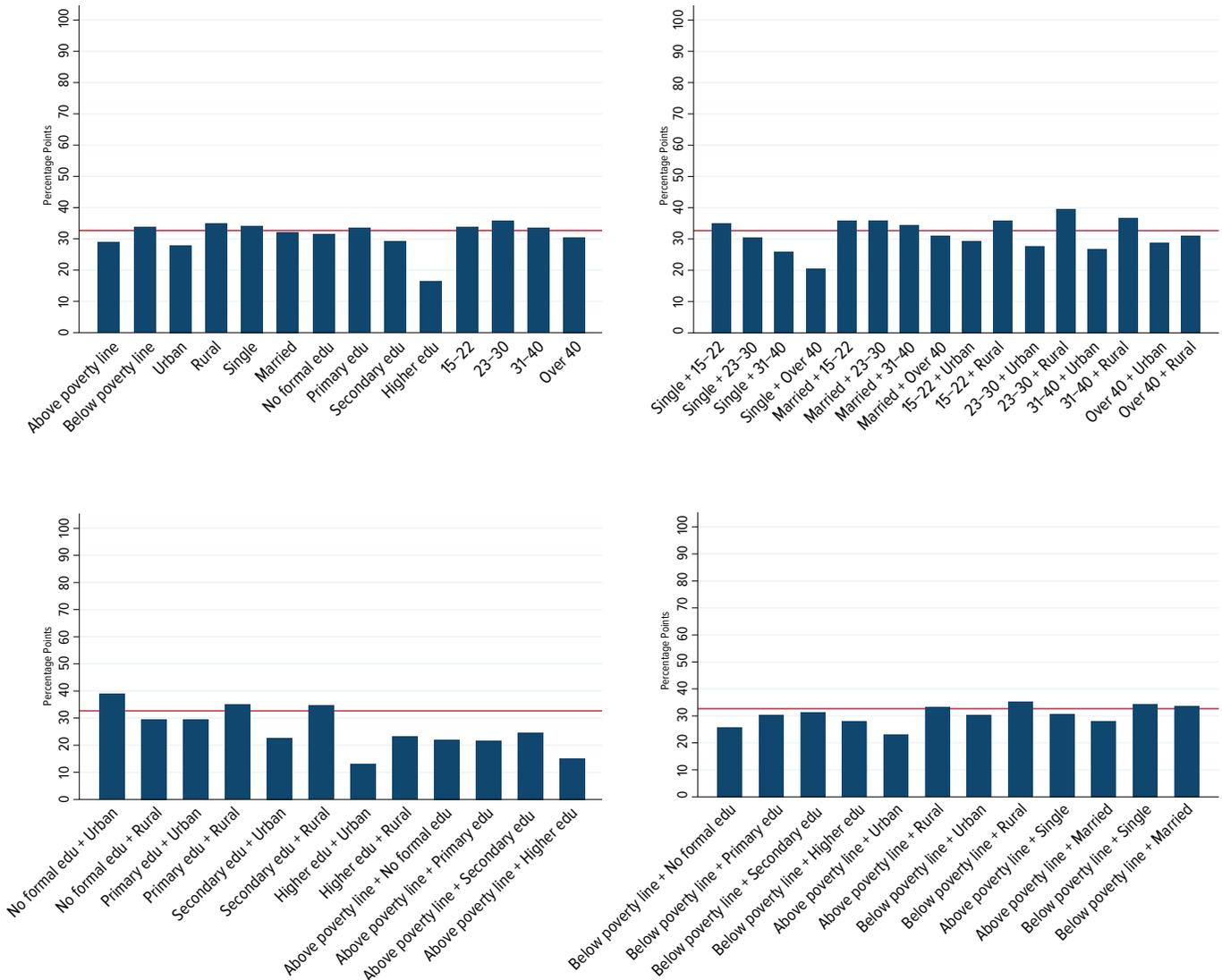
While there is some variation, the gap persists across all groups. At its lowest, the gap remains at 10 percentage points for women versus men with higher education living in urban areas. This gap practically doubles for those with higher education living in rural areas, which is indicative of a broader pattern: rural areas tend to have persistently higher gaps than urban areas.[13] Our qualitative work echoes this observation: in our rural samples, respondents

indicated a strong community sentiment against women's phone use or ownership, while respondents in the urban samples expressed more muted sentiments. A similar but less dramatic pattern emerges when comparing groups above and below the poverty line: poorer segments have higher gaps. In contrast, marital status yields little variation in the gap, except when combined with age. In particular, the gap decreases for single women as they get

13 In fact, the group with the highest gender gap in this analysis is rural men and women aged 23–30 years.

older, but not as much for married women. All together, we see that the gender gap is persistent for a variety of demographic cuts, which suggests that none of these demographic characteristics are the central cause of the gender gap. In other words, there is room for other explanations (such as social norms) to explain the gaps that remain for even the most equitable subpopulations.

To complement the segmentation analysis, we also investigate how the gap varies across India's physical landscape in Figure 8.[14] On its own, Figure 8a suggests that economic development facilitates phone ownership: wealthier states in the Northwest and South tend to exhibit higher rates of male phone ownership. Yet Figure 8b shows a much weaker gradient for women. Female phone ownership is low across most states regardless of economic development, especially in Iaryana and Rajasthan. Moreover, Figure 8c demonstrates that many of the wealthier states in the Northwest and South regions have some of the largest gender gaps in phone ownership. Evidently, living in a wealthy area is not enough to guarantee women's phone access or to close the gender gap.

What explains this geographic variation, if not economic development? While the gender gap is highest in the Northwestern states and somewhat high in the South East, it is lowest in Kerala and the Northeastern states. Some population groups in Kerala and the Northeastern states practice matrilineality, which indicates less restrictive social norms (Jayachandran and Pande, 2017). In contrast, past literature and our own qualitative research suggest that states in the North tend to be more conservative and traditional than those in the South (Rahman and Rao, 2004; Rammohan and Vu, 2017). The variation in Figure 8c is roughly parallel to this, which suggests that gender norms could have explanatory power. In the next section we explore this possibility at length and discuss more specifically how gender norms emerge in the context of women's phone ownership.

FIGURE 8 — STATE HEAT MAPS OF PHONE OWNERSHIP

Source: 2016 and 2015 FII India data. Estimates pool years.

(a) Male Ownership (%)

>80
70-80
60-70
50-60
40-50
30-40
20-30
10-20
<10
No data

(b) Female Ownership (%)

>80
70-80
60-70
50-60
40-50
30-40
20-30
10-20
<10
No data

(c) Gender Gap in Ownership (pp)

>40
30-40
20-30
10-20
<10
No data
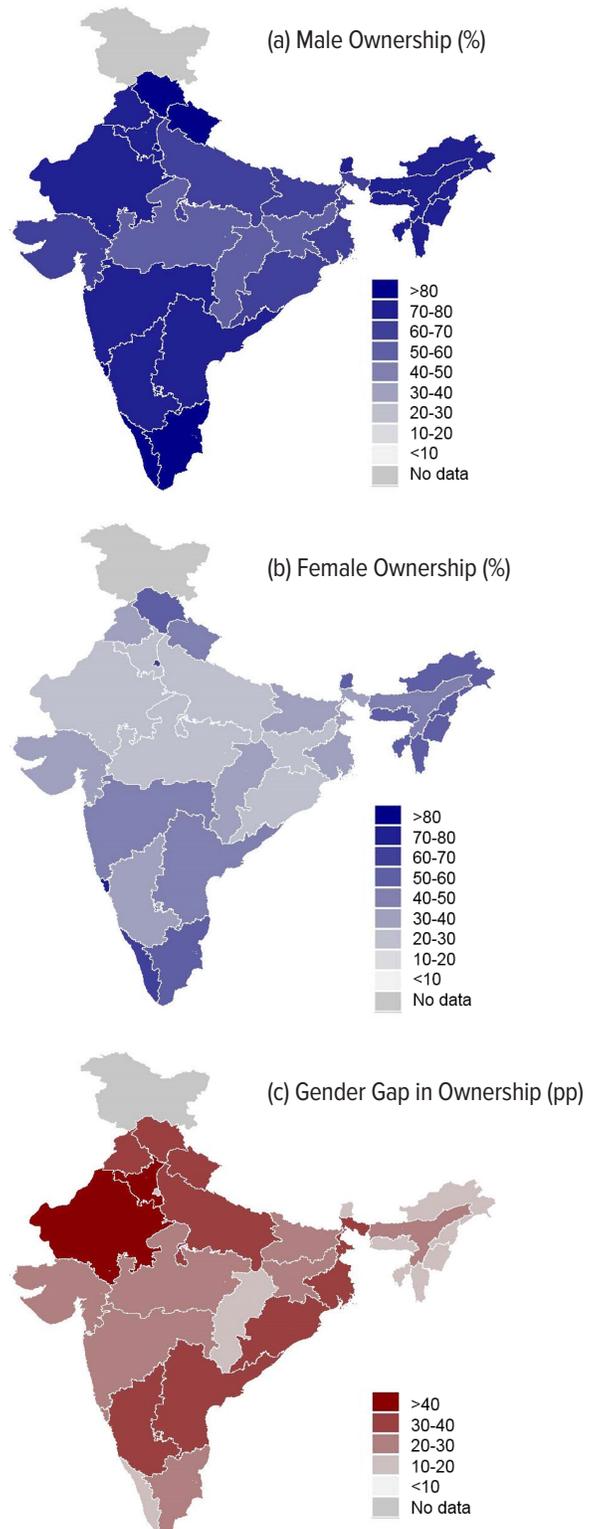
14 The FII dataset groups several states in Northeastern India (Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, and Tripura) as one cluster which is reflected in the heat map.

3 Gender Norms and Mobile Phones

In order to understand the cultural and social factors limiting female phone engagement, our qualitative research team spoke with 125 individuals across 7 study sites. Before delving into the results of these discussions, it is necessary to put more structure on the nature of norms, both conceptually and in our Indian context.

Most broadly, social norms, of which gender norms are a subset, are a grammar of social interactions that outline behaviors or beliefs that society deems acceptable (Bicchieri and Muldoon, 2014). This is the definition that we use in Section 3.1. Yet this broad definition does not specify how social norms evolve or how they relate to individual beliefs. To make progress on this dimension, we follow Tankard and Paluck (2016): *personal beliefs* refer to individuals' personally-held opinions and actions, *actual norms* represent the average set of behaviors or beliefs among some reference group, and *perceived norms* are what people perceive to be the average set of behaviors or beliefs among the reference group. (See Box 5 for more detail.)

3.1 Gender Norms in India

Traditional Indian society is highly patriarchal, with strong norms governing many aspects of women's lives. Our literature review identified four key norms that could limit women's and girls' use of mobile phones. These include maintaining purity for marriage, patrilocal exogamy (women go to live with their husband's family upon marriage), subservience, and prioritization of caregiving.

We briefly summarize these gender norms in Box 6 in order to contextualize our qualitative findings in the next section.

BOX 5 — WHAT IS A SOCIAL NORM?

A **social norm** is a grammar of social interactions that outlines behaviors that society deems acceptable (Bicchieri and Muldoon, 2014).

The Tankard and Paluck (2016) Framework
Actual norms represent the average set of beliefs or behaviors among some group, while *perceived norms* are what people perceive to be the average set of beliefs or behaviors among some group. These are distinct because individuals often do not know the distribution of actual norms in society; ample evidence shows that individuals base their perception of what is normal in their relevant social groups rather than the overall distribution. Tankard and Paluck (2016) further argue that these perceptions are more directly malleable than individual beliefs or behaviors. People tend to behave in line with whatever they perceive the norm to be, often times regardless of their *personal beliefs*. This is important because in this way, perceived norms are a vehicle for social change. From this framework, a theory of how norms change emerges: by shifting perceptions of which attitudes and behaviors are typical or desirable (i.e. perceived norms), one can influence actual behaviours down the line (i.e. actual norms).

BOX 6 — AN OVERVIEW OF GENDER NORMS IN INDIA

Pre-Marriage

Purity for Marriage

Girls should remain chaste and pure for their husbands before marriage (Jayachandran, 2015; Radhakrishnan, 2009; Vijayakumar, 2013; Parameswaran, 2004)

↓

Behavioral consequences: constrained physical mobility due to safety concerns (Muralidharan and Prakash, 2017), reduced access to education (Muralidharan, 2013)

Subservience

Girls are expected to obey and follow the wishes of their parents for marriage arrangement (Jejeebhoy and Sathar, 2001; Sonalde et al., 2010), and their in-laws and husband once married

↓

Behavioral consequences: limited say in who or when they will marry (Vijayakumar, 2013), restricted role in household decisionmaking (Jejeebhoy and Sathar, 2001).

Post-Marriage

Patrilocal Exogamy

Women move in with in-laws and obey wishes of husband and his parents (Arnold, Choe, and Roy, 1998; Dyson and Moore, 1983; Gupta, 1987)

↓

Behavioral consequences: decreased ties with natal family (Sonalde et al., 2010), constrained physical mobility (Jejeebhoy and Sathar, 2001), reduced investment of household resources toward daughters (Alfano, 2017; Agnihotri, Palmer-Jones, and Parikh, 2002; Jejeebhoy and Sathar, 2001), son preference and skewed male to female sex ratios (Jayachandran and Pande, 2017; Ramaiah, Chandrasekarayya, and Murthy, 2011; Murthi, Guio, and Dreze, 1995)

Caregiver First

A women's primary role in society is seen as a caregiver, prioritizing caring for her husband, her in-laws, her children, and general maintenance of the household (Sharma et al., 2013; Jejeebhoy and Sathar, 2001)

↓

Behavioral consequences: low labor force participation (Chen, 1995; Vijayakumar, 2013), inability to leave spouse despite abuse or violence

3.2 Gender Norms as Barriers to Women's Engagement with Mobile Phones

Our conversations with 125 women and men across 5 states (see Figure 9) reveal that the gender norms outlined in Section 3.1 present normative barriers to women's mobile engagement. Based on a qualitative analysis of these conversations, in this section we describe how and why these normative barriers form.

FIGURE 9 — QUALITATIVE INTERVIEW SITES

South & East Delhi, Delhi
- 16 women, 1 man
- Urban population
- Centred around the city
- Age range: 26 – 50 years
- Domestic workers, micro-entrepreneurs

Gwalior, Madhya Pradesh
- 23 women, 16 men
- Rural population
- Disjoint from the main city
- Range: 19 – 65 years
- Mostly housewives

Amravati, Maharashtra
- 23 women, 4 men
- Urban and peri-urban population
- Centred around the main city
- Age range: 16 – 54 years
- Mostly micro-entrepreneurs working from home

Kolkata, West Bengal
- 18 women, 3 men
- Sub-urban population
- Easy access to the main city
- Age range: 17 – 45 years
- Mostly business/shop owners with their husbands

Thanjavur and Ariyalur, Tamil Nadu
- 18 women, 3 men
- Rural population
- Connected to main town area
- Age range: 21 – 52 years
- Private/government jobs, shop owners and housewives

Our team interviewed 98 women and 27 men, both individually and as groups. The main analysis sample is composed of 66 transcripts that were recorded, transcribed, and coded. We have field notes from the 14 remaining unrecorded interviews, which were also coded and used in the analysis. These field notes cover interviews with respondents who did not consent to their interviews being recorded. For more details about each interview site, see Appendix Section C.

3.2.1 Methodology: Qualitative Data Collection and Analysis

The research team employed a semi-structured approach to qualitative interviews, which were typically 40–45 minutes long and took place in an environment familiar to the respondent — usually their home or shop. Interviews began by introducing the research team, obtaining informed consent, and collecting demographic data on respondents and their families. This was followed by a series of questions about phone ownership, access, and usage for the respondent and his/her family. The final part of the interview asked respondents about norms around mobile ownership and use in their community. Starting from general questions about mobile ownership, we gradually probed respondents about gender differences in phone engagement and why they think these differences exist. In addition to individual interviews, we also conducted

some focus group discussions in order to better understand the prevailing norms and usage patterns from particular profiles of respondents (e.g. college students, married women, young unmarried men). In sum, we conducted 65 individual interviews and 15 focus group discussions with a total of 60 participants. All interviews were recorded and transcribed from the local language to English before performing analysis.

We began our analysis by open coding several interviews in order to develop a coding framework for the entire set. From this procedure, we grouped codes into four broad themes: phone ownership, phone use, norms, and empowerment. Next, in order to code the entire set of transcripts, we used Dedoose [v. 7.6.24] and the indexing technique, which systematically applies the codes from the agreed analytical framework to the whole dataset (Gale et al., 2013).[15] In addition to categorizing transcripts by themes,

we used socio-demographic descriptors such as gender, site, marital status, and age to categorize the respondent. This two-dimensional structure of analysis allowed us to see how the themes varied by demographic characteristic. Finally, to analyze the data, we read all the quotes within a given code and descriptor before discerning any patterns that emerged. In what follows we present the results of our analysis of the normative and economic barriers faced by women in our sample.

Mobile phones are viewed as a risk to women's reputation. Perhaps the strongest normative barrier that emerged over the course of our qualitative work is that phones — and the access to others that they facilitate — threaten the purity of women and girls. Phones are viewed as a potential risk to women's reputations in multiple ways, which emerge differently across our sample: most respondents in rural Madhya Pradesh and some in urban Maharashtra associated women's ownership and use of phones with promiscuity, while most respondents in Maharashtra, West Bengal, Tamil Nadu and Delhi expressed concerns about mobile and digital harassment as threats to women's reputation.[16] Across our sample, we find that the risk to reputation is the highest for girls in the pre-marriage age group, but the implications of this norm varies from context to context. For example, in our most conservative field site (rural Madhya Pradesh), most individuals stated that women should not own phones before marriage: a young married respondent cited the reason that *"they will get bad because they will make boyfriends."* In other sites women were allowed to own phones before marriage, but faced restrictions on uploading their pictures on Facebook, spending too much time on their phones, or using their phones outside the home.

While respondents would acknowledge that inappropriate premarital relationships required the involvement of a boy and a girl, the social costs of violating purity norms fall almost exclusively on girls. This was even true in cases of digital harrassment, where typically the male was fully responsible for romantic pursuit. This indicates that women's reputation, which is inextricably tied to their marriageability, is considered fragile and needs protection, while on the other hand, men's reputation is considered sturdy and is not affected by concerns about their marriageability. As noted by an unmarried respondent in Maharashtra *"It is said in our community that girls are like earthen pots and boys are like metal pots. Boys remain strong, but girls are easy to break."* This fragility associated with women's reputation was echoed among several male respondents across the sample.

Concerns about pre-marriage ownership and use very much stemmed from worries about what other members of the community might think of a girl with a phone. For example, a 20 year old college student in Maharashtra articulated the pitfalls of talking on the phone in public as follows: *"When a girl is talking on the phone, they will surely think she is talking to a boy. They never understand that a girl could be talking about her schoolwork."* This worry about community perceptions was internalized primarily by parents of girls. Within the community, parents are held responsible for their daughter's actions since they oversee her upbringing. For example, several respondents in Tamil Nadu and Delhi said that community members complain to mothers about their daughters' behavior or when gossiping about the girl, blame her upbringing. Pressure for parents to enforce norms is magnified by the fact that parents are responsible for finding a suitable husband for their daughter. In some instances, young women themselves regulated their behavior by limiting mobile based activities that are deemed inappropriate by the community. For example, an unmarried woman in Maharashtra expressed discomfort with using phones for social media because it may hurt her marriage prospects if she is seen uploading photos. In an extreme case, the norm against unmarried girls' phone use materialized as a law. A member of a local community organization in a village in Madhya Pradesh explained that they have instituted a fine for families who allow their unmarried daughters to own phones, enforced by a committee of men: *"unmarried girls should not have a phone. This committee will charge a fine of 5,000 on the first offense, 11,000 on the second offense, and outcast the household on the third offense."*

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15 All transcripts were transcribed into English and quality checked. Coding took place over 4 weeks and was checked by one lead researcher to ensure consistency among coders.

16 These patterns also emerge in the anthropology and sociology literature, with phones reportedly characterized as responsible for the "breakdown of traditional courtship patterns" (Bell, 2006), elopements (Allendorf, 2013), and turning women into "sluts" (Allendorf, 2013). There have also been cases of backlash against women's use of technology in response to digital harassment (Masika and Bailur, 2015; WSJ, 2016). Importantly, many of the social norms discussed here are also central to the discussion on mobile internet specifically, as in a recent GSMA report from 2017. See Appendix Section B for a more detailed synthesis of the literature on these topics.

For married women, caregiving takes precedence over phone use. Purity concerns ease somewhat after girls marry, with the practice of patrilocal exogamy generating a new rationale for phone use — a new bride can use the phone to communicate with relatives in her natal village or her husband. A respondent from Delhi suggested that *"marriage gives the individual a license in the society,"* suggesting that the community places a significant amount of trust in the institution of marriage. A respondent from Maharashtra said: *"After marriage nobody minds her having a phone because she has a different family…and in her newly married life, she will get calls from different people; in the beginning everyone wants to communicate with each other and ask about one another."* In fact, several respondents suggested that it was becoming common to get a phone as a gift in marriage, instead of traditional items such as jewelry.

However, even though marriage eases pressures from purity norms, it also introduces new barriers tied to the "woman as caregiver" norm — here, prolonged public use of phones can send a signal that a woman is not properly caring for her family. Several respondents across our sample said that people in the community tend to comment on married women using their phones, particularly when they are seen using their phones for long hours; respondents in Maharashtra and Tamil Nadu specified that a woman's phone use indicates to the community that she is not focused on housework. At times the media reinforced these community perceptions: one respondent gave the example of a video of a child's hand getting stuck in an elevator because the mother was busy on her phone.

Caregiver norms also indirectly suppress women's use of phones by limiting the extent to which women engage in productive activities outside the home. Across our sample, we find that women who work or study, and thus commute outside their homes, can justify owning a phone to the community. In fact, most women considered phones a necessity for safety during their commute. Here normative barriers that suppress women's labor supply or educational attainment intersect with entry points that define individuals' perceived returns to phone use.

Normative and economic barriers intersect. Our conversations with men and women also reveal how gender norms mediate economic barriers to mobile phone ownership. This is clearly the case for women with limited technical literacy, who must depend on their husbands and sons to assist them with phone features. Women were often resigned to this fact. As one respondent stated *"If my son teaches me how to save contacts, I will learn. But for now, I don't want to waste my time thinking about it. My son will do it for me."* This was especially true in contexts like Madhya Pradesh where women had little education. This dependency often impedes women's learning, as their husbands or children may not have the time or interest to teach them.

Norms also mediate how households address the problem of handset cost — though cost was not the primary reason most women cited for not owning a mobile phone, women often restricted access to phones in an effort to save the household money. This came through in multiple ways, including an expressed preference for basic rather than smartphones, as a rationale for sharing a household phone instead of purchasing a separate phone for the woman, and in limiting use of airtime and data credits. Implicit in these behaviors is the notion that women should be putting the needs of the household before their own desires. Moreover, if women did want to purchase a phone, they rarely had the authority to do so on their own. Few female respondents bought their phones from their own earnings — either because they did not have any or they did not have decision-making authority over household expenditures. Rather, it was common for women to be gifted phones by their husbands, brothers, or fathers.

4 How Do Norms Compare? The Mobile Phone Gap over a Woman's Lifetime

Section 2 provided suggestive evidence that interlinked normative and economic barriers impede women's mobile phone engagement. In Section 3 we discussed how normative and economic factors hinder female engagement. How much of the gender gap can these barriers account for and how do they measure up against each other? Now we turn to survey data to quantitatively answer this question.

One difficulty is that most large-scale, representative datasets lack viable proxies of normative barriers. We use the Indian Human Development Survey (IHDS), a nationally representative household survey conducted in 2012. Although the survey is over five years old, its strength is that it measures individual and household-level phone use and includes a suite of variables that can plausibly proxy for important normative barriers.

Yet challenges remain: the IHDS only measures individual phone use, not ownership, and was not expressly designed to measure gender norms. There are no questions that directly ask about appropriate behaviors or social roles for women, and furthermore, questions are not designed to differentiate between personal beliefs and norms. Rather, the survey was designed to measure various aspects of women's empowerment, which we use to proxy for gender norms. Broadly, we focus on proxies that capture the consequences of gender norms enumerated in Box 6. We first group proxies into four families: The *economic engagement* family includes measures of past, current, and latent labor supply as well as a measure of the woman's ownership over her home, her access to a savings account, and her possession of spending money.[17] The *decision making* index includes measures of self-reported decision-making power and measures of the woman's involvement in her marriage.[18] The *mobility* index includes measures of whether the woman has been to other localities or abroad in the past five years. The *community attitudes* index includes measures of whether it is typical for men to beat their wives over various matters in the woman's community and a measure of the extent to which unmarried girls are harassed in the community — this index comes the closest to directly capturing perceived norms, as the questions ask women to report what others in their community think and do. We also take the average of all index components to create a single overall index of women's empowerment.

Since we are especially interested in drivers of gender gaps, we limit our attention to households with at least one mobile phone and ask whether women use the phone.[19] The overall analysis is split into two main components. First, to gain initial insight on how the transition into marriage influences women's phone use, we study how the gender gap varies with age. Then we study the relationship between female phone use,[20] the empowerment proxy, and other demographic and economic characteristics. Since the survey only administered the empowerment module to married women aged 23–49, we limit our attention to this subgroup in the analysis.

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17 Latent labor supply refers to women who are not working but say they would take a job if offered a suitable one. Indices are created by demeaning and standardizing each index component and then taking the average of all standardized components. This way all indices have a mean of zero and a standard deviation of one.

18 Marriage involvement measures include a measure of how long the woman knew her husband before marriage, and whether she met, spoke with, saw a photo, or messaged with her husband before the marriage. Women involved in the decision to marry tend to come from more progressive households.

19 Results are very similar if we limit the sample to women whose husbands use a mobile phone or consider all women and ask whether they use a mobile phone. (See Appendix D.)

20 This variable is binary and equal to one if the female respondent uses a mobile phone. As alluded to previously, we limit the sample to households that own a mobile phone, so this variable roughly reflects within-household equality of mobile phone use.

4.1 Pre-Marriage Norms: The Gap Emerges

Our FII segmentation analysis shows how the gender gap in mobile phone ownership persists across demographic cuts, including age groups and marital status (Figure 7, Section 2.2). One limitation of the FII data is that it collects data from adults aged 15 and older. In contrast, the IHDS collects phone use data down to the age of 10, which lets us track the evolution of the gender gap as girls approach adolescence. Figure 10 graphs the share of males and females who use a mobile phone across ages 10–65 alongside the share of females who have ever been married. The male-female gap in mobile use emerges as girls enter puberty and widens as they become more likely to marry. This is consistent with the idea that as girls become more likely to marry, courtship and chastity norms that constrain phone use become increasingly salient. The gap persists after women marry. By adulthood (age 18), the mobile gender gap is 21 percentage points, and continues to grow with age. This persistence suggests that lower post-marriage barriers from purity norms are offset by new pressures on women to take care of their families.

Overall, this analysis shows how the gender gap varies over the course of a woman's lifetime as normative barriers to phone use evolve leading up to and through her marriage. In spite of phones becoming more common and gender gaps in school enrollment eroding since 2012, the gap in mobile use for adolescents persists to this day: among 14-18 year olds, boys are 10 percentage points more likely than girls to have ever used a phone (Pratham, 2017).[21]

FIGURE 10 — MOBILE PHONE USE BY GENDER AND AGE

Source: IHDS, 2011-201
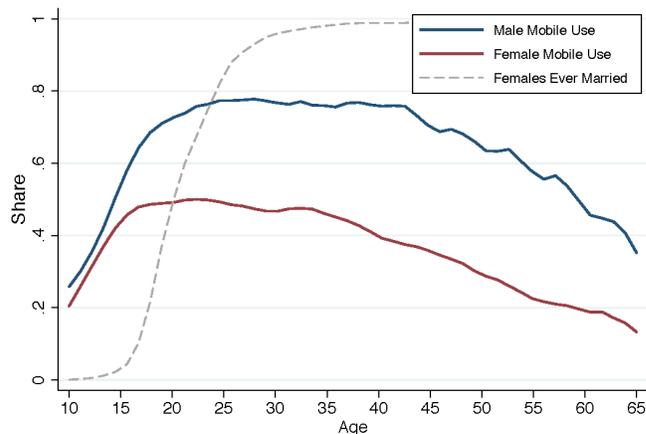
4.2 Empowerment Matters for Married Women, Even After Accounting for Income

Our qualitative data and secondary data analysis pointed to norms, income, and education as central barriers to women's mobile phone use. We therefore focus on these factors in an ordinary least squares regression framework while controlling for other background factors. We begin by graphing the relationship between women's mobile inclusion (the share of women using a mobile phone in households that have at least one mobile phone) and deciles of the overall empowerment index, income deciles, and educational attainment in Figure 11.[22] Broadly, the results are consistent with our findings throughout the entire report: women's mobile phone use increases significantly with all three factors.

Yet Figure 11 does not account for the fact that empowerment, income, and education are interlinked: as one variable increases, the other two also increase. Thus we cannot tell which of the variables is primarily responsible for the pattern that we see. In order to make progress, we refine

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21 Unfortunately, this sample is not nationally representative, so we do not analyze these data further.

22 We derive these estimates from regressions of women's mobile phone inclusion on empowerment, income, and education groups. Each bar except the first represents the (predicted) probability of mobile phone use for the relevant group. Whiskers give 95 percent confidence intervals on the difference between the average value for a given group and the average value for the lowest group. See Appendix Section D for more details.

our regression analysis in Figure 12 to hold other factors constant while looking at the same relationships.[23]

After holding demographic and economic factors constant, mobile phone inclusion still increases with empowerment,

although the gradient is less steep than in Figure 11. This suggests that women's empowerment and these demographic and economic factors are indeed related. Nevertheless, empowerment remains independently important and statistically significant. Furthermore, the

FIGURE 11 — MOBILE PHONE USE CONDITIONAL ON HOUSEHOLD HAVING A MOBILE PHONE (NO CONTROLS)
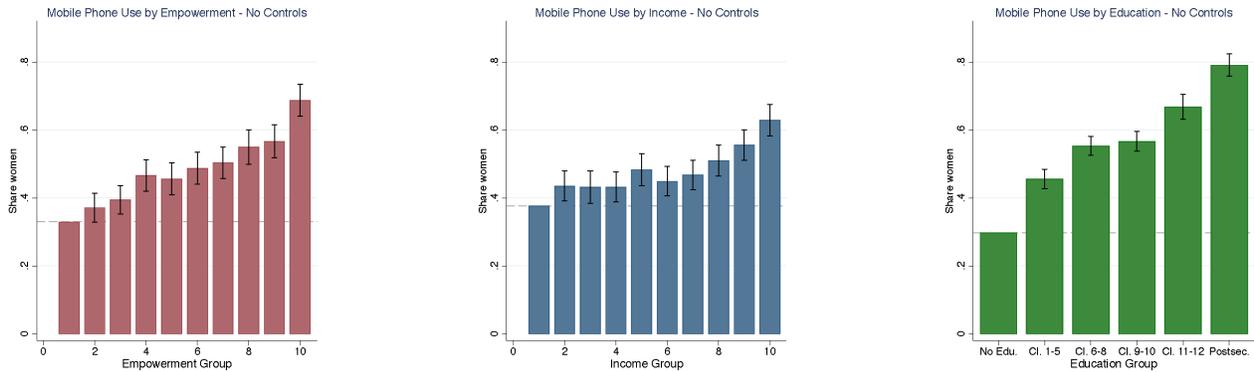
Source: IHDS, 2011-2012.
Notes: These estimates are from regressions of women's mobile phone use on empowerment deciles, standardized income deciles, and educational attainment (6 levels). Each bar represents the predicted probability of mobile phone use for the relevant group: the first bar is the average mobile phone use for women in the lowest group, and the remaining bars are the coefficients on the relevant decile/level added to the mean of the lowest group. Whiskers give 95 percent confidence intervals on the difference between the average value for a given group and the average value for the lowest group. Standard errors are clustered at the primary sampling unity level. Sample weights are applied such that the estimates are representative at the national level.

FIGURE 12 — MOBILE PHONE USE CONDITIONAL ON HOUSEHOLD HAVING A MOBILE PHONE (WITH CONTROLS)
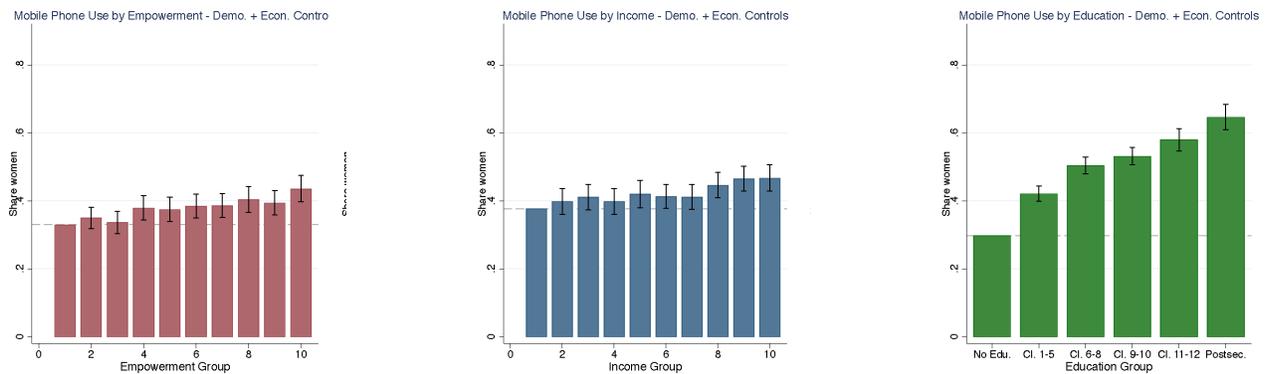
Source: IHDS, 2011-2012. Notes: These estimates are from regressions of women's mobile phone use on empowerment deciles, standardized income deciles, and educational attainment (6 levels). Each bar represents the predicted probability of mobile phone use for the relevant group: the first bar is the average mobile phone use for women in the lowest group, and the remaining bars are the coefficients on the relevant decile/level added to the mean of the lowest group. Whiskers give 95 percent confidence intervals on the difference between the average value for a given group and the average value for the lowest group. Controls include empowerment deciles, standardized income deciles, and educational attainment, age, age squared, number of years married, number of children, Scheduled Castes and Scheduled Tribes, household assets, whether the respondent lives in an urban area, and primary sampling unit fixed effects. Standard errors are clustered at the primary sampling unity level. Sample weights are applied such that the estimates are representative at the national level.

23 Empowerment regressions control for income decile and education, income regressions control for empowerment decile and education, and education regressions control for empowerment and income deciles. All regressions also control for age, number of years married, number of children, whether the respondent is a Scheduled Caste or Scheduled Tribe, household assets, and whether where the respondent lives is urban. Again, see Appendix Section D for more details.

magnitude of the relationship is meaningful. Women's phone use increases by 10.6 percentage points between the first and 10th decile of women's empowerment, while income is associated with a 9 percentage point increase in mobile inclusion between the first and 10th decile, after controlling for other factors. Thus, empowerment matters just as much as income, holding a variety of other demographic characteristics constant. This reaffirms an important theme emerging from our findings: apart from other factors, gender norms (as proxied by women's empowerment) directly relate to the mobile phone gender gap. It is important to note that the largest differences appear by education: women with a class 11-12 education are 28 percentage points more likely to use a phone than women with no education, holding empowerment, income, and other factors constant. This steep gradient likely reflects technical literacy, as well as economic and normative factors that are correlated with education and not adequately captured by our other controls.

Table 1 delves more deeply into the relationship between the empowerment proxy, income, education, and mobile inclusion. The first column studies the relationship between women's mobile inclusion and the empowerment proxy, here entered linearly. This means that the regression coefficient can be interpreted as the change in mobile inclusion associated with a one standard deviation increase in the empowerment proxy. The second column adds controls for the same set of demographic and economic factors included in Figure 12. The last three columns add additional controls for state-specific, district-specific, and finally locality-specific[24] factors. It should be noted that norms are —to a certain extent — commonly held within local geographic areas.[25] In this case, the district and locality controls may soak up some of the influence of norms, and we would expect the coefficient on the empowerment index to decline. In practice this does not occur, which suggests that individual practices and beliefs are also important determinants of women's mobile inclusion. Overall, our most conservative estimate indicates that one standard deviation increase in the empowerment index is associated with a 3.1 percentage point increase in mobile

phone use (Column 5). Notably, this is larger than the percentage point increase in women's mobile phone use indicated by the coefficients on income per capita (1.4) and household assets (2.9), though only the difference with the income index is statistically significant. The table also makes it clear that education remains the largest predictor of women's mobile use: column 5 shows that women with post-secondary schooling are 32 percentage points more likely to use a phone as compared to women with no education, holding all other factors constant. This is striking, especially given that all households in our sub-sample own at least one phone.[26]

In order to understand what specific components of empowerment are at work, we split the empowerment measure into its sub-components and perform the same analysis (Table D3 in Appendix Section D). We find that there is no single empowerment component driving the results: without geographic controls the only sub-component that is not significantly related to mobile inclusion is decision-making, while all four sub-indices are significant once geographic controls are included. Coefficients on all sub-indices except decision-making attenuate as geographic controls are included, which is consistent with the notion that these sub-indices do capture some aspects of gender norms. More broadly, these results suggest that normative barriers are complex and manifest themselves in multiple aspects of women's lives.

Overall, our IHDS analysis suggests that normative barriers are both statistically and quantitatively important determinants of women's mobile phone use, but that economic factors — particularly education — matter as well. A key caveat here is that our results are only indicative of correlations (sometimes conditional on other factors) — they need not reflect the causal effect of lifting a given barrier on women's mobile phone use. Hence our assessment is that observational data strongly points to gender norms as an important driver of the mobile gender gap; however, additional research is needed to quantify the causal effects of policies and interventions designed to target these barriers.

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24 We use fixed effects analysis that controls for all factors that are constant within a locality and vary across localities.

25 In practice some norms will be more granular — if, for example, the reference group is community members in one's locality of the same caste and some norms may be more widely held.

26 To ensure robustness, we perform the same analysis with two similar outcome variables — women's mobile phone use and women's mobile phone use conditional on her husband's phone use (Tables D4 and D5 in Appendix Section D). Results are similar, therefore indicating our main results are not sensitive to outcome variable specification.

TABLE 1 — FEMALE RESPONDENT USES PHONE (CONDITIONAL ON HOUSEHOLD HAVING A MOBILE PHONE)

	(1)	(2)	(3)	(4)	(5)
Empowerment Index	0.101***	0.037***	0.040***	0.032***	0.031***
	(0.006)	(0.007)	(0.005)	(0.005)	(0.005)
Education: Class 1-7		0.144***	0.150***	0.142***	0.148***
		(0.014)	(0.012)	(0.011)	(0.011)
Education: Class 8-12		0.259***	0.252***	0.243***	0.241***
		(0.014)	(0.013)	(0.0112)	(0.012)
Education: Class 13 and over		0.390***	0.344 ***	0.340***	0.321***
		(0.021)	(0.020)	(0.018)	(0.019)
Income Per Capita		0.020***	0.018***	0.017***	0.014*
		(0.005)	(0.005)	(0.005)	(0.006)
Household Assets (index)		-0.004	0.015*	0.026***	0.029***
		(0.006)	(0.006)	(0.005)	(0.006)
Outcome Mean	0.484	0.484	0.484	0.484	0.484
Fixed effects	None	None	State	District	PSU
Control set	No	Demo. + Econ.	Demo. + Econ.	Demo. + Econ.	Demo. + Econ.
R-squared	0.037	0.112	0.240	0.348	0.457
Observations	26607	26607	26607	26607	26607

Source: Indian Human Development Survey-II, 2011–2012. Notes: Subsample of all eligible women in households that have a mobile phone. Standard errors in parentheses are clustered at the primary sampling unit level. Demographic variables include age, age squared, education level (indicator variables), number of years married, number of children, and Scheduled Castes and Scheduled Tribes (SC/ST) caste groups. Economic controls include income per capita (standardized), household assets (standardized index), and whether the respondent lives in an urban area. The empowerment aggregate is a standardized mean of Empowerment Components: Mobility, Marital Harmony, No Veil, Financial Independence, Freedom from Harassment: Unmarried Girls in Community, Latent Work, and Marriage Decision Involvement. Empowerment Components indices are means of standardized survey questions grouped thematically (specific questions contained in description table). Stars indicate significance levels: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. F tests compare the empowerment aggregate coefficient with the variable listed.

5 Entry Points Through a Normative Lens

How, then, can policies most effectively boost women's mobile phone use in a context where economic and normative barriers are operative and interlinked? Although we lack evidence on efficacy of policies targeting the mobile gender gap, a growing body of work evaluates programs and policies designed to change other outcomes in contexts with similar environments. We reviewed this literature and identified four distinct, evidence-based strategies to affect change. Figure 13 summarizes the approaches and highlights studies that successfully changed outcomes using each approach.

A key finding is that effective interventions need not directly target norms when barriers are interlinked: policies that target economic barriers can be effective provided they take the normative context into consideration. Thus, the first policy decision is whether to explicitly target norms (row 1 of Figure 13) or instead target economic barriers (row 2 of Figure 13).[27] Once the class of barrier has been identified, policy stakeholders must determine how aggressively to target the barrier.

Higher-powered approaches are required when the targeted behavior directly challenges norms (column 1 of Figure 13). For example, the upper left quadrant represents approaches that directly confront and attempt to change norms by changing individuals' beliefs. Successful programs of this type usually require extensive community engagement and targeted behavior change communication (Tankard and Paluck, 2016).[28] Alternatively, economic incentives can induce people to challenge the norm (lower left quadrant), but it is critical that these incentives are large enough to make behavior change compelling to the beneficiary. This approach has been successful in South Asia with political reservations for women and payments to delay child marriage (Beaman et al., 2009; Buchmann et al., 2017).

FIGURE 13 — FRAMEWORK FOR CLASSIFYING INTERVENTIONS WHEN BARRIERS COLLIDE

	Direct	Indirect
Normative	**I. Target normative barriers directly** E.g. Behavior/norms change campaigns for IPV *Abramsky et al. (2014)*	**II. Target normative barriers indirectly** E.g. Soap operas in Brazil, TV in India *La Ferrara, Chong, and Duryea (2012); Jensen and Oster (2009)*
Economic	**III. Provide high-powered incentives to break normative barriers** E.g. payments to delay marriage, reservations for women in India *Buchmann et al. (2017); Beaman et al. (2009)*	**IV. Create entry points in line with normative context** E.g. bicycles for girls, white collar jobs for women *Muralidharan and Prakash (2017); Goldin (1995)*

Subtler, indirect, approaches can succeed, provided they do not directly challenge the norm (column 2 of Figure 13). For example, entertainment or media-based programming can change norms by offering a desirable, alternative norm (upper right quadrant).[29] Such an approach might be especially desirable if there is distance between the targeted groups' personal beliefs and the perceived norm.[30]

Finally, sometimes a desired final outcome does not directly conflict with norms, but a required input or intermediate outcome does. In this case, economic incentives that make it easier to attain the desired outcome without violating the norm can be highly effective (lower right quadrant).[31]

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27 A key open question is whether interventions that change behavior by targeting economic barriers eventually change norms. We hope to contribute to answering this question in Phase II of this research engagement.

28 This is a common strategy used to counter intimate partner violence, as in Abramsky et al. (2014), which studies the effect of a community mobilization effort to reduce intimate partner violence in Uganda.

29 For example, La Ferrara, Chong, and Duryea (2012) argue that soap operas significantly reduced the fertility of Brazilian families by depicting glamorous, small families in plot lines. Similarly, Jensen and Oster (2009) find that the introduction of cable television in India reduced acceptability of violence towards women and son preference, and they argue one plausible mechanism is exposure to other lifestyles.

30 For instance, in our qualitative work we found that young people (30 and under) often lamented "society's bad thinking" and characterized traditional beliefs as a "village type thinking" and said that the "village environment is bad," thus distancing themselves from the norm.

31 Consider the example of girls schooling in India. Muralidharan and Prakash (2017) show that a program that gave bicycles to girls had a large impact on secondary school enrollment. In this case, going to school did not violate gender norms, but walking alone/unsupervised did. The bicycles likely affected the desired outcome by making the required input (traveling to school safely) less costly. A similar story emerges from history of women's work in the United States. Goldin (1995) argues that the availability of white collar jobs pulled women into the labor force since unlike blue collar jobs, white collar jobs were cleaner, neater, generally shorter in hours, and they commanded considerably more respect.

6 The Way Forward

Indian women from a wide range of socioeconomic backgrounds lack access to mobile phones, and the mobile gender gap is higher than expected given the cost of owning and operating a phone in India. Combining a literature review, qualitative interviews across India, and analysis of multiple secondary data sources, we argue that interventions aimed to address these mobile gaps should account for and potentially directly target social norms that restrict women's access to mobile technology.

Yet this does not imply that all barriers are *solely* the result of norms or that addressing economic barriers, such as a lack of technological literacy, would not help address the gender gap. It is also not clear whether economic barriers and social norms can be targeted in isolation, or need to be addressed together. Only causal analysis can shed light on these questions. Our literature review found little empirically rigorous research on the effects of barriers Indian women face in accessing and owning mobile phones; our future research seeks to fill this gap.

Our research thus far points to a number of important questions around women and mobile phones that merit further investigation. First, how can gender norms be effectively changed, and what does this mean for women's access to mobile technology? A growing body of work focuses on if and how policies can be designed and implemented to change underlying social norms, some of which we highlighted in Section 5 when developing our framework.[32] However, as we outlined in Box 5, there is an important distinction between actual norms (i.e. average behavior) and perceived norms (i.e. perception of average behavior). The latter are often easier to change than the former, which require mass persuasion (Tankard and Paluck, 2016). For the most part, the social norms literature does not carefully differentiate between perceived and actual norms.[33] Moving forward in our research, understanding how these distinctions work in practice will be key to designing an effectively targeted intervention.

Specific questions tied to norms that warrant further investigation include whether perceptions of mobile technology can be changed so that phones are viewed as a mechanism to increase, rather than threaten, women's safety and well-being. Since women's interactions with men are typically restricted (Jejeebhoy and Sathar, 2001), providing more opportunities for women to see women using mobile technology seem promising. Alternatively, incentivizing female mobile usage by pushing information about government schemes to women, especially related to household or children's well-being, is another promising on-ramp for women into acceptable mobile usage. One open question is whether such policies can spark additional mobile use outside traditional spheres, or if these policies instead further entrench existing gender norms and attitudes.

Another open question is how to optimally design interventions that address economic barriers. For example, simply giving mobile phones to women without regard to norms may instigate backlash within households or simply not work (e.g., phones will be taken by other household members). Complementing policies like this with interventions that change norms or build socially-acceptable use cases for women may be a promising way forward.

More broadly, addressing both economic and normative barriers at once may reveal important synergies relevant to large-scale policy solutions for women's low mobile access and usage.

Finally, the formative work reported here points out that future research should answer one of the most fundamental questions motivating our work to date: namely, what is the impact of mobile access on women's economic and social well-being? And given the potential of mobile technology to bring information, markets, and networks to a woman's fingertips, can mobile engagement begin to close some of the other large gender gaps in India? Moving ahead, we look forward to providing much needed evidence on these important questions.

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32 For example, some high-quality evidence — mostly from African countries — exists on changing norms related to inter-group violence and Intimate Partner Violence. Methods include using media (radio, TV) and more expensive methods like community mobilization (Abramsky et al., 2014; Abramsky et al., 2016; Arias, 2014; Ditlmann, Samii, and Zeitzo, 2017; Green, Wilke, and Cooper, 2017; Jensen and Oster, 2009; Pulerwitz et al., 2015; Wagman et al., 2015). Other research shows that similar methods can effectively change norms surrounding fertility and family structure in Brazil (La Ferrara, Chong, and Duryea, 2012; Chong and Ferrara, 2009) and health behaviors in India and Nigeria (Banerjee, Barnhardt, and Duo, 2015; Banerjee, La Ferrara, and Orozco, 2017). Furthermore, there is evidence that India's reservation system for female politicians successfully changed attitudes toward women in India (Beaman et al., 2009). Importantly, this suggests that views of women and their role in households and society are not immutable, and that policies that directly target norms may help move the needle on the mobile gender gap.

33 Arias (2014), Green, Wilke, and Cooper (2017), and Paluck and Green (2009) are key exceptions.

Appendix

A FII Time Series Analysis

One benefit of the FII data is the time series element: because there are multiple years (2013–2016), we can analyze changes in the gender gap over time. This is useful for illustrating where the gap has grown worse or stagnated, thus highlighting locations or certain demographic groups that constitute a high-value target population for an intervention. Unfortunately, the time series analysis proved unreliable. Below we discuss why this is the case.

In Figure A1, we display male and female levels of any phone access, any phone ownership, and smart phone ownership over time between 2013 and 2016. We also graph the gender gap in percentage points. Between 2015 and 2016 there appears to be a large drop in phone access for everyone, especially women. A similar but less dramatic drop occurs for phone ownership. In contrast, smart phone ownership appears to increase slightly for men while remaining relatively fat for women between 2015 and 2016.

These trends seem counterintuitive given that many cite an upward trend in mobile phone ownership and access in India in recent years. Thus we gathered time trends from other sources in order to cross-validate the FII trends (Figure A2). In Figure A2a, we see that according to the nationally representative Gallup World Poll, mobile phone access has dropped slightly between 2015 and 2016 in India. Yet the drop is not disproportional for males and females and not nearly as sizable as we see in Figure A1. Furthermore, the ITU reports that mobile phone subscriptions as a percentage of the population has been steadily increasing over time between 2013 and 2016. While this is not the same exact measure of mobile phone ownership from the FII data, it seems inconsistent with the finding that mobile phone ownership is declining.[34] Finally, we include a measure of mobile phone ownership over time (2014–2016)[35] from the nationally representative Pew Global Attitudes survey (Figure A2c). The trends over time are fairly stable in comparison to the FII trends in ownership, which show a sudden increase (and subsequent decrease) in ownership, especially for women.

FIGURE A1 — GENDER GAP OVER TIME

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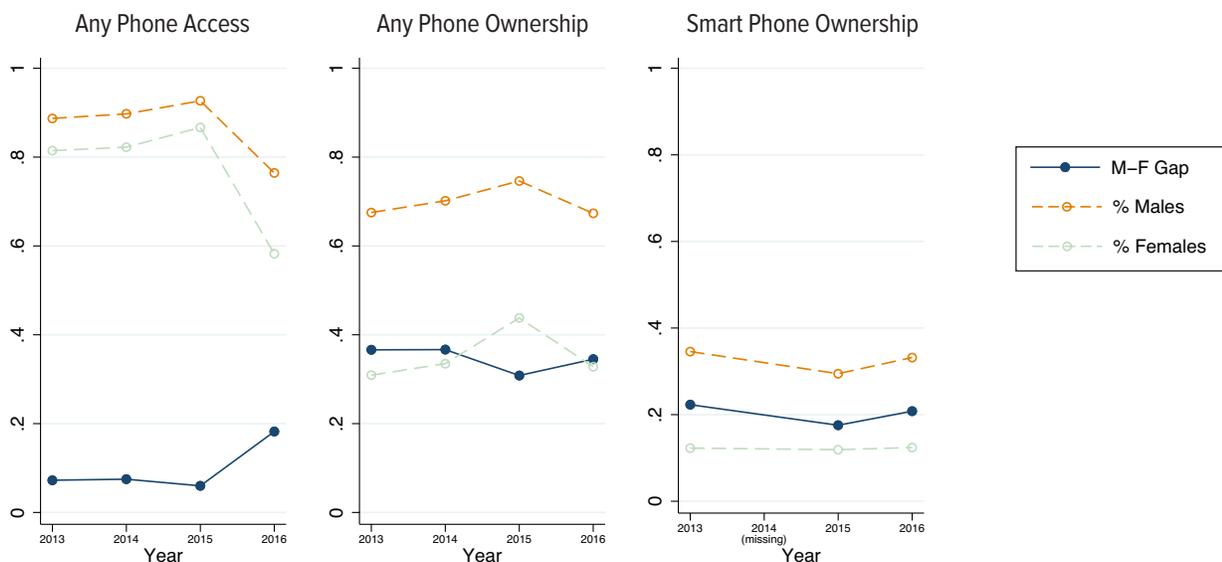
34 In order for both the ITU trend and the FII trend to be true, mobile phone ownership would need to be consolidating into a smaller group of people over time. This seems unlikely.

35 The Pew Global Attitudes survey did not collect data from India in 2013. Also, note that the dataset includes two rounds of data from 2014.

(a) Mobile Phone Access, World Poll
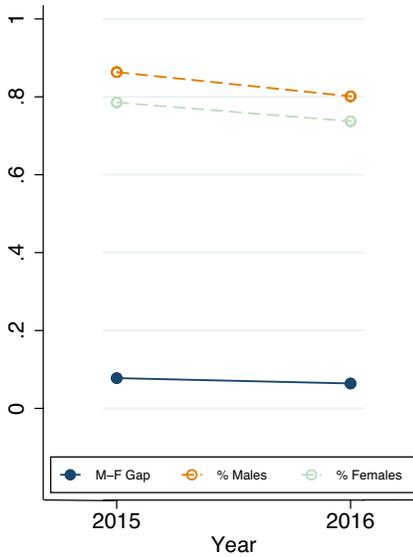
(b) Mobile Phone Subscriptions as Percentage of Population, ITU
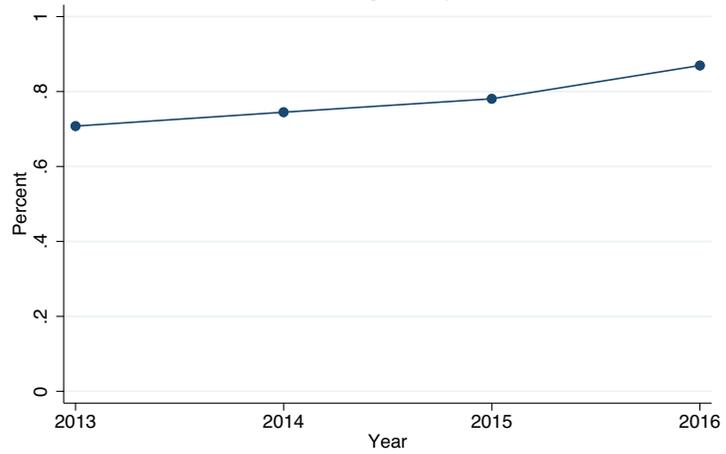
(c) Mobile Phone Ownership, Pew Global Attitudes
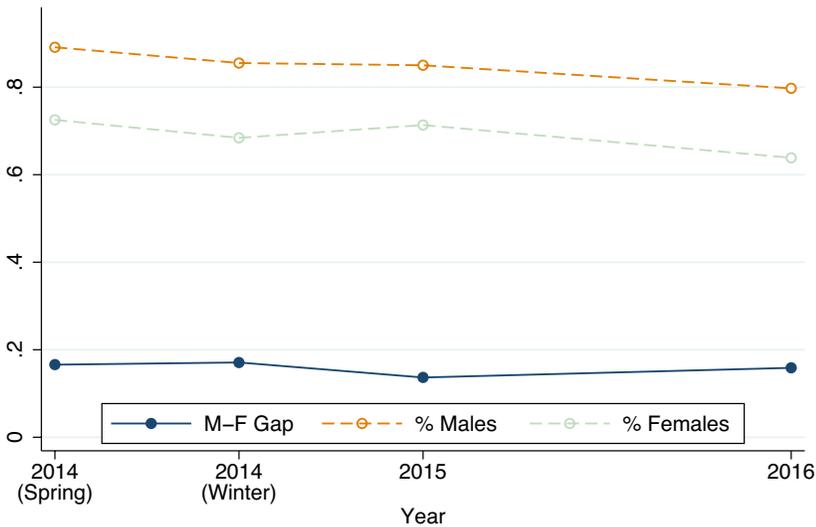
Given this evidence, we limit our analysis to pooled data between 2015 and 2016. We keep only the most recent years in order to get a sense for the current state of the gender gap. We pool 2015 and 2016 data for two reasons. First, we pool the two years in order to maintain a large sample size for when we analyze the gap among specific populations. Second, if there is an undocumented discrepancy in the sampling strategy over time that explains the suspicious trend, we avoid having to arbitrarily choose which year of data most correctly reflects the population.

B Literature Review

B.1 Introduction

As part of Phase I, we conducted an interdisciplinary literature review. We outline the resulting narrative in this section.

We begin by covering research on the economic benefits of mobile phones, paying close attention to evidence seen through a gender lens. Next we outline the barriers to mobile phone ownership and use faced by women in India.

B.2 Methodology

We identified relevant literature using several approaches. For the economics literature, we input key words in search engines available through Harvard University (EconLit and Hollis+), limiting the search to top economics journals.[36] We also identified core papers, then expanded by gathering papers cited therein. Finally, we used Google Scholar to search for literature that cited the seminal economics paper on mobile phones, Jensen (2007).[37] From each search we gathered papers that were both high-quality and relevant to the current project. We considered a paper high-quality if it was published in a upper-tier economics journal (unless it was a working paper) and if the empirical methods plausibly identified a causal effect.[38] We deemed a paper relevant if the research involved mobile phones and the study took place in a developing country.

We conducted a similar search for relevant research in the anthropology and sociology literatures. Once again we used academic search engines (Hollis+, Anthropology Plus, and ProQuest Sociology) to find papers on mobile phones, this time limiting our search to papers published in top anthropology and sociology journals.[39] From these searches we included papers that were relevant to the current project. We classified a paper as relevant if it involved mobile phones, gender, and the study took place in a developing country.[40]

In addition to including relevant literature in economics, anthropology, and sociology journals, we reviewed reports on mobile phone ownership and literature cited therein. Similarly, to find reports we input key words on barriers to mobile phones in search engines (Hollis+, EconLit, and Google Scholar). To limit the scope, we narrowed the relevance criteria for inclusion to research related to technology in India or other similar developing countries.[41]

Ultimately, we identified and discuss here 29 economics papers, 16 anthropology/sociology papers, and 4 reports of high-quality and relevance. This literature review summarizes the main results, with a focus on literature and reports that are key for informing Phase II of the project.[42]

B.3 Economic Benefits of Mobile Phones

There are many channels through which mobile phones can affect the economy (Aker and Mbiti, 2010). The most fundamental functions of a phone facilitate communication between people, a direct way that mobile phones impact economies. Phones also impact the economy in a more indirect way by providing a platform for other innovations. Furthermore, interventions can employ phones as a tool in order to address market failures and affect individual behavior. In this section we outline the ways that mobile phones impact the economy, highlighting

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36 We considered journals listed in the top 20 IDEAS/RePEc rankings and also applied discretion in searching other high quality applied economics and field journals, such as *American Journal: Applied Economics* and *Journal of Development Economics*.

37 Paper to be discussed further.

38 Acceptable empirical methods were quasi-experiments, natural experiments, and randomized control trials (RCTs). Note that for working papers we only relied on the latter criterion. The same is true when we found papers published in medical journals, which happened a couple of times (Flax et al., 2014; Zurovac et al., 2011).

39 We considered a journal in our search if it was listed as a top ten journals in anthropology and sociology in any of the following rankings: InCites, Scimago Journal Ranks , and American Anthropological Association. In addition, we searched two journals, *Gender, Technology, and Development* and *Media, Culture, and Society*, that fell outside of these criteria because of their relevance to research on mobile phones and gender. Note that we did not use a snowballing approach in addition to this keyword search. This is because we did not know of any core papers on mobile phones from this literature, and none in particular emerged in the subsequent search.

40 Rather than developing inclusion criteria for this literature, we simply relied on limiting our search to top anthropology and sociology journals (as described in Footnote 40) to filter out low-quality papers in these fields.

41 Two journals in particular, *Information Technologies & International Development* and *Information Technology for Development*, appeared several times with useful content. Thus we also searched these journals chronologically for relevant articles.

42 For instance, we omitted papers that looked at political economy outcomes from this review. While the papers met inclusion criteria for quality and relevance, we decided that the interventions we design will likely not involve a political angle, and therefore the value-added of reviewing these papers was low.

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if and how the literature addresses women in particular. We show that for the most part research in this area has not been devoted to studying how mobile phones impact women. Also, we show that what little research does exist on mobile phones and women reveals social norms are a key component of the discussion.

B.3.1 Mobile Phones Improve Market Coordination

The most well-documented economic benefit of mobile phones is improved coordination between market actors that results in more efficient markets. Jensen (2007) provided the first robust evidence for this, and the paper became a landmark in the literature on mobile phones. Using a natural experiment in Kerala, India that relies on exogenous timing in the introduction of mobile phone service, Jensen (2007) shows that mobile phones reduced price dispersion between different fishing areas by improving coordination between fishermen and consumers, thus creating a more efficient market. Using a similar identification strategy, Aker (2010) shows that the same result prevails in Niger grain markets. More recent work by Jensen and Miller (2018) illustrates how mobile phones can reduce productivity dispersion and increase firm size using the same natural experiment as Jensen (2007). A few other papers come to similar conclusions, thus creating a solid body of work concluding that mobile phones improve market coordination (Aker and Fafchamps, 2014; Aker and Ksoll, 2016; Muto and Yamano, 2009; Tack and Aker, 2014).[43]

Gender and Market Coordination. Gender-disaggregated analysis within this literature is nearly non-existent. In fact, the only two papers that include a gender angle are not very informative. Aker and Ksoll (2016) use an RCT to analyze how mobile phone access affected agricultural households' production decisions. They find that households that received a mobile phone increased the variety of crops that they grew and sold. In particular, households were more likely to grow a marginal cash crop usually grown by women. The crop variety effect was concentrated among households where women participated in the intervention. However, while the authors allude to the fact that women have "fewer opportunities to travel to markets and sell output," the discussion about this finding is limited. Tack and Aker (2014) show how mobile phones reduce search costs in markets, and

they investigate treatment heterogeneity across men and women. They find statistically insignificant results, but their analysis is underpowered since so few women (10%) make up their sample, which makes it difficult to interpret the results. Notably, the most seminal works in this literature — Jensen (2007), Aker (2010), and Jensen and Miller (2018) — use samples composed of 0.15% females. This is indicative of a broader point: literature on market-level impacts of mobile phones is void of analyses specific to women.

B.3.2 Mobile Phones as a Platform for Innovation: Mobile Money

One well-known mobile phone-based innovation is mobile money. This app where users can deposit, transfer, and withdraw money without access to a formal bank account has rapidly spread across many developing countries, and in particular, many countries in Sub-Saharan Africa. In fact, over 50% of mobile money users live in Sub-Saharan African countries (Suri, 2017). Thus much of the research to date on the impacts of mobile money has been in the African context, with a particular focus on M-PESA, the Kenyan mobile money platform. Research on this product shows that mobile money can impact money transfers and savings.

Transfers. There is some evidence that M-PESA has improved social insurance by reducing the transaction costs of transferring money. Jack, Ray, and Suri (2013) find that M-PESA users are more likely to exchange money within their personal networks and make larger transfers over longer distances than non-users. Jack and Suri (2014) provide stronger evidence for this point, using exogenous variation in mobile money agent networks to show that mobile money users are more resilient to shocks. They show that the mechanism at work is an increase in remittances and personal financial networks. In addition, Blumenstock, Eagle, and Fafchamps (2016) find that an earthquake in Rwanda led to an increase in airtime transfers, a pre-cursor to mobile money demonstrating how mobile phones can reduce transaction costs of social insurance.

NGOs and the private sector have been using digital payments to reduce the cost of transfers. Mobile money not only improves personal transactions but also transfers from organizations to recipients. In an RCT evaluating the

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43 More broadly and from a macroeconomics perspective, Röller and Waverman (2001) provide cross-country evidence that telecommunications structures cause economic growth. The authors cannot disentangle the mechanisms at work, but they discuss improved coordination as a potential channel. Note that this result is specific to telecommunication structures for landline telephones but the results could extend to mobile phone infrastructure as well.

impacts of unconditional cash transfers, Haushofer and Shapiro (2016) illustrate one example of how organizations can use mobile money to deliver cash directly to the poor. Aker et al. (2016) use an RCT to evaluate the implementation costs of a cash transfer program in Niger, and they find that the per-transfer cost of a cash transfer via a mobile phone is lower than transfers made directly in cash, both for the program recipient and implementing agency. There is also some work on how mobile money can improve digital payments between employers and employees. Results from an RCT in Afghanistan show that salary distribution among firm employees was less costly when the employer used mobile money transfers rather than the status quo cash transfer system (Blumenstock et al., 2015).

Savings. Suri and Jack (2016) provide the best-identified evidence about how mobile money affects savings using exogenous changes in mobile money agent access to study the impacts of mobile money on poverty in Kenya. The results are striking: M-PESA lifted 2% of Kenyan households out of poverty. They provide evidence that one of the main mechanisms at work was an increase in household savings. Other literature on mobile money-linked savings products provides less clear evidence. Aker et al. (2016) and Blumenstock et al. (2015) find that access to a mobile money platform (in Niger and Afghanistan, respectively) did not induce more accumulation of savings. However, there is suggestive evidence from Haushofer and Shapiro (2016) that independent of the cash transfer itself, the M-PESA service increased savings and remittances by a small amount. Furthermore, Blumenstock, Callen, and Ghani (2017) develop a mobile money add-on where users can save money they receive through transfers, thus illustrating the potential for the mobile money platform to affect savings behavior. While they do not test the effect of the service alone, they do experimentally vary the way in which users are initially introduced to a mobile money savings program, either through default savings or match rates. They find that the default has a large effect on propensity to save, while a match rate shows only modest growth in savings in comparison.

Gender and Mobile Money. Three of the nine papers on mobile money include a gender angle, but only one has conclusive findings. Aker et al. (2016) find evidence that giving a cash transfer via mobile money rather than cash increased women's mobility and clothing expenditures. Two other papers test for treatment heterogeneity across gender. Blumenstock, Callen, and Ghani (2017) find no statistically significant differences in men's and women's

responses to various mobile money savings products. They do not include any accompanying discussion; yet only 15% of their sample is women, thus indicating the authors have low statistical power to detect a heterogeneous effect. In contrast, Suri and Jack (2016) provide the only conclusive, meaningful insight about how mobile money impacts women. One large focus of the paper is how a change in women's occupational choice was a key mechanism driving the reduction in poverty. Also, they find that increases in consumption causally attributable to M-PESA are concentrated among female-headed households. This result shows the potential gains for women upon access to mobile money.

B.3.3 Other Mobile Phone-Based Interventions

A wide array of interventions in developing countries have employed mobile phones as means to an end not necessarily related to mobile phones themselves. Research reveals that mobile phone-based interventions have the potential to affect financial behavior, health behavior, and human capital.

Finance. A growing body of research highlights how text message reminders can nudge people towards beneficial financial behaviors. For example, Cadena and Schoar (2011) use an RCT to evaluate whether or not text message reminders increase loan repayment in Uganda. They find that inexpensive SMS reminders were just as effective at promoting loan repayment as other more expensive treatments such as a future interest rate reductions. Similarly, experimental evidence from Chile shows that feedback text messages can be just as effective as pressure from self-help peer groups in inducing people to meet savings commitments (Kast, Meier, and Pomeranz, 2012). Karlan et al. (2016) look at three different impact evaluations (from Bolivia, Peru, and the Philippines) of SMS reminders on savings and find that the reminders significantly improve the likelihood of meeting savings commitments. Karlan, Morten, and Zinman (2012) find that SMS reminders can effectively leverage personal reciprocity in order to improve loan repayment by including the loan officer's name. All of these papers demonstrate how SMS reminders can improve financial behavior in a cost-effective way.

Health. Other RCTs have also shown how SMS reminders can affect health-related behaviors. For example, Flax et al. (2014) find that SMS reminders combined with learning sessions can improve women's breast-feeding practices in Nigeria. Similarly, Zurovac et al. (2011) find that SMS reminders improve health clinic workers' adherence to

malaria treatment guidelines in Kenya. Finally, Dammert, Galdo, and Galdo (2014) show how simple SMS reminders can promote preventative health behavior among households susceptible to mosquito-borne viral diseases in Peru.

Human Capital and Labor Markets. Other research focuses on how mobile phones can address human capital issues. Aker, Ksoll, and Lybbert (2012) report results from an RCT where a subset of adult education program participants in Niger were given shared access to mobile phones and technical literacy training. They find that test scores were higher among trained mobile phone users and that the main mechanism was increased student effort and engagement. A study from Brazil demonstrates how SMS's can successfully communicate children's attendance and grades to parents, thus nudging parents to improve students' academic performance (Cunha et al., 2017). Another intervention addresses matching issues in the labor market in Peru by informing job seekers through SMS of job opportunities that match their labor profile (Dammert, Galdo, and Galdo, 2015). They find short term positive effects on employment, which suggests that SMS could be a useful tool for labor market intermediation.

Gender and Mobile Phone-Based Intervention. Of these eight mobile phone-based intervention papers, only one was designed exclusively for women (Flax et al., 2014). Three papers investigate whether men and women respond differently to the treatment, and none find a significant difference (Aker, Ksoll, and Lybbert, 2012; Dammert, Galdo, and Galdo, 2014; Dammert, Galdo, and Galdo, 2015). Notably, however, Aker, Ksoll, and Lybbert (2012), Dammert, Galdo, and Galdo (2014), and Dammert et al. (2015) include small discussions on gender to motivate their treatment heterogeneity analysis. Aker, Ksoll, and Lybbert (2012) discuss how the Nigerien women in their sample were traditionally constrained in their physical mobility. They discuss how women might have a stronger incentive to use a mobile phone to communicate with others because of this, therefore strengthening the program impacts. Dammert, Galdo, and Galdo (2014) are motivated to include treatment heterogeneity by gender in order to test the idea that women might have stronger preferences for health investments. Dammert, Galdo, and Galdo (2015) are motivated by the fact that are large gender gaps in Peruvian labor markets.

B.4 Barriers to Women's Phone Ownership and Use in India

In India, women lag behind men in phone use and ownership. If this trend continues, then the promises alluded to above may become pitfalls, and mobile phones may only exacerbate existing gaps. A GSMA report from 2015 estimated that women were 36% less likely to own a phone than men, a gap much higher than most low-and middle-income countries.[44] While this gap in mobile phone ownership between men and women in India is well-documented, there is not much methodologically rigorous research on why it exists. We break up the small literature into two main categories of barriers to mobile phones for women: economic and normative.

B.4.1 Economic Barriers

According to female respondents in the 2015 GSMA report, the barriers that most differentially impact women more than men are handset costs, poor network coverage and quality, and poor technical literacy and confidence. Some descriptive literature highlights how these economic barriers impact mobile phone ownership in general. O'Neill (2003) cites handset cost and poor infrastructure as a barrier to mobile phone ownership in India. In addition, Behl, Singh, and Venkatesh (2016) cite reliability of network in rural India as a barrier to mobile banking use specifically. Patil, Dhere, and Pawar (2009) and Huyer and Sikoska (2003) support this claim by citing poor infrastructure for ICTs as a barrier to take-up in India and elsewhere. Patil, Dhere, and Pawar (2009) also claims that lack of technical support and operator knowledge has been a challenge in ICT adoption.

Yet there is evidence that these barriers disproportionately affect women as the GSMA report suggests. We outline this evidence below, and how the economic barriers described here could ultimately be tied to social norms.

Handset Cost. Past research reveals that the costs of ICTs disproportionately affects women in India and around the world (Hafkin and Taggart, 2001; Intel, 2012). Some ethnographic work provides insight on why this might be the case. Pulling from 245 interviews with female slum-dwellers in India who do not own mobile phones, Potnis (2016) describes how the economic barriers that women face are

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44 The gender gap estimates from the GSMA report are not nationally representative (e.g. their sample has roughly an 80-20 female to male ratio of respondents), but it is the most recent and reliable estimate within the literature. In Section 2 of the main text, we give more representative and recent estimates of the gender gap in phone access, ownership, and use in India.

a product of the gender norms that confront them. For example, since Indian social norms dictate that women are caretakers of family members, many women are pressured into sharing their savings and earnings with their in-laws. This leads them to be more financially constrained than men. Social norms also constrain women's occupational choice, which further limits their financial resources (Field et al., 2016). Ultimately, women in India and other developing contexts rely on men for mobile phone access and ownership (USAID, 2013; Seshagiri, Aman, and Joshi, 2007).

Network Coverage and Quality. To our knowledge, there is no literature (besides the 2015 GSMA report) claiming that women are disproportionately affected by lacking network coverage or quality. However, it is easy to see why this might be the case. Research shows that women in India often face large constraints to physical mobility; for example, the vast majority of Indian women must ask permission to go on a trip alone (India Human Development Survey, IHDS). If women are limited in their mobility, then they cannot travel to access better coverage if their network at home is unreliable. Thus, the social norms that constrain women's mobility could ultimately constrain their access to mobile phones by limiting their access to good network quality.

Literacy and Confidence. A more well-cited barrier in the literature is lack of confidence, technological literacy, or literacy in general. Kumar and Prakash (2016) and Seshagiri, Aman, and Joshi (2007) both find that women feel uncomfortable using mobile technology due to illiteracy or technical illiteracy, and that this is magnified with age. The USAID reports that the same is true for women in Afghanistan (2013). Another report from Intel claims that the full potential of many mobile apps has not been met due to illiteracy (2012). More broadly, this same issue has been cited for women's internet and ICT adoption in India and elsewhere (Best and Maier, 2007; Huyer and Sikoska, 2003; Intel, 2012; Rashid, 2016). Arguably, norms that define a woman's role as caretaker of the household also could provide little rationale for girls to develop technology-related skills, which are typically rewarded on the labor market (Bornman, 2016).[45] In this way, social norms might constrain women's human capital development, which in turn could cause women to lack the know-how and literacy necessary to operate a mobile phone.

B.4.2 Normative Barriers

Gender norms constrain women in many developing countries, a problem that is especially prevalent in India. Specifically, these norms constrain women's fertility decisions, marital choice, education attainment, occupation choice, and physical mobility. It is no surprise that norms would also constrain women's interaction with mobile phones and technology in general. In the previous section we outlined economics barriers to mobile phones and discussed how these economic barriers might arise from social norms. Here we outline the research on how social norms directly constrain women's mobile phone ownership and use.[46]

Preserving Women's Reputations

> *"If a girl is walking on the road playing music on her phone, what will people think? They'll say she isn't a decent girl."*
> – Father of several young girls from Delhi (Bellman and Malhotra, 2016)

In India, people tend to associate women's mobile phone use with romance and promiscuity, thus women risk damaging their reputation if they use or own a mobile phone. Ethnographic work shows how communities tend to label women as provocative for using their mobile phones, and they attribute the rise in divorce rates in India to mobile phones (Bell, 2006).[47] Similarly, an ethnography from West Bengal reveals that many people associate mobile phones with elopements (Allendorf, 2013). Even more extreme, in 2009, a conservative Hindu religious party claimed that women have been "corrupted by technologies" and that mobile phones have turned them into "sluts" (Arora and Scheiber, 2017). These norms push women to make a trade-off between mobile phone use and reputation maintenance, while men do not face the same trade-off. This is compounded by power structures within households: if families or husbands are also concerned with maintaining their daughter's or wife's reputation, they have an incentive to constrain women's access to mobile phones—and in fact, they have the power to do so. These attitudes appear to be rooted in the social norms surrounding women's purity, as described in Section 3.1. Mobile phones generate fears among those who believe that girls ought to stay pure and those who think others believe this. Because of this, people constrain women's mobile phone use.

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45 On the other hand, it is also possible that dowry norms incentivize parents to invest in girls' education in order to reap returns on the marriage market. For example, an educated girl might match with a higher quality husband or the husband's family might demand a smaller dowry (Jayachandran, 2015). In other words, different gender norms could have competing effects.

46 We focus on mobile phones broadly, but note that the norms discussed here closely parallel those that reportedly constrain South Asian women's mobile internet use, as outlined in a recent GSMA report (2017).

47 More broadly, Bell (2006) reports that newspapers characterize mobile phones as leading to "a breakdown of traditional courtship patterns."

Protecting Young Women from Harm

> "Mobile phones are really dangerous for women. Girls are more susceptible to bringing shame upon themselves."
>
> – Village elder from Lalpur, Uttar Pradesh (Bellman and Malhotra, 2016)

Others worry that phones are a channel through which women can be harassed—in which case norms may direct male "caretakers" to restrict women's and girls' access to phones. Ethnographic research from West Bengal provides evidence of this "digital harassment" in the literature, reporting a few cases of men calling women at random in order to become romantically involved (Allendorf, 2013; Tenhunen, 2008).[48] Similarly for internet use, ethnographic work from Telangana and Punjab reveals that many girls felt unsafe while on the internet because of various online stalking incidents (Arora and Scheiber, 2017). Cases from Karnataka and Uttar Pradesh demonstrate how Indian society reacts to digital harassment—by pulling women further away from technology and establishing that technology is too dangerous for women, rather than developing ways to protect women so that they can safely use technologies (Masika and Bailur, 2015; Bellman and Malhotra, 2016).

B.4.3 Summary: Barriers to Women's Mobile Phone Access in India

Overall, barriers to women's mobile phone access described in the literature can be classified as either economic or normative. Extrapolating from the evidence on how women's lack of access to economic resources more generally is often tied to gender norms, we argue that these barriers might intersect to form complex constraints on women's phone access. Yet the descriptive analyses present in this literature is not sufficient to determine the best strategies to increase women's mobile phone access. Doing so will require causal research that disentangles the complex constraints on women at play. The current state of the literature highlights the need for such research, which is something that we aim to accomplish in Phase II.

C Qualitative Analysis Site Descriptions

We conducted qualitative interviews in 5 states in India: Madhya Pradesh, Maharashtra, Tamil Nadu, West Bengal and Delhi. We selected sites of previous studies/experiments, which allowed us to leverage primary survey data for sampling. Note that we only interviewed study participants from the control group of these studies, which ensured we were speaking to women unaffected by past interventions that might have impacted their views on mobile phones and gender. These studies spanned four states and covered both rural (Gwalior, Madhya Pradesh and Thanjavur, Tamil Nadu) and urban (Amravati, Maharashtra and Kolkata, West Bengal) areas, thus also introducing some regional variation in the sample. We chose the fifth study site, Delhi, in order to explore another metropolitan sample after Kolkata. All interviews in Madhya Pradesh, Maharashtra and Delhi were conducted in Hindi, the local language in these regions. (Amravati is located in the Vidharbha region of Maharashtra, where there are more Hindi speakers than the rest of Maharashtra. Respondents from this sample were conversant in Hindi.) Interviews in West Bengal and Tamil Nadu were conducted in Bengali and Tamil respectively. The transcription took place in two steps: audio files were first transcribed into the local language, and then translated from the local language to English.

Primary survey data from the four study sites were used to create a list of target respondents based on information about phone ownership, occupation, marital status and age. The latest of these surveys was conducted in 2017 in Gwalior, and the earliest being 2012 in Kolkata, thus giving us access to fairly recent data on our variables of interest. This sampling strategy enabled us to focus on villages/localities with high variation in phone ownership, occupation and marital status within each study site. Thus, we could observe how phone ownership, use and norms could vary across different profiles of women within the same socio-economic strata. In Delhi, which was not a previous study sample, we approached respondents by snowballing, contacting local organizations, and identifying gatekeepers in the localities we chose. We interviewed two sets of participants in Delhi: the first was a group of

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48 A recent news article entitled "India's 'Phone Romeos' Look for Ms. Right via Wrong Numbers" also provides anecdotal evidence of this trend (Barry, 2017).

women affiliated with a trade union for self employed women, and the second was a set of women living in a slum, whom we approached through snowballing, starting from a local contact and expanding to her neighbors and acquaintances.

We used a combination of purposive and snowball sampling to find our respondents: if the targeted respondents were not available, we snowballed respondents by asking community members for 'unmarried women', 'young,

married women', or 'old, married women' who worked or did not work.[49] In rural areas, we approached local child care workers (known as "aanganwadis") in order to guide us to specific respondents.

For broad context, Table C3 below outlines some key demographic statistics on the cities or districts we visited. We provide details on the study participants in each site in the paragraphs that follow.

TABLE C3 — DEMOGRAPHIC STATISTICS OF QUALITATIVE SITES

Location	Population (millions)	Sex Ratio (females per 1000 males)	Female Literacy Rate (%)	Female Labor Force Participation Rate (%)	Average Age of Marriage for Boys	Average Age of Marriage for Girls	Poverty Rate (%)
Gwalior, Madhya Pradesh	2.03	852	67.38	21.9*	22	20	9.7
Amravati, Maharashtra	2.88	957	83.1	19.4	26	21	63.1
Kolkata, West Bengal	4.49	908	84.06	17.9*	28	23	N/A
Thanjavur, Tamil Nadu	2.4	1,035	76.5	49.6	27-29	22-23	N/A
Ariyalur, Tamil Nadu	0.75	1,015	61.4	46.7	27-29	22-23	N/A
South West and East Delhi	3.43	868	80.7	10.8	N/A	N/A	9.9

All figures reported for South West and East Delhi are for the state, national capital territory of Delhi. Population numbers are from the Census of India, 2011. Sex ratio, literacy rate, and average age at marriage from National Institution for Transforming India Aayog, District Statistics, years 2012-13. Female labor force participation rates for Amravati, Thanjavur, and Ariyalur are from 2013-14 and the Ministry of Labor and Employment District wise Report for the State of Maharashtra and for the State of Tamil Nadu respectively. The figures reported are for urban Amravati and rural Thanjavur and Ariyalur. Female labor force participation figures reported for Kolkata and Gwalior are the percentage of working women to the total number of women in urban Kolkata and rural Gwalior, respectively, from the Census of India, 2011. Female labor force participation rate for Delhi are from 2011–12 from the NSS Key Indicators of Employment and Unemployment in India Report. Poverty rates reported for Gwalior are the % of rural population living below poverty line, from the District wise Poverty Estimates for Madhya Pradesh Report by the State Planning Commission, Madhya Pradesh in 2004–05. The poverty rate reported for Amravati is the incidence of poverty, urban (%), from the Maharashtra Human Development Report, Government of Maharashtra, in 2004–05. For Delhi, it is the percentage of population living below poverty line in 2011–12, from the Delhi Human Development Report, 2013.

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49 We tried to achieve some variation in the kinds of respondents we targeted or looked for, however, the study site often determined the typical kinds of women found in that area. For example, it was particularly rare to find a college-going, unmarried woman in rural Gwalior, as it was uncommon for girls to attend college or marry at later ages.

Gwalior, Madhya Pradesh

Places visited: 11 villages in Morar, a block in Gwalior district

Number of Respondents: 39

Number of Female Respondents: 23

Number of Interviews (IV's)/Focus Group Discussions (FGD's):
29 IV's, 1 FGD's

Respondent Selection. Using a list of study participants and data collected from a previous study done in Gwalior, we selected interviewees with variation in mobile ownership, and occupation. In the case that we were not able to locate the selected respondents, we asked around for other women in the same occupation category who owned or did not own a mobile phone. Once we saturated a particular user profile in a village or cluster of neighboring villages, we started varying other variables, such as age and marital status.

Respondent Profile. 57% of the respondents were housewives while the rest were either casual laborers, self-employed, or salaried workers. In general, the community considered it more important for women to take care of the household than to have a job. It was rare for a woman in our sample to have studied after class eight or 10. Our female respondents had very low levels of mobility as compared to their male counterparts. For example, many had to be accompanied by a male member of the household since it was not safe for women to travel on their own. Their social interactions rarely extended beyond their family members, while it seemed that men were able to interact with other men through work or college. It was rare for married women to stay in touch with their friends from their natal village or interact with other married women in their neighborhood.

Mobile Phone Landscape. All households in our sample owned at least one basic phone, and smart phone ownership was common among younger respondents. Respondents mentioned that mobile phones were a common marriage gift in most villages since it was considered necessary for newly-wed brides to stay in touch with their natal home or husbands. Hence, it was common for married women to own phones. 57% of the female respondents owned phones, all of whom were married women. For men, both married and unmarried, mobile ownership was justified by having broad social networks as they worked outside their homes.

Amravati, Maharashtra

Places visited: 7 localities in Amravati city

Number of Respondents: 27

Number of Female Respondents: 23

Number of Interviews (IV's)/Focus Group Discussions (FGD's):
21 IV's, 2 FGD's

Respondent Selection. Using a list of study participants and data collected from a previous study done in Amravati, we selected interviewees with variation in age, marital status, occupation, and mobile ownership. In many cases we were not able to locate the selected survey participants, and thus employed a snowballing strategy to find participants.

Respondent Profile. Our sample was fairly educated, with 56% of the respondents were college students or graduates currently looking for jobs or currently working in the private sector. Women had typically completed class 12 and were pursuing their undergraduate degree. 58% of the working female respondents were micro-entrepreneurs who worked from their homes as tailors and beauticians. Working from home was considered superior to working outside the home because it gave women a lot of flexibility to manage household work and look after kids. Women were fairly mobile, but preferred to travel with their female friends and relatives. They didn't have to travel with a male companion and felt that the locality was safe for women. However, some women mentioned that lingering around in public spaces was not considered appropriate for girls because they need to stay safe from the wrong kinds of boys. Most women's social networks were limited to their neighborhood. Their network outside of their family largely consisted of customers they interacted with.

Mobile Phone Landscape. All households owned at least one phone. In contrast to rural Gwalior, it was common to find households with at least one smart phone. It was common for children, both boys and girls, to obtain phones after completing grade 10 as they would have to travel to college on their own. Only 35% of the female respondents did not own phones; among these, half were below the age of 18 years and 25% were unemployed. Some young female respondents, who were also aspiring micro-entrepreneurs, mentioned using their phones to look up designs for their stitching business.

Kolkata, West Bengal

Places visited: Khardaha, Sodepur, and Agarpada localities in suburban Kolkata

Number of Respondents: 21

Number of Female Respondents: 18

Number of Interviews (IV's)/Focus Group Discussions (FGD's): 21 IV's

Respondent Selection. We used data from a previous study to select our respondents in Kolkata. The study was over 10 years old, which made it difficult to identify young or middle-aged respondents and locate them. Thus, instead we employed the snowballing approach to find younger participants who were either working, studying, or operating their own business.

Respondent Profile. 27% of the female respondents were unmarried and were either working or studying. 8 out of 13 middle-aged women ran businesses on their own or with their husbands. On average, respondents were 35 years of age and educated through secondary or high school. Female respondents in Kolkata were fairly mobile, and most of them would walk to their workplaces from home on their own and did not need to be accompanied by a male member of the family. The only restriction on women was on being outside their homes late in the evenings, as the localities were not considered safe for women. Women's social networks mainly consisted of their families, but they would also interact with other women in the neighborhood. Some women even mentioned being connected to friends from the natal village. In general, the communities here were more liberal than in other sites.

Mobile Phone Landscape. It was common for households to own at least two phones. In fact, all but two female respondents from Kolkata owned phones. In the community, phones were considered a necessity for everyone —young and old, married and unmarried, housewives and working women alike. It was common for children, both girls and boys, to start owning a phone after they completed high school.

Thanjavur and Ariyalur, Tamil Nadu

Places visited: 2 villages in Thanjavur district and 2 villages in Ariyalur district

Number of Respondents: 21

Number of Female Respondents: 18

Number of Interviews (IV's)/Focus Group Discussions (FGD's): 8 IV's, 6 FGD's

Respondent Selection. We were unable to locate any respondents from a previous study in this site, so we instead approached local daycare (aaganwadi) centers in the village to identify women with variation in mobile phone ownership, self-help group membership, occupation, and education status.

Respondent Profile. 47% of the female respondents were housewives. It was common and considered appropriate for women to work: women would take up a range of occupations in the private sector (e.g. factory jobs), government, and family enterprise. Respondents were 30 years of age on average, and educated through at least grade 10. When compared to our other study locations, women in this sample seemed to have the highest mobility levels both within and outside the village. It was common for them to travel to the nearest urban center for work and even to larger cities which were located at some distance from their village for education. Women in our sample had broad social networks of people in their neighborhood and workplace.

Mobile Phone Landscape. Phone ownership was common among all households, but smart phone ownership was more common among the youth in rural areas in Thanjavur. The community in general recognized that women needed phones—married and unmarried, housewives and working women alike. Older respondents said that women only needed basic phones, even if they were more educated or were working; however, most younger female respondents said that working and more educated women needed smart phones.

South-West and East Delhi, Delhi

Places visited: N/A

Number of Respondents: 17

Number of Female Respondents: 16

Number of Interviews (IV's)/Focus Group Discussions (FGD's):
4 IV's, 1 FGD

Respondent Selection. We conducted two rounds of scoping in Delhi. The first was conducted in South Delhi, in a slum identified by a local contact. We used the snowballing approach in order to select respondents. The second round took place in East Delhi and was a group discussion with members of a women's trade union, SEWA (Self Employed Women's Association).

Respondent Profile. 16 of the 17 respondents were female and 3 of them were college students or of college age. Respondents said it was common and acceptable for girls to pursue a career of their choice. Most respondents from East Delhi were middle-aged, married women engaged in stitching and tailoring work, while the respondents in South Delhi were all domestic workers. Women in the Delhi sample were fairly mobile within and outside their locality. Mobility was necessary for the domestic workers since they had to commute to their workplace daily, while most micro-entrepreneurs would have to travel across Delhi to other community centers of their trade union. All respondents were comfortable traveling around the city on their own. Women appeared well connected with people in their neighborhood.

Mobile Phone Landscape. As in all other study sites, phone ownership was common among all households, but it was more common for male heads and young people to own smart phones. Domestic workers were often gifted phones from their employers in order to coordinate with them for work. All our respondents from south Delhi owned phones. Some of the micro-entrepreneurs in the east Delhi sample obtained their smart phones by participating in a digital literacy camp, where they were taught how to use Google's voice search feature to look for tailoring designs on the internet. Other participants would borrow a family member's phone when they needed to use one. They typically used their phones for entertainment, but some respondents used their phones to look up recipes on the internet or to look up some information. While some respondents said that it is not considered appropriate for girls to have their own phones before marriage, most of them agreed that phones are necessary for safety, especially for girls who travel for school and work.

D IHDS Analysis

D.1 Introduction

In Section 4, we quantify and compare barriers to women's mobile phone use. Using data from the Indian Human Development Survey (IHDS), we find robust correlations between women's mobile phone use and proxies of women's empowerment, socioeconomic factors and education. Many different aspects of women's empowerment and gender norms matter for women's mobile phone use. Women's mobile phone use increases with these factors, even after accounting for demographic and economic factors, and the region where women live.

In this appendix, first, we describe the data that we use in our analysis. The IHDS measures individual mobile phone use and has rich data on proxies of women's empowerment. We detail the samples that we use, how we measure women's mobile phone use, and how we construct proxies of women's empowerment and gender norms. Second, we outline our analysis methodology. Third, we present the results from our additional robustness checks, which compare with the main analysis that is reported in Section 4.

D.2 Data

In this section, we describe the data used for the analysis, our main outcome and two other outcome variables for women's mobile phone that we use as robustness checks, and how we construct the empowerment and norms proxy variables.

We use the second round of the Indian Human Development Survey (IHDS-II) in our analysis. Conducted over 2011–2012, IHDS-II is a nationally representative survey of households in rural and urban areas in 33 states and union territories of India (IHDS, 2011). We make use of the Individual, Household, and Eligible Women datasets.

We focus on the sample of ever-married women interviewed in the Eligible Woman questionnaire. The Eligible Woman questionnaire focuses on health, education, family planning, marriage, female empowerment, and fertility. These "eligible" women are ever-married women ages 15–49. The sample also includes women older than 49 who were already interviewed in the first round of the

IHDS survey in 2005.[50] For these interviewed ever-married women, we construct proxies of women's empowerment and gender norms using their Eligible Woman questionnaire responses.

The IHDS includes questions about household phone ownership and individual phone use. We define women's phone use several different ways, which ultimately yields similar results. Our main outcome variable is women's mobile phone use in households with at least one mobile phone. As we are examining the role of norms in explaining female mobile phone use, we study 26,607 ever-married women in households that own mobile phones for whom economic barriers will be less of an issue.

In order to define proxies of women's empowerment and gender norms, we thematically group survey questions focused on different aspects of female empowerment from the IHDS Eligible Woman's Questionnaire. We calculate the means of these standardized survey questions, which we call empowerment component indices.[51] The themes cover mobility, marital harmony, whether women don't wear a veil ("No Veil"), financial independence, whether sexual harassment of unmarried girls is rare in the village ("Freedom from Harassment: Unmarried Girls in Community"), whether domestic violence of wives is rare in the community ("Freedom from Domestic Violence: Wives in Community"), latent work, and the say that women had in their marriage and whether they communicated with their husband before their marriage ("Marriage Decision Involvement"). Table D1 contains the specific survey questions in each empowerment component index.

TABLE D1 — DEFINITIONS OF EMPOWERMENT COMPONENTS INDICES

Empowerment Component	Description
Decision Making	Compound index of self-reported answers to whether respondent makes decisions of what to cook on a daily basis; purchase expensive item; number of children; what to do if they fall; whether to buy land; wedding expense
Mobility	Compound index of whether respondent has been to 1) a town, metro city, and another village or 2) state or 3) abroad in past 5 years
Marital Harmony	Compound index of whether respondent discusses community or politics, work or farm with husband, and has family outings to cinema, mela or restaurant
Eat Together	Whether respondent eats together with family at meals
No Veil	Whether respondent practices ghungat/burkha/purdah/pallu
Natal Family Contact	Compound index of how often respondent talks to natal family on telephone, visits natal family, or natal family visits respondent
Financial Independence	Compound index of whether respondent has name on bank account, has home ownership, or rental papers; has cash-in-hand for household expenditures
Freedom from Domestic Violence: Wives in Community	Compound index of whether it's unusual in community for husband to beat wife if she doesn't cook properly or respect elders, neglects house or child, natal family neglects them, husband suspects extramarital affairs, or wife leaves without permission
Freedom from Harassment: Unmarried Girls in Community	Whether unmarried girls are rarely and not often harassed in village/neighborhood
Latent Work	Respondent currently working for wage or pay; willing to work if suitable job; ever worked for pay or wages
Marriage Decision Involvement	Compound index of whether respondent emailed or spoke on internet with, saw photo of, spoke on telephone to, or met husband prior to marriage being fixed; age respondent first started living with husband; whether respondent knew husband before wedding; and whether respondent had a say in choosing husband

Source: Indian Human Development Survey-II, 2011–2012.
Notes: Empowerment component indices are means of standardized relevant survey questions contained in above table.

50 Henceforth, we use "ever-married women" to refer to women interviewed for the Eligible Woman questionnaire or eligible women, even though this sample doesn't necessarily include all ever-married women across all surveyed households.

51 These indices are means of the standardized survey questions.

We group these empowerment indices to capture various aspects of gender norms: economic engagement, decision making, mobility and community attitudes (described in Section 4). We use these variables as proxies of gender norms to quantify normative barriers facing women. We combine the measures for mobility, marital harmony, whether they don't wear a veil, financial independence, freedom from harassment for unmarried girls in community, latent work, and their involvement in their marriage decision into one index which we call the empowerment aggregate.[52] Building these proxies of norms and empowerment allows us to study how these factors relate to women's mobile phone use. As such, we can understand whether overcoming normative or empowerment barriers is associated with increased women's mobile phone use.

In Table D2, we show sample averages using the sample of ever-married women in households with at least one mobile phone (from our main outcome variable). The average age is 36.1, and women have 5.8 years of education. 66.5% of women are literate. 38.3% of women live in urban areas, and women have 2.5 children on average. Furthermore, we find statistically significant differences in demographic and socioeconomic characteristics among users and non-users of mobile phones. There are also statistically significant differences in empowerment component indices between users and non-users of mobile phones for all empowerment components except "Latent Work" and "Freedom from Harassment: Unmarried Girls in Community."

TABLE D2 — DESCRIPTIVE STATISTICS OF FEMALE RESPONDENTS (CONDITIONAL ON HOUSEHOLD HAVING A MOBILE PHONE)

	All		Non-users		Users		Regression		
	Mean (1)	St. Dev. (2)	Mean (3)	St. Dev. (4)	Mean (5)	St. Dev. (6)	Coeff. (7)	St. Err. (8)	N (9)
Demographic and Socioeconomic Characteristics									
Age	36.140	9.691	37.520	9.987	34.735	9.168	-1.904***	0.163	26607
Education (years)	5.778	4.953	4.079	4.460	7.509	4.830	3.378***	0.099	26606
Literacy	0.665	0.472	0.525	0.499	0.807	0.395	0.267***	0.009	26605
Number of children	2.526	1.522	2.772	1.605	2.276	1.390	-0.420***	0.031	26596
Number of years married	18.003	10.609	20.069	10.917	15.898	9.849	-3.244***	0.190	26566
Income Per Capita	0.050	1.068	-0.064	0.916	0.166	1.192	0.209***	0.016	26607
Total Income	0.061	1.064	-0.023	0.932	0.147	1.177	0.148***	0.019	26607
Household Assets (index)	0.176	0.944	-0.001	0.831	0.356	1.015	0.361***	0.018	26480
Urban	0.383	0.486	0.309	0.462	0.459	0.498	0.157***	0.012	26607
Scheduled Castes	0.202	0.402	0.214	0.410	0.190	0.392	-0.044***	0.008	26560
Scheduled Tribes	0.063	0.243	0.076	0.265	0.050	0.217	-0.025***	0.005	26560
Empowerment Component Indices									
Decision Making	-0.010	1.002	-0.012	0.992	-0.008	1.012	0.061*	0.026	25288
Mobility	0.052	1.015	-0.093	0.927	0.200	1.076	0.266***	0.021	25735
Marital Harmony	0.032	0.993	-0.084	1.014	0.151	0.958	0.197***	0.021	26284
Eat Together	0.021	0.996	-0.034	1.005	0.077	0.985	0.082***	0.019	26508
No Veil	0.028	1.004	-0.042	0.992	0.099	1.012	0.072***	0.020	26578
Natal Family Contact	0.048	0.996	-0.008	1.011	0.103	0.978	0.119***	0.020	25693
Financial Independence	0.033	1.010	-0.088	0.989	0.156	1.016	0.197***	0.023	25456
Freedom from Domestic Violence: Wives in Community	0.007	1.002	-0.023	1.014	0.038	0.989	0.097***	0.021	26504
Freedom from Harassment: Unmarried Girls in Community	0.003	1.005	-0.057	1.055	0.052	0.948	0.017	0.023	26111
Latent Work	-0.057	1.000	-0.076	1.027	-0.037	0.972	-0.012	0.021	26195
Marriage Decision Involvement	0.058	1.022	-0.138	0.914	0.257	1.085	0.359***	0.020	26402

Source: Indian Human Development Survey-II, 2011–2012. Notes: Subsample of all eligible women in households that have a mobile phone. Standard errors are clustered at the primary sampling unit level. Column (7) is the coefficient from regressing individually each characteristic on whether female respondents use mobile phones with state fixed effects, and column (8) is the standard error of the coefficient. Stars indicate significance levels: * p<0.05, ** p<0.01, *** p<0.001. Whether respondents live in an urban area and SC/ST group characteristics are indicator variables. Empowerment Components indices are means of standardized survey questions grouped thematically (specific questions contained in description table).

52 The empowerment aggregate is defined as the standardized mean of empowerment components: Mobility, Marital Harmony, No Veil, Financial Independence, Freedom from Harassment: Unmarried Girls in Community, Latent Work, and Marriage Decision Involvement.

D.3 Methodology

We describe our methodology to examine the relationship between women's mobile phone use and proxies of women's empowerment and socioeconomic factors, including education. We correlate women's mobile phone use with the empowerment aggregate and other factors. These descriptive regressions provide suggestive evidence of these factors as barriers to women's mobile phone use.

We start with the ordinary least squares (OLS) regression, where we regress the women's mobile phone use outcome variable $mobuse_{ihk}$ on using deciles $decile_{ihk}^d$ of the empowerment aggregate, income, or educational attainment (1). This is Figure 11 in Section 4:

$$mobuse_{ih} = \beta_1 + \sum_{d=2}^{10} \beta_d decile_{ih}^d + \varepsilon_{ih} \qquad (1)$$

$$mobuse_{ihk} = \beta_1 + \sum_{d=2}^{10} \beta_d decile_{ihk}^d + \gamma X_{ihk} + \alpha_k + \varepsilon_{ihk} \qquad (2)$$

$decile_{ihk}^d$ is equal to 1 if female i in household h in state k is in decile d of the right-hand side variable of interest and 0 otherwise. We run these regressions separately using deciles of the empowerment aggregate, deciles of income per capita (standardized) or levels of education (6 levels).

βd is interpreted as the additional change in women's mobile phone use associated with being in decile d over the first decile of the variable of interest. Standard errors are clustered at the primary sampling unit level, following Abadie et al. (2017). For rural areas, this is the village level; for urban areas, this is the neighborhood level. We use sample weights in the regressions so that the correlations are representative at the national level.

In (2), we perform the same regressions controlling for all of the deciles of the empowerment aggregate, income, educational attainment, and other factors (Figure 12 in Section 4). X_{ihk} contains demographic controls (age, age squared, number of years married, number of children, and Scheduled Castes and Scheduled Tribes groups) and economic controls (household assets and whether the respondent lives in an urban area). We also include α_k regional (primary sampling unit) fixed effects, to account for the region where women live.

Next, in Table 1 (Section 4), we use levels of the right-hand side variables in order to understand how these factors are associated with women's mobile use $mobuse_{ihk}$ and how they compare in magnitude.

$$mobuse_{ihk} = \beta_0 + \beta_1 Emp_{ihk} + \gamma X_{ihk} + \alpha_k + \varepsilon_{ihk} \qquad (3)$$

In (3), we replace the deciles of the right-hand side variable of the empowerment aggregate with the indicator variable for the empowerment aggregate Emp_{ihk}. $\beta 1$ is interpreted as the change in women's mobile phone use associated with a one standard deviation increase in the empowerment aggregate. X_{ihk} contains demographic controls (age, age squared, educational attainment, number of years married, number of children, and Scheduled Castes and Scheduled Tribes groups) and economic controls (income per capita, household assets, and whether the respondent lives in an urban area). We also control for regional fixed effects (α_k) that account for unobserved differences across regions, subsequently adding finer geographic controls in each column (state, district, then primary sampling unit fixed effects).

To further examine normative barriers, in Table D3 we look at the correlations between women's mobile phone use and the gender norms groupings (4):

$$
\begin{aligned}
mobuse_{ihk} = {} & \beta_0 + \beta_1 EconomicEngagement_{ihk} \\
& + \beta_3 DecisionMaking_{ihk} + \beta_4 Mobility_{ihk} \qquad (4) \\
& + \gamma X_{ihk} + \alpha_k + \varepsilon_{ihk}
\end{aligned}
$$

D.4 Robustness Checks

As robustness checks, we study two other outcomes, which changes the sample used in the analysis. First, we use women's mobile phone use as the outcome variable, which defines all ever-married women as the sample. We include 4,594 women in households without mobile phones that are excluded from the main analysis sample. Second, we use women's mobile phone use conditional on whether their husbands use mobile phones. In this robustness check, we exclude from our analysis households where the husband of the married woman doesn't use a phone. Husbands do not use mobile phones in 26.1% of all eligible women households. In 1.5% of eligible women households, wives use mobile phones while their husbands do not. Neither husband nor wife uses mobile phones in 24.7% of ever-married women households.

TABLE D4 — FEMALE RESPONDENT USES PHONE

	(1)	(2)	(3)	(4)	(5)
Empowerment Index	0.119***	0.038***	0.035***	0.030***	0.031***
	(0.005)	(0.006)	(0.005)	(0.005)	(0.005)
Education: Class 1-7		0.132***	0.138***	0.133***	0.134***
		(0.012)	(0.011)	(0.010)	(0.010)
Education: Class 8-12		0.251 ***	0.251***	0.244***	0.236***
		(0.013)	(0.012)	(0.011)	(0.011)
Education: Class 13 and over		0.364***	0.328***	0.326***	0.307***
		(0.020)	(0.019)	(0.018)	(0.018)
Income Per Capita		0.012***	0.010**	0.010**	0.009*
		(0.004)	(0.003)	(0.004)	(0.004)
Household Assets (index)		0.054***	0.074***	0.079***	0.079***
		(0.006)	(0.006)	(0.005)	(0.006)
Outcome Mean	0.412	0.412	0.412	0.412	0.412
Fixed effects	None	None	State	District	PSU
Control set	No	Demo. + Econ.	Demo. + Econ.	Demo. + Econ.	Demo. + Econ.
R-squared	0.050	0.153	0.253	0.339	0.436
Observations	31201	31201	31201	31201	31201

Source: Indian Human Development Survey-II, 2011-2012. Notes: Standard errors in parentheses are clustered at the primary sampling unit level. Demographic variables include age, age squared, education level (indicator variables), number of years married, number of children, and Scheduled Castes and Scheduled Tribes (SC/ST) caste groups. Economic controls include income per capita (standardized), household assets (standardized index), and whether the respondent lives in an urban area. The empowerment aggregate is a standardized mean of Empowerment Components: Mobility, Marital Harmony, No Veil, Financial Independence, Freedom from Harassment: Unmarried Girls in Community, Latent Work, and Marriage Decision Involvement. Empowerment Components indices are means of standardized survey questions grouped thematically (specific questions contained in description table). Stars indicate significance levels: * $p<0.05$, ** $p<0.01$, *** $p<0.001$. F tests compare the empowerment aggregate coefficient with the variable listed.

We find similar results as in the analysis of the women's mobile phone use primary outcome variable. The robustness check includes all households, even those that don't have mobile phones. As a result of including whether or not households owns phones, we see a few minor differences in the results. First, in Table D4 the outcome mean of this robustness check is 0.412 whereas the mean of the sample of women conditional on their household having a mobile phone is 0.484. Second, in Table D4, another key difference between the robustness check and the analysis of the main outcome variable is how much household assets matter for women's mobile phone use. In the robustness check for all ever-married women, household assets matter more once we account for where (the state, district

or primary sampling unit) women live. In the main analysis, we exclude households that don't have mobile phones, and once we account for the district or primary sampling unit where women live, we cannot conclude that empowerment and household assets matter differently.[53] However, when we limit the analysis to women's mobile phone use conditional on her husband's use (Table D5), the results are strikingly similar to the main results.

We ultimately find similar results in our robustness checks as in the main analysis. While there are some minor differences, women's mobile phone use increases with proxies of empowerment and gender norms, income and education, even after accounting for demographic and economic factors, and the region where women live.

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53 In the main analysis, we find that the empowerment aggregate matters for women's mobile phone use but that the household assets don't matter for women's mobile use, after accounting for demographic and economic controls. After we account for where women live, we find that household assets matters for women's mobile phone use. However, as we more finely account for where women live, we cannot say that women's empowerment matters more than household assets.

TABLE D5 — FEMALE RESPONDENT USES PHONE (CONDITIONAL ON HUSBAND USING A MOBILE PHONE)

|	(1)	(2)	(3)	(4)	(5)
Empowerment Index	0.091	0.034	0.042	0.035	0.034
	(0.006)	(0.007)	(0.006)	(0.005)	(0.006)
Education: Class 1-7		0.144	0.153	0.144	0.152
		(0.015)	(0.013)	(0.012)	(0.012)
Education: Class 8-12		0.253	0.248	0.237	0.234
		(0.015)	(0.013)	(0.012)	(0.012)
Education: Class 13 and over		0.396	0.348	0.337	0.315
		(0.022)	(0.020)	(0.018)	(0.019)
Income Per Capita		0.017	0.015	0.015	0.012
		(0.004)	(0.004)	(0.005)	(0.006)
Household Assets (index)		-0.009	0.013	0.027	0.031
		(0.007)	(0.006)	(0.006)	(0.006)
Outcome Mean	0.537	0.537	0.537	0.537	0.537
Fixed effects	None	None	State	District	PSU
Control set	No	Demo. + Econ.	Demo. + Econ.	Demo. + Econ.	Demo. + Econ.
R-squared	0.031	0.088	0.239	0.354	0.473
Observations	23622	23622	23622	23622	23622

Source: Indian Human Development Survey-II, 2011-2012. Notes: Subsample of all eligible women whose husbands use a mobile phone. Standard errors in parentheses are clustered at the primary sampling unit level. Demographic variables include age, age squared, education level (indicator variables), number of years married, number of children, and Scheduled Castes and Scheduled Tribes (SC/ST) caste groups. Economic controls include income per capita (standardized), household assets (standardized index), and whether the respondent lives in an urban area. The empowerment aggregate is a standardized mean of Empowerment Components: Mobility, Marital Harmony, No Veil, Financial Independence, Freedom from Harassment: Unmarried Girls in Community, Latent Work, and Marriage Decision Involvement. Empowerment Components indices are means of standardized survey questions grouped thematically (specific questions contained in description table). Stars indicate significance levels: * $p<0.05$, ** $p<0.01$, *** $p<0.001$. F tests compare the empowerment aggregate coefficient with the variable listed.

E Stakeholder Engagement

Figure E4 maps the three main categories of stakeholders that we contacted during Phase I: potential data partners, implementation partners and policy partners. Data partners are those who collect, aggregate and analyze data related to mobile phone usage. Implementation partners largely refer community-based organizations that have women-centric programming or work with mobile based

technology. Policy partners refer to governmental departments and nodal agencies that have an interest in leveraging technology to reach out to women. Each of the three types of partners have potential to disseminate and scale up findings.

FIGURE E4 — MAP OF STAKEHOLDER ENGAGEMENT

Mobile-based Industry Associations	Research Agencies	Telcos	Gender		Mobile-based Technology	Government Agencies
Internet and Mobile Association of India	Centre for the Study of Developing Societies	Vodafone	Facebook	MFIs: KGFS, Arohan, Sonata	Awaaz De	Ministry of Electronic and IT
Cellular Operators Association of India	Centre for Social Research	Reliance JIO	Safe City, Safetipin	SEWA	Votomobile	Chhattisgarh Infotech Promotion Society
GSMA	Tandem Research, Ideas 42	Payment Banks: IBBP, Airtel, Aditya Birla, Paytm	BBC Media Action	MannDeshi Foundation	Digital Empowerment Foundation	Department of Telecommunication
	Nowfloats, Media Ant		Ajeevika Bureau		Catalyst	Ministry of Rural Development
	Dalberg		Tata Trusts		FAT, Girl Effect	Ministry of Woman and Child Development
	Oxford Policy Management		Internet Saathi Program		Graam Vaani	
	Internet Democracy Project		Center for Crime Prevention and Victim Care		EkStep	
					Dimagi	

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