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The Social Implications of Technology Diffusion: Uncovering the Unintended Consequences of People's Health-Related Mobile Phone Use in Rural India and China

MARCO J. HAENSSGEN [a,b] and PROOCHISTA ARIANA [a,*]
[a] *University of Oxford, UK*
[b] *Green Templeton College, Oxford, UK*

Summary. — After three decades of mobile phone diffusion, thousands of mobile-phone-based health projects worldwide ("mHealth"), and hundreds of thousands of smartphone health applications, fundamental questions about the effect of phone diffusion on people's healthcare behavior continue to remain unanswered. This study investigated whether, in the absence of specific mHealth interventions, people make different healthcare decisions if they use mobile phones during an illness. Following mainstream narratives, we hypothesized that phone use during an illness (a) increases and (b) accelerates healthcare access.

Our study was based on original survey data from 800 respondents in rural Rajasthan (India) and Gansu (China), sampled from the general adult population in 2014 in a three-stage stratified cluster random sampling design. We analyzed single- and multi-level logistic, Poisson, and negative binomial regression models with cluster-robust standard errors. Contrary to other research at the intersection of mobile phones and healthcare, we captured actual health-related mobile phone use during people's illnesses irrespective of whether they own a phone.

Our analysis produced the first quantitative micro-evidence that patients' personal mobile phone use is correlated with their healthcare decisions. Despite a positive association between phone use and healthcare access, health-related phone use was also linked to delayed access to public doctors and nurses. We considered theoretical explanations for the observed patterns by augmenting transaction cost and information deficit arguments with the prevailing health system configuration and with notions of heuristic decision-making during the healthcare-seeking process.

Our study was a first step toward understanding the implications of mobile technology diffusion on health behavior in low- and middle-income countries in the absence of specific mHealth interventions. Future research will have to explore the causal relationships underlying these statistical associations. Such a link could potentially mean that development interventions aimed at improving access to healthcare continue to require conventional solutions to sustain healthcare equity.

Key words — social implications of technology diffusion, mobile phones, healthcare access, India, China, mHealth

1. INTRODUCTION

The world has undergone a rapid mobile connectivity transition during the past decade: Up to 630 million new subscriptions per year were added in low- and middle-income countries (LMICs; 40% of this growth was occurred in India and China), and these countries now account for three in four mobile phone subscriptions worldwide (ITU, 2015a, 2015b). As mobile technology diffuses, hopes arise that previously stubborn development challenges can be overcome with their help (Duncombe, 2012: p. 2; Díaz Andrade & Urquhart, 2012: p. 289; Flor, 2015; Heeks, 2014: p. 2; Unwin, 2009: p. 1).

Public health actors have responded to this trend with 1,123 ongoing and planned "mHealth" projects worldwide (according to the mobile industry organization Groupe Speciale Mobile Association as of January 5, 2016; GSMA, 2016). mHealth interventions use mobile phones to improve health systems and health service delivery. LMICs dominate the mHealth landscape, representing eight of the top-ten countries by project count (GSMA, 2016, 2015). In addition to such specific interventions, Apple's *iTunes* smartphone application ("app") store alone contains 101,672 health-related apps across the categories "Health & Fitness" and "Medical" (our count as of January 5, 2016), and the global health app market is expected to soar from a volume of $2.4 billion in 2013 to $26 billion by 2017 (Apple Inc., 2016; research2guidance, 2014: p. 7). For comparison, the worldwide program expenditures of the Bill and Melinda Gates Foundation in 2014 amounted to $4.8 billion (Bill & Melinda Gates Foundation, 2015: p. 14).

The excitement, enthusiasm, and activity surrounding mHealth reflect common narratives that mobile technology offers near-limitless public health "potential" and "tremendous opportunities" that should not go unharnessed (Agarwal & Labrique, 2014: p. 230; Philbrick, 2012: p. 6; Qiang, Yamamichi, Hausman, Miller, & Altman, 2012: p. 15; Rodin, 2010: p. 6; WHO, 2011: p. 1). Moreover, the emphasis on LMICs follows aspirations to deliver health services and information more efficiently, effectively, and equita-

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bly—especially for otherwise disadvantaged groups (Anglada-Martinez *et al.*, 2015: p. 28; Kwan, Mechael, & Kaonga, 2013: p. 27; van Heerden, Tomlinson, & Swartz, 2012: p. 394).

Despite the enthusiasm, fundamental questions about the healthcare implications of mobile phone use have remained unanswered. Based on our knowledge of the social implications of technology diffusion in high-, middle-, and low-income contexts (e.g. technological change influencing social roles and relationships), we should expect mobile phone diffusion to affect health and healthcare because it also influences other dimensions of development like political participation or economic activity. Yet the research on the healthcare consequences of mobile phone use among patients (which is the focus of this paper) remains surprisingly limited. A better understanding of positive as well as negative consequences of mobile phone use on people's health-seeking behavior is therefore important for the branch of mHealth that delivers interventions through this platform to patients.

As part of the broader study of the social implications of technology diffusion, this paper investigated the effect of mobile phones on people's healthcare-seeking behavior in two rural low- and middle-income contexts. We focused specifically on the health-related use of mobile phones regardless of whether somebody actually owns a phone (thus including uses by a third party for the patient) and on contexts where mHealth interventions are yet underdeveloped (as this would confound specific health interventions with more general processes of technological change). The overarching research question for this paper therefore was, "In the absence of specific mHealth interventions, do people make different healthcare decisions if they use a mobile phone during an illness?" To answer this question, we tested two hypotheses on the implications of phone-aided healthcare-seeking behavior, using novel survey data from rural Rajasthan (India) and rural Gansu (China):

H1. Compared to illness episodes that do not involve a mobile phone, phone-aided healthcare-seeking increases access to healthcare.

H2. Compared to illness episodes that do not involve a mobile phone, phone-aided healthcare-seeking leads to faster access to care.

Our analysis produced the first quantitative micro-evidence that patients' mobile phone use is correlated with decisions in their healthcare-seeking process. An implication of our study is that future patient-focused mHealth projects potentially compete with people's existing (non-mHealth) mobile-phone-based solutions, and mHealth interventions may have to combat adverse behaviors created by the mobile phone platform itself.

2. RELATED LITERATURE AND HYPOTHESES

This paper speaks to the technology diffusion literature, in particular to the social implications of technological change. Previous social sciences research has revealed that technology diffusion affects societal behavior and economic practices, on the basis of which we could expect mobile phones to have similar implications. While such research has been carried out with a focus on economic activity, political participation, and social interaction, the impact of phone diffusion on healthcare as an important dimension of human development has been neglected. In response to this gap, we carried out the first quantitative study to explore the influence of mobile phone use on people's healthcare-seeking behavior in the absence of a specific intervention. Drawing on conventional transaction cost and information deficit arguments, we hypothesized that mobile phone diffusion increases and accelerates healthcare access.

(a) *The social implications of technology and mobile phone diffusion*

Our study started from the assumption that mobile phone use has health-specific implications that relate to the broader body of literature on the social implications of technology diffusion. According to this literature, a technological innovation evolves and interacts with society during the process of its diffusion (Brown, 1981: p. 174; Ling, 2012: pp. 4–50; Pedersen & Bunkenborg, 2012: p. 565). This process can lead to emerging and unexpected uses of the technology (as exemplified by Bijker (1995: p. 270), Cresswell (2002: pp. 182–185) and von Hippel (2010: pp. 414–415)), but it is also widely understood to have social, economic, and political implications.

Development-related outcomes often ensue where technical change interacts with social change, but there is no guarantee that technological change processes are advantageous from a development perspective (Murdock, Hartmann, & Gray, 1994: p. 148; Pfaffenberger, 1992: pp. 511–512). Anthropological, sociological, and economic studies have provided some first insights that the diffusion of mobile phones as information and communication technologies (ICTs) interacts with social change (for a selection of recent reviews, see e.g. Aker & Blumenstock, 2015; Aker & Mbiti, 2010; Duncombe, 2011; Jensen, 2010; Martin, 2014; May & Diga, 2015; Nakasone, Torero, & Minten, 2014; Porter, 2012; Walsham, 2010). Research in this area considers especially the economic consequences of mobile phone diffusion and LMIC-focused studies typically investigate the impacts on poverty levels of the general population and the market activities of farmers and entrepreneurs (Aker & Mbiti, 2010: pp. 213–214; Jensen, 2007: p. 896). Less research attention—mostly from high-income contexts—has been devoted to changes in social interactions and relationships emanating from phone diffusion (Miritello *et al.*, 2013; Roberts & Dunbar, 2011; Saramäki *et al.*, 2014). In addition, despite the rapid growth of phone-based interventions (e.g. information services) under the heading of "information and communication technologies for development" or "ICT4D" (Duncombe, 2012: p. 2; Díaz Andrade & Urquhart, 2012: p. 289; Flor, 2015; Heeks, 2014: p. 2; Unwin, 2009: p. 1), we do not yet understand sufficiently the behavior of mobile phones as platforms for mobile-phone-based development initiatives like mHealth (Aker & Mbiti, 2010: pp. 225–227).

Despite the limited evidence on the social implications of mobile phone diffusion, the growing body of anthropological, sociological, and economic research should lead us to expect that mobile phone diffusion entails social change. The domain of health—arguably an important dimension of development—is probably no exception.

(b) *Mobile phones in healthcare*

Research interest at the intersection of mobile technologies and healthcare in high-, middle-, and low-income countries has grown rapidly over the last decade. With at least 60 systematic reviews and reviews of reviews, the vast majority of

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