# Users as innovators in developing countries: The global sources of innovation and diffusion in mobile banking services

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ABSTRACT

This paper examines the extent to which users in developing countries innovate, the factors that enable these innovations and whether they are meaningful on a global stage. To study this issue, we conducted an empirical investigation into the origin and types of innovations in financial services offered via mobile phones, a global, multi-billion-dollar industry in which developing economies play an important role. We used the complete list of mobile financial services, as reported by the GSM Association, and collected detailed histories of the development of the services and their innovation process. Our analysis, the first of its kind, shows that 85% of the innovations in this field originated in developing countries. We also conclude that, at least 50% of all mobile financial services were pioneered by users, approximately 45% by producers, and the remaining were jointly developed by users and producers. The main factors contributing to these innovations to occur in developing countries are the high levels of need, the existence of flexible platforms, in combination with increased access to information and communication technology. Additionally, services developed by users diffused at more than double the rate of producer-innovations. Finally, we observe that three-quarters of the innovations that originated in non-OECD countries have already diffused to OECD countries, and that the (user) innovations are therefore globally meaningful. This study suggests that the traditional North-to-South diffusion framework fails to explain these new sources of innovation and may require re-examination.

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## 1. Introduction

Information and Communication Technologies (ICT) offer a myriad of opportunities for low-cost innovations by users that sometimes can be of high value and can significantly increase the usage of the underlying technology. An example of this is *Twitter*, in which users added a very valuable new functionality via hashtags, by simply using the platform capabilities differently. Similarly, users of *Nokia Beta Labs* pioneered mobile services leveraging the Nokia platform; two of the most popular examples are *Sportstracker*, which tracks and stores workouts, and *PC Suite*, which connects and synchronizes mobile devices with PCs (Mahr and Lievens, 2012). These types of modifications by users are often low-cost, yet the resulting services can add great value to a given technology.

Low-cost innovations are also increasingly observed in developing countries, and are sometimes called frugal innovation (Bound and Thornton, 2012) or grass-roots innovation (Gupta et al., 2003). One such example is *A Little World* (ALW), a system pioneered in India, which reduced a bank branch to a smart-phone and a fingerprint scanner, thereby bringing financial services normally reserved for urban populations to rural customers. Many service innovations that originated in developing countries have had a tremendous impact on the financial service landscape. For example, *M-Pesa*, one of the most successful implementations of a mobile money service (i.e., Jack and Suri, 2011), is used by more than 70% of Kenyan adults (IMF, 2011) and by 50% of the poor, unbanked and rural populations (Alexander, 2010).

Despite its increasing importance, there is a dearth of rigorous research looking at the role that users play as innovators in developing countries. This paper investigates three main questions. First, to what extent can users play a role in innovation in developing countries? Second, what are the main factors that enable users from developing countries to innovate? Third, what is the global relevance and diffusion pattern of innovations that originate in the developing world? To address these questions, we investigated the

origins and types of innovations in financial services offered via cell-phones, a multi-billion-dollar industry termed "mobile banking." Users pioneered some of the most important services in this industry, such as the transfer of domestic airtime, i.e., prepaid cell-phone credit to be used for text and voice. When mobile phones became available in developing countries, pre-paid users would recharge their phone using scratch cards. These scratch cards would be distributed by the telecom operator and could be bought at any corner store. When scratched, the card would reveal a unique multi-digit activation code that, when typed into the phone, would credit airtime to that customer's phone number. In 1998, customers in the Philippines, an archipelago made up of 7100 islands with poor access to financial services, realized that they could use this functionality to transfer airtime load between each other (Petalcorin, 2011). One person would buy a scratch card and send the unique activation code by SMS to a relative across the country, who would then use the code to upload the credit onto his or her own phone. These users pioneered domestic airtime transfer between two different phone numbers. Shortly after, in December 2003, Smart, the largest telecom company in the Philippines, realized the potential of this service and launched *PasaLoad*, which allowed electronic airtime transfer among customers.

The development of these novel services defies the way we typically think about innovation. First of all, users self-provided the services of domestic airtime transfer, and several others such as merchant payment, before any producer offered them in the market. This contradicts the bulk of the service innovation literature, which describes innovation as a process carried out by service providers (e.g., Hertog Den, 2000; Miles, 2007, 2008; Tether et al., 2001). Second, it is surprising to observe these globally significant innovations in an emerging economy, such as the Philippines, because R&D activity and major innovation activity are not expected to take place outside of Organization for Economic Co-operation and Development (OECD) countries (Bayoumi et al., 1999; Coe et al., 1997; Seck, 2011). However, since the two aforementioned innovations were first marketed in the Philippines, more than 50 other telecom providers around the world have offered Domestic Airtime Transfer, and 30 have offered a merchant payment service, including in the United States. This evolution demonstrates the value of these innovations. It is also at odds with the traditional "North–South" portrayal of world-class innovation as typically appearing in industrialized nations and then flowing from these regions to developing economies (Bayoumi et al., 1999; Coe et al., 1997; Saggi, 2002).

As there is no adequate conceptual and empirical toolkit for studying and understanding these phenomena, we set out to systematically analyze the financial services currently offered through mobile phones. We detailed the development of all services in the mobile banking industry, developed a structured set of rules to analyze the origin of service innovations, and applied these to currently available mobile banking innovations. We also investigated their relative importance and subsequent diffusion around the world. To the best of our knowledge, this is the first study to assess the global relevance of user innovations coming from developing countries. It is also the first to provide evidence of an industry in which user-innovations in developing countries have successfully diffused to industrialized countries.

The rest of this paper is structured in five parts. Section 2 lays out the literature that is pertinent to our research question. Section 3 outlines the empirical work: how the data on mobile banking services was collected, how the innovations were coded and verified using inter-rater reliability methods, and, finally, what further analyses were conducted. Section 4 presents the main findings of the analyses and explains the results related to the types of innovations and the sources of innovation, as well as the geographic origin and diffusion of the innovations. Finally, Section 5 contains

a brief discussion of these results and their implications, and offers conclusions together with suggestions for further research.

## 2. Background

We briefly outline previous research that inform our work in three themes: users as innovators in services; need as a driver for innovation and its impact on innovation in developing countries; and the geographic origin and diffusion of innovations.

### 2.1. Users as service innovators

In contrast to producers, who pursue innovation for profit, users typically innovate to satisfy their unmet needs. The idea of users improving products is not new (e.g., von Hippel, 1976). Yet, a number of studies over the last few years (Herstatt and Hippel, 1992; Jeppesen, 2004; Shah, 2006; von Hippel, 2005) have concluded that user-innovation is gaining importance (see Bogers et al., 2010, for a survey of the literature). This trend has been observed in a wide range of products and industries, ranging from scientific instruments (von Hippel, 1976, 2005), to industrial products (Morrison et al., 2000; Franke and Hippel, 2003) and consumer goods (Franke and Shah, 2003; Luthje, 2004).

Although the notion that users can be a source of innovation for new products has been receiving increasing attention, work on the topic of users as innovators in services is scarce. While a few studies have considered consumers as service co-producers (Drejer, 2004; Gallouj and Weinstein, 1997), most existing research do not look at users as potential service creators or innovators (e.g., Barras, 1986; Menor and Roth, 2008). Yet, services constitute a significant share of the world's economy, especially in developed nations (Buera and Kaboski, 2009). For example, in the United States, 75% of the GDP and 80% of employment derives from services (OECD, 2013). Therefore, we need to better understand the nature of service R&D and innovation (Gallouj and Savona, 2009). Considering the role of users in service innovation appears to be an important avenue to be further developed.

Initial work on the role of users in service innovation has shown that users can play an important role in the development of novel services for their own use, which later become important innovations throughout the industry (e.g., Oliveira and Hippel, 2011; Baldwin and von Hippel, 2011; Repo et al., 2004). However, because the literature in this area is still scarce, no systematic or standardized methods for analyzing and categorizing the origin of service innovations are available. Furthermore, there is no clear understanding of how user service-innovation fits into the existing service-innovation paradigms, such as the "reverse product cycle" (Barras, 1986), or what characteristics it exhibits (Gallouj and Weinstein, 1997). These observations beg for additional exploration on the role of users in service innovation, which is at the core of this paper.

### 2.2. Need as a driver for innovation in developing countries

The notion that a larger expected benefit for innovation increases the investment in innovation has been recognized since the early literature on the economics of innovation (Mansfield, 1968; Mowery and Rosenberg, 1979; Schmookler, 1966). Recent work confirms this longstanding perspective. For example, Acemoglu and Linn (2004) showed that a larger potential market size for a new drug would lead pharmaceutical firms to invest more in its development. The problem is that such perspective leads to investment decisions that are skewed toward the most developed and rich markets, instead of addressing people and issues of the highest need. This is evident in the pharmaceutical industry, where, for example, "investment in research for malaria,

at $42 per fatal case, is at least 80 times lower than for HIV/AIDS and 20 times lower than for asthma" (Trouiller et al., 2002, p. 2191). This is attributed to the fact that malaria predominantly affects patients in the developing world who have little to no purchasing power. Not only are the levels of investment in innovation lower in markets with a lower potential for profits, but the quantity of commercialized drugs is also smaller, as is shown by the proportion of new drugs for diseases that are most prevalent among the poor: only 16 out of the 1393 new chemical entities marketed between 1975 and 1999 were for tropical diseases and tuberculosis (Trouiller et al., 2002).

In the case of users, individual need is often a more important driver of innovation than potential market size, as shown in a variety of empirical studies of user innovation (Franke et al., 2006; Urban and von Hippel, 1988). In particular, users with characteristically higher-than-average-needs have been shown to be particularly keen innovators. For example, practitioners of extreme sports (Tietz et al., 2005) are responsible for a high proportion of user innovation related to the acute and unresolved need for life-saving solutions and improved safety.

Franke and Hippel (2003) observe that there is often a large heterogeneity of customer needs in a given market, and that standard products in the marketplace often leave important needs unfulfilled. In developing markets, in which the portfolio of commercially offered products and services is typically smaller and of lower quality (Flam and Helpman, 1987; Trouiller et al., 2002), one is more likely to find a wider range of unmet needs, as well as customers who potentially create solutions to meet their own needs.

Analyzing need as a determinant for the locus of innovation is especially relevant at a time when users across the developed and developing worlds are gaining more access to tools and technologies that allow them to solve problems in novel ways (Baker and Nelson, 2005, p. 333). For example, as cell phones, smart phones and the internet infiltrate our lives, the costs for the user to overcome a variety of unmet needs, from accessing information on the value of a tradable commodity, to paying the bill of a remote supplier, are greatly reduced. As a result, one would expect more novel and significant innovations emerging from constrained environments, especially through users trying to solve unmet needs. Users are more likely to resort to bricolage when resources are scarce (e.g., Baker and Nelson, 2005; Cunha et al., 2014), but despite the notion that one should expect a high incidence of user innovation in developing countries, spurred by high need, there is little to no work that looks at this.

### 2.3. Origin and diffusion of innovation

When looking at the geographic origin of innovations, existing studies have found that R&D activity and innovation are typically concentrated in industrialized nations, the so-called "North" (Porter, 1990). Technology then makes its way from industrialized nations to the remainder of the world within the established North–South diffusion framework (Krugman, 1979; Coe et al., 1997). The literature (Flam and Helpman, 1987; Grossman and Helpman, 1991) largely considers that no innovation happens in the South, and that any products created there are not "new to the world"—the most significant innovation category, as classified by OECD (2005). Moreover, when an innovation occurs in the South, it is only valuable there—i.e., innovations from the South have low utility in industrialized countries and therefore, do not diffuse there (Acemoglu et al., 2006; Gupta et al., 2003).

Despite this perspective, a growing number of examples show that several significant innovations in recent years were developed outside the realm of OECD countries. An example is the hand-held electrocardiogram (ECG) called the Mac 400, developed by General Electric (GE) in Bangalore. This is now seen as a benchmark technology in developing and developed nations alike, and has sparked the term "reverse innovation" (Immelt et al., 2009; Govindarajan et al., 2012), defined as an innovation that originates and is likely to be adopted first in developing countries and only later in the developed world. This and other cases show that the unique needs of the market and a scarcity of alternatives can lead to valuable innovation in the South.

Evidence that producers such as GE India have come up with novel innovations that eventually transferred to the North is starting to challenge the North-South innovation-diffusion paradigm. It appears that the rapid diffusion of information and communication technology, including to developing nations (Comin et al., 2006; Fu et al., 2011; Keller, 2002), is leveling the innovation playing field. Therefore, in some industries, the North and South might be converging on the same rung of the "quality ladder" (Flam and Helpman, 1987; Grossman and Helpman, 1991). When this happens, and the lag between industries in the North and South is reduced, there is a higher chance that new products and services created in the South will also be new to the world, and that they will eventually trickle up. This observation suggests that one should systematically explore the extent to which, and under what conditions, innovations from the South can also be novel to the world and diffuse to the North.

Our understanding of the North-South relation on innovation and diffusion is also limited because technology transfers through trade, foreign direct investment, and knowledge markets have been studied mainly as a producer-centric process (Bayoumi et al., 1999; Keller, 2002; Saggi, 2002). However, there is still much we do not know about the role that users can play in innovation in developing countries and other high-need environments, and how they can condition the diffusion patterns of these innovations. Considering the user perspective is important because a set of countervailing forces condition the diffusion of user innovations. On one hand, since users innovate to solve their own needs, they lack incentives to diffuse their innovations (De Jong and Hippel, 2009). In addition, because users typically share their innovations for free (Harhoff et al., 2003), they often do it via non-market mechanisms, such as peer-to-peer diffusion, or through communities (Baldwin and von Hippel, 2011), which can be seen as limiting. In contrast, producers are profit-driven, which they secure through sales to new customers. Therefore, they are strongly incentivized to widely diffuse their innovations. However, information regarding market needs is often "sticky" to users—where "sticky" means costly to acquire, transfer and use. Therefore producers have higher costs in obtaining this information (von Hippel, 1994). As a result, user innovations are more likely to cater accurately to market demand, which could lead to higher adoption rates, when compared to producer innovations. This study provides a unique opportunity to advance our understanding of these phenomena.

## 3. Research design

### 3.1. Empirical context: financial services and mobile phones in developing markets

The telecommunications industry is known for its fast technological progress and is currently the most rapidly growing technology in the developing world (Duncombe and Boateng, 2009). Initially, the mobile phone was conceived as a basic tool for communication. Yet the mobile phone quickly evolved into a multipurpose platform that is now used for all sorts of services: games, SMS gambling, broadcasting, as an anti-corruption tool during elections, increasing market efficiency, map services, music, and video (Jensen, 2007). With the introduction of smart phones and

mobile applications, the list has become nearly infinite and is still expanding.

Thus far, as with most existing technologies, it has been assumed that the frontier of mobile phone service innovations is in the developed world. However, the constrained circumstances in poorer countries appear to be particularly important in terms of pushing the functional boundaries of mobile phone use. In fact, many important and inventive uses for the mobile phone, as well as new mobile services, are being created by start-ups in developing countries, in areas as diverse as education (e.g., Campomoja, M-Prep), disaster response (e.g., Ushahidi, Ufahamu), or agricultural information (e.g., DrumNet, M-Kilimo). These examples suggest that local resources are being successfully deployed to address local problems in the South.

Within the telecom industry, mobile banking is a particularly attractive sector to consider when studying service innovation because adoption of services in this field has been particularly rapid and widespread. This is not surprising, as financial and business services are often leaders in service innovation (Barras, 1990). There have also been several important technological innovations in the field of mobile payments.[1] The real innovations, however, have been in new service delivery, mostly building on technological capabilities already available on all mobile phones, such as SMS or USSD.[2] In little more than a decade, 20 new services were introduced that diffused to more than 70 countries, representing over 400 individual firm-country service entries. Furthermore, mobile banking has provided unprecedented access to financial services, especially in the developing world.

Cell-phone use in poorer areas of the world is different from that in developed countries. For many users in less developed environments, the availability of services is not good enough, handsets are too expensive, airtime runs out too quickly, and promised services are not delivered (Hellstrom, 2010). These and many other reasons lead to unconventional usage. For example, many people share handsets (Heeks, 2009), or use phones for their built-in radio, clock, or flashlight functions.

Financial services in developing countries also have specific characteristics. It has been commonly thought that poorer people make use of few and simple financial services in their lives. Yet, contrary to this long-held perspective, recent empirical studies have shown that these users are dynamic and creative in assembling their financial services. For example, Collins et al. (2009) analyzed the financial diaries of people earning less than $2 per day in South Africa, Bangladesh and India, and found that, on average, these people used up to 10 different financial instruments. Additionally many people created their own portfolios and develop elaborate savings mechanisms. The use of financial services through mobile phones is at the core of these dynamics. Widespread adoption of mobile financial services has been possible because of the nearly six billion mobile subscriptions worldwide, of which more than 4.5 billion are in the developing world (ITU, 2012) – see Appendix D in Supplementary data. Within this group, approximately 1.5 billion people with a mobile phone subscription do not have access to a bank account, which means that nearly half of the unbanked population has access to a mobile phone (Kunt et al., 2008; Pickens, 2009). This access gap has been a key driver for producers and consumers to explore the functionalities of the mobile phone with the purpose of providing financial services. Not surprisingly, a plethora of innovations centered around mobile phones has appeared in the past decade, creating enormous benefits for producers and consumers alike (Aker and Mbiti, 2010; Porteous, 2006). In the following sections, we will use the term "mobile banking" in a broad sense, encompassing mobile money and mobile commerce.

### 3.2. Methods and data collection

Our study follows previous work (e.g., von Hippel, 1976; Morrison et al., 2000; Franke and Hippel, 2003; Franke and Shah, 2003; Luthje, 2004; Oliveira and Hippel, 2011) in using a multi-method longitudinal analysis, including an in-depth historical analysis drawing on primary and secondary sources. We extend existing practice by creating and applying a novel method to systematically categorize service innovations and, for the first time, apply inter-rater coding to categorize user service innovations. A demarcation approach is used, as defined by Coombs and Miles (2000), in which service innovations are studied using distinctive methods and are not directly compared to manufacturing innovations. The services in our sample were introduced over the last 20 years, following the adoption of cell-phones, but most appeared in the last decade. We first identified all of the financial services offered through mobile phones. For that purpose, we used as a baseline the complete list of financial services that are currently available through mobile phones, as reported in the Deployment Tracker published by the GSM Association (GSMA).[3]

An in-depth historical analysis is performed on these services, using primary and secondary sources that include company reports, news articles, case studies, documents by vendors, and interviews with experts and researchers from the Consultative Group to Assist the Poor (CGAP) and GSMA. Additionally, we visited global trade conferences organized by GSMA on mobile banking and mobile money transfer services, and interviewed the creators of some of these services. Interviews were held with industry leaders and researchers to understand better how the industry emerged. We identified the histories of each service as well as its innovation source, and examined the roles of users and producers in the process. Based on analysis of the detailed developmental histories of the services and their innovation process, we identified the date and location of first commercialization. The innovation date we considered in coding the data was the date of implementation of the service; in other words, the date at which its use was first witnessed in the market. The detailed histories of each innovation are presented in Appendix A (Supplementary data).

The advantage of using these historical methods is that we were able to share our innovation histories with experts for validation, making the data collection process iterative and continuous. The disadvantage is that we might have missed some of the innovation histories, especially those hardest to find, often the user innovation efforts.

In our thorough search, we also found that several services reported in GSMA's list were overlapping or missing. We thus modified GSMA's list of services slightly with data from October 2011, to ensure that it included all current, commercially available mobile financial services. After these adjustments, the base sample for our analysis comprised 24 services. We then used a series of criteria to demarcate our sample clearly and decide whether or not the

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[1] Some examples of technological innovation include Near Field Communication (NFC) for proximity payments; software functionalities that integrate mobile "wallets" with bank accounts; and safety measures such as cryptographic mechanisms or the Public Key Infrastructure (PKI) mechanism (Sadeh, 2003).

[2] USSD = Unstructured Supplementary Service Data (USSD), which is a service protocol used by mobile phones to communicate with the network service provider's system.

[3] The Deployment Tracker (GSMA, 2011) contains country-level data on the range of mobile money and mobile banking initiatives offered by members of the GSM Association, which include 750 mobile operators and 200 companies in the global mobile ecosystem. A deployment consists of one firm offering a portfolio of mobile financial services in a national market under its brand name. In most cases, there were multiple deployments per country, and each deployment included multiple services.

service belonged in our consolidated list; ultimately, it was decided that mobile phones needed to be used as part of the service, and producers needed to have commercialized the service. By requiring that the producer commercialize the service, we were conservative with our sample, because user innovations that have not (yet) been commercialized by a producer are excluded (for more details see Appendix E in Supplementary data). Because of the condition of commercialization, our sample also excludes innovations diffused via non-market mechanisms, such as peer-to-peer diffusion or open and collaborative innovation, methods of diffusion often used by user innovators (Baldwin and von Hippel, 2011).

The result was a sample of 20 services (listed in Table 1) that were classified according to four sub-categories used within the industry literature (Donner, 2007; Porteous, 2006): Mobile Banking (performing banking services through the mobile phone), Mobile Commerce (buying goods using the mobile phone), Mobile Money (handling money and currency through the mobile phone) and Telecom Services (regular telecommunications services through the mobile phone).

### 3.3. Coding and validation

After completing the historical analysis, we created a novel framework to categorize the services, using their innovation histories. Using this framework and the help of 23 coders, we classified the services into one of three categories: user-, producer-, or joint-innovation. Of those coders, 20 were independent and three were the authors. For robustness, we compared coding results when excluding the authors' coding, and found that the results still hold.

A user innovation is defined as an innovation carried out by a user for the purpose of his or her use. Producer innovations originate from firms for profit purposes (von Hippel, 1986). Joint innovations are those that require significant contributions from both the user and the producer (Oliveira and Hippel, 2011). A joint innovation occurs when the innovation resources, such as sticky information and problem-solving capabilities (Luthje et al., 2005), are distributed between the user and the producer, and cooperation is required for successful innovation. Furthermore, users are often not permitted to modify existing products or services that are owned by producers.

An example of a user-innovation is the case of *Text-a-Sweldo* (which means text-a-salary), a service that allows employers to pay wages into a mobile wallet. This service was initially self-provided by a rural Filipino bank, PR Bank, but after several months, the mobile operator Globe (the producer) stepped in by creating a more automated system, and the service was given a name: *Text-a-Sweldo*.

An example of a joint innovation was the development of *Text-a-Deposit*, which allows transfer of money from a mobile wallet into a normal bank account. A housekeeper in the Philippines approached her employer, the director of RBAP-MABS, and proposed a way to address her need to transfer money to her brother's bank account, a need she felt might also be relevant to others. The "problem-information" regarding the need was located with the user, but the solution capabilities were only available to the producer. However, because the director had access to Globe Telecom, he brought together his housekeeper, as well as her brother (the users) and the employees of Globe Telecom to develop a solution. They were all present during the first pilot and an iterative approach was taken. The knowledge and capabilities of the users were not sufficient to meet the need on their own. Instead, Globe and RBAP-MABS used their resources to develop a solution that would meet that need, and that of many other customers.

The OECD (2005) defines innovation novelty according to three categories: new to the firm, new to the market, and new to the world. Our sample includes only new-to-the-world innovations,

which is the most stringent criterion. We found that a significant number of new-to-the-market mobile financial innovations originate with users. For example, the use of airtime-transfer to send remittances was reinvented independently at least twice, in Kenya and South Africa.[4] We found a variety of similarly creative solutions and user-driven re-innovations of existing technology that would be classified as new to the market, because the service had already been implemented elsewhere. Therefore, if commercial counterparts existed in other markets (i.e., if they were not new to the world), then the innovations were coded as "producer innovations" in the sample. An example of this coding method is given in Appendix C (Supplementary data). This standardized framework, besides being novel in this area, had the advantage of reducing qualitative bias, and making the categorization process replicable.

For 14 of 20 services, we found both user- and producer-innovation histories. For five services, we were not able to find evidence that suggested the innovation might have been self-provided by users or that they were involved in the process, and so we automatically classified them as producer-innovations. In one case, we found only a joint-innovation history, and categorized it as such.

The 14 services for which we had multiple innovation stories were coded independently 11 times (including the authors' coding) into the three categories—user, producer, and joint innovations—using the rules and questions in the decision tree shown in Fig. 1. The majority of the coding was done via Amazon Mechanical Turk, an online service in which non-expert anonymous coders are paid a small cash fee to perform Human Intelligence Tasks (HITs). In our case, their task was to categorize the services. The Mechanical Turk workers were provided with instructions, user and producer service innovation histories, and the decision tree, which they had to use to provide a justification for their decisions. In our sample, 17 unique coders, also known as "Turkers," participated in categorizing our sample of services (for more information, see Appendix E in Supplementary data). The advantage of using Mechanical Turk was that we had access to a large number of coders who could code quickly and cheaply. However, because coders could not be briefed personally, this tool required a categorization scheme with rules that could be used by non-experts. The disadvantage of using this method is that extensive information regarding the innovation history is needed to have a third party code the innovations. The result of the coding is a comprehensive list of categorized services, shown in Table 1, which includes the 20 services that represent the entire portfolio of financial services for the mobile phone.

## 4. Main findings and discussion

In this section we summarize and discuss the main findings and provide answers to the three research questions. In Section 4.1 we discuss the extent to which users in developing countries are important sources of new-to-the-world innovations in mobile financial services. In Section 4.2 we identify the main factors enabling innovation in developing countries. Finally, in Section 4.3, we analyze the relevance and diffusion of the innovations and conclude that these user innovations diffuse twice as widely and three times faster than producer innovations.

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[4] Many users were using the functionalities provided by the producer, such as airtime transfer, for alternative purposes. Comninos et al. (2009) provides evidence for the use of airtime transfer as way to pay for goods and services or as a remittance. For example, 88.3% of people in Kenya who had received airtime received it as a favor from a friend or family member, compared to only 1.2% who received airtime as payment for the provision of goods or services.

**Table 1**
Coding of the innovations as U = user, P = producer or J = joint.

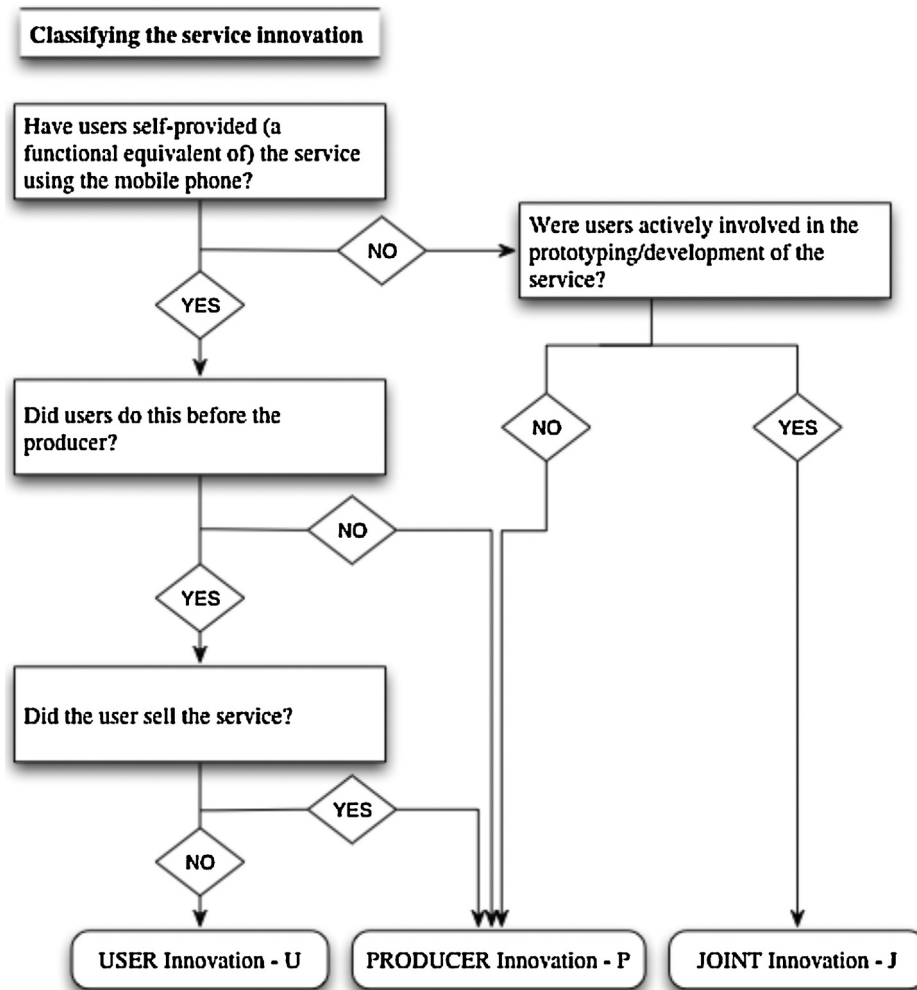| Service | Innovation source | | | | | | |
|---|---|---|---|---|---|---|---|
| | U | P | J | Not sure | Agreement | Final coding | Country in which innovation took place |
| *Category: Mobile Banking* | | | | | | | |
| 1 Bank Account Balance Alert | | | Only producer story | | | Producer | Finland |
| 2 Bank Account Deposit | | | Only joint story | | | Joint | Philippines |
| 3 Bank Account Withdrawal | | | Only producer story | | | Producer | Philippines |
| 4 Bank Transfer | 10 | – | – | 1 | 91% | User | Afghanistan |
| 5 Storage of Savings | 10 | 1 | – | – | 91% | User | Kenya |
| *Category: Mobile Commerce* | | | | | | | |
| 6 Automated Service Payment | | | Only producer story | | | Producer | Finland |
| 7 Merchant Payment | 10 | – | 1 | – | 91% | User | Philippines |
| 8 Mobile Insurance | 8 | 1 | 2 | – | 73% | User | Kenya |
| *Category: Mobile Money* | | | | | | | |
| 9 Authorized Cash Collection | 5 | 4 | – | 2 | 45% | Producer | Zambia |
| 10 Bill Payment | – | 9 | 1 | 1 | 82% | Producer | Finland |
| 11 Domestic Money Transfer (P2P) | 10 | – | 1 | – | 91% | User | Philippines |
| 12 Emergency Credit | 8 | 1 | 1 | 1 | 73% | User | Kenya |
| 13 G2P (Government to Person) | | | Only producer story | | | Producer | DRC |
| 14 International Money Transfer | 2 | 9 | – | – | 82% | Producer | Philippines |
| 15 Microfinance Loan Disbursement | 10 | – | 1 | – | 91% | User | Kenya |
| 16 Microfinance Loan Repayment | 5 | 4 | – | 2 | 45% | Producer | Philippines |
| 17 Salary Disbursement | 9 | – | 2 | – | 82% | User | Philippines |
| *Category: Telecom* | | | | | | | |
| 18 Ask a Load | 11 | – | – | – | 100% | User | Philippines |
| 19 Domestic Airtime Transfer (P2P) | 9 | 1 | 1 | – | 82% | User | Philippines |
| 20 International Airtime Transfer (P2P) | | | Only producer story | | | Producer | Philippines |



**Fig. 1.** Decision tree used to classify the innovations.

**Table 2**
Sources of innovation and origin of mobile financial services.

| Source of innovation | Origin of innovation | |
|---|---|---|
| | Developed country | Developing country |
| User | 0 (0%) | 10 (50%) |
| Producer | 3 (15%) | 6 (30%) |
| Joint | 0 (0%) | 1 (5%) |

The Fisher's exact test comparing user and producer innovations against the location of innovation gives a *p*-value of 0.087.

### 4.1. Users in developing countries are an important source of innovation

Our study finds that users pioneered over 50% of the mobile financial service innovations, while producers originated 45%, and the remaining were jointly developed by users and producers (see Table 1). These figures appear to be on the upper range of the spectrum in comparison with previous user innovation studies conducted in industrialized countries (for a comparison of incidences of user innovation found in other studies, see Table 2.1 in von Hippel, 2005, p. 20). However, they are in line with those of Oliveira and Hippel (2011), who focused specifically on financial services, and found user innovation rates of 55% and 44% for computerized commercial and retail banking services, respectively.

The average inter-rater agreement between our coders for the categorization of the 14 services was 80% (SD = 0.17). This measure does not correct for agreement by chance, and is therefore overly liberal (Lombard et al., 2002). In addition we report that Cohen (1960), which is 0.73 (SD = 0.23). More importantly, Table 1 shows that most coded services (10 out of 14) had a high degree of agreement (>80%) in the categories that the coders had assigned. To be conservative, the two services with lower levels of inter-rater agreement were coded as producer innovations. The justifications of the user/producer coding, as well as the references for the coding, are provided in Appendices A and E.

We proceed to look at the geographical sources of the innovations in our sample. We distinguish between developed and developing countries by following prior empirical work in economics (Coe and Helpman, 1995; Coe et al., 1997), which classifies OECD countries as the so-called industrialized North (developed), and the non-OECD countries as the South (developing). Of the total sample of service innovations considered in our study, 85% originated in developing countries (see Table 2). Our findings lead us to conclude that users in developing countries have pioneered a significant proportion of mobile financial service innovations that are new to the world.

### 4.2. Main factors enabling innovation in developing countries

We proceed to expound upon our findings, considering three main enablers of innovation in the developing world: the role of need as a driver for user innovation in developing markets, the reduction in technological lag between the developed and developing world, and the importance of platform openness and flexibility.

#### 4.2.1. Need as a driver for innovation

There are two main ways in which need works as a driver for innovation. First, high levels of need increase the number of user innovators (Franke et al., 2006; Urban and von Hippel, 1988) and, second, high need increases diffusion rates because of the increase in potential market size (Mansfield, 1968; Geroski, 2000). Both mechanisms were active in the context of developing countries.

Our study shows that many of the users that innovated had few or no alternatives or substitutes to provide the financial solutions they required. The lack of adequate alternative services created a high latent demand for improved financial services. As a result, this high need for adequate financial services was an important driver for many user innovations in our sample. In Kenya, for example, *M-Pesa* was introduced as a money transfer service, with the marketing slogan "*send money home.*" Part of *M-Pesa*'s functionality early on was the mobile wallet, which users could use to load money before sending it to another mobile wallet. However, as soon as the mobile wallet was introduced by *M-Pesa* in March 2007, users started using the mobile wallet to save money as well (FSD, 2009), which was not actually part of the *M-Pesa* service. By the time Vodafone introduced M-Kesho, its official savings product, in 2010, "21% of people were already using their mobile wallet as a savings account."[5] Users had been faster at implementing this innovation because they had access to sticky information regarding market need, while also possessing adequate problem-solving capabilities (Luthje et al., 2005). More specifically, the sticky information of users was detailed information about their financial needs. As a result, they quickly realized that storing money on a mobile wallet offered increased safety and security compared to keeping savings in cash under their mattresses at home (Collins et al., 2009; Mas and Kumar, 2010). This finding is consistent with the work of Ivatury and Mas (2008), which had already predicted that people in developing countries, with fewer options for transferring money and accessing banking services due to limited formal banking infrastructure, would be more likely than rich people to use mobile phones to undertake financial transactions. And, in fact, a variety of studies conclude that users in these regions consider mobile phones to be the safest, least expensive, and most reliable financial services platform compared to any other formal and informal alternatives (FSD, 2007; CBK, 2009).

Our finding that innovations are more likely to occur in places in which need is high resonates with the fact that we know that the majority of innovations are stimulated by market needs, as opposed to technological opportunity (Hipp and Grupp, 2005, Utterback, 1974). Many user innovations evolved around safer, cheaper, or more efficient ways to use mobile phones to effect payments for a type of good or service, or to make transactions. The countries in which users pioneered these services were often cash-based economies, which often required physical displacement of cash and/or its owner, and transport was often risky and costly in terms of both time and money. High need and sometimes-slow diffusion processes often led to re-innovations by users in countries other than those where the first introduction appeared. This is the case of "Sente" in Uganda, which was new to the market or country, but not new to the world.

While we should be cautious in concluding that need was the main driver, it certainly appears to have played an important role in prompting users to find better ways of making payments and accelerating subsequent diffusion.

#### 4.2.2. Reduced technological lag between developed and developing countries

While need is undoubtedly an important factor contributing to the role of users as innovators in mobile banking, the market, technology, and institutional conditions regarding service innovation cannot be seen in isolation (Barras, 1990). An important contributing factor is the global convergence in communication costs and a reduced technological lag between developing and developed countries (Comin et al., 2006), which erodes the competitive advantage of the latter. The convergence in communication costs is a result of increasingly ubiquitous technology platforms,

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[5] Greg Reeve, head of Vodafone Innovation Global, presented these figures at the Global Mobile Money Transfer Conference in Dubai, October 2010. Vodafone was the partner of Safaricom, the producer of this service.

especially of mobile phones, in developing countries (Duncombe and Boateng, 2009). In terms of innovation, this means that users and producers in developing countries can innovate at the global frontier using the latest technology. For example, in the Philippines mobile phones have been extremely prevalent and, by 2008, 75% of the population had a mobile subscription (ITU, 2012). Without such widespread access to wireless communications, it is unlikely that several important mobile financial service innovations would have originated in the Philippines. In particular, users in developing countries who have access to technology and face decreasing costs of information are gaining similar innovative capabilities to those of Japan, often seen as a lead innovator in mobile services (Ishii, 2004).

Moreover, mobile phone users in these regions where innovations took place are often comparatively astute users of mobile technology. The example of the Philippines lends support to this idea. The country has been referred to as the "texting capital of the world," is known for deposing an elected president using SMS, and has been ranked as the most SMS-intensive country in the world (Mendes et al., 2007). Given the intense usage rate, the behavior displayed by mobile phone users in the Philippines indicates a high Leading Edge Status as defined by being ahead of a trend, having high levels of need, and actual development of innovations (Morrison et al., 2004). Our findings suggest that, when industries in developing countries are at the global frontier (Acemoglu et al., 2006), they are more likely to be the source of new-to-the-world innovation.

Hence, our empirical findings challenge the assumption that developing countries are too many rungs behind on the quality ladder to innovate (Flam and Helpman, 1987; Grossman and Helpman, 1991), which we attribute partly to a decreased technological lag in the industry that we studied, when compared to traditional North-South gaps in manufacturing (Comin et al., 2006; Fu et al., 2011; Keller, 2002). Additionally, new products and services from the South can now also trickle up to the North. As far as we are aware, this is the first paper to show evidence of this process on an industry level.

In developing markets, which are dominated by cash transactions and have a low rate of formal financial service penetration, credit cards and bank accounts are being leapfrogged by mobile wallets. This is analogous to the rapid adoption of mobile phone subscriptions, which meant that most people in developing countries had access to a mobile phone before they ever owned a fixed phone line. As a consequence of decreasing adoption times, an entire generation of technology is being leapfrogged (Brezis et al., 1993) instead of being displaced, as would historically be the case for evolutionary diffusion and adoption processes (Hobijn and Comin, 2004).

### 4.2.3. Platform openness and flexibility

We believe the extent to which a platform is open and flexible plays an important role on the emergence of user innovations. Users in our sample came up with low-cost innovations that put existing platform capabilities to new and valuable uses through insight and behavioral changes. Often, a low level of technological know-how was required to test and use the new applications we identified. Users could implement solutions because the innovations were low in complexity (Hall, 2004; Nelson and Rosenberg, 1993), and the skills required to implement the solution consisted of having basic knowledge on using a mobile phone. However, for users to be able to do this, a certain level of platform openness is required (Boudreau, 2010).

Users are known to devise their own solutions by building on existing platforms (Franke and Hippel, 2003), ranging from software (e.g., operating systems such as Linux or Free BSD; data analysis packages such as R, STATA; web server applications such as Apache) to electronic hardware (e.g., Arduino), as well as medical devices (e.g., Coloplast). The general sequence of events observed in many of the user innovations in our sample was as follows. Initially, producers introduced new technologies into the market. Users would then take the existing technology platform provided by the producer and leverage its functionality in novel ways to create a solution based on their need, which was in no way envisioned by the platform provider.

In the Philippines, users bought scratch cards from the telecom operator Smart with the expected use of topping-up their mobile voice and data credits. Yet, some of them, instead of using the scratch-card credits themselves, were sending the activation codes via SMS to distant relatives who would use the codes to top-up their own airtime credits. Because users had identified this as an effective way of sending money across long distances, they had thus invented mobile airtime transfer long before Smart became aware of it. A similar innovation was also observed in Uganda (Chipchase, 2009), where it became very popular and even received its own name, "Sente" (which means "money" in Swahili). As was the case in the Philippines, the user-created solution Sente was developed before the producers in Uganda became aware of it. Yet, while the producers in both regions may not have predicted the user-created solution, the platform they designed was sufficiently flexible to support this alternate use. These examples illustrate our finding: many users were coming up with non-technical service innovations by using the functionalities provided by the producer, such as airtime transfer, for alternative purposes, without knowledge of the platform provider.

The role of platform openness can be seen by comparing two different cases in the Philippines, where different firms offered platforms that enabled multiple innovations simultaneously. Two of the country's major telecom companies, Smart and Globe, innovated simultaneously but independently. Smart introduced Smart Money in December 2000 (Proenza, 2007), which allows users to withdraw credit or to charge purchases through any MasterCard terminal (Mendes et al., 2007). This system was very rigid compared to Globe's competitive product G-cash, because the former was subject to MasterCard protocol and had to abide by rigid standards. Globe's system was more open, and hence users were able to use it in more ways than those for which it was designed. While our data does not offer conclusive evidence on the extent to which the openness and flexibility of a platform has an impact on the level of user innovation, the relationship is clearly positive, and helps to explain why six out nine innovations in the Philippines were a result of Globe's efforts, compared to only three from Smart.

The owner of the platform, usually a firm or community, decides the extent of its openness, and can choose to grant access or concede control (Boudreau, 2010). In contrast to many of the open platforms studied in the literature (West, 2003), the mobile financial service providers we studied were trying to keep the platform closed for security reasons, or were forced to do so because of regulations. Firms often took a long time to identify that users were manipulating the platform for their own purposes. Innovations that were first developed by users were later picked up by cell-phone providers, which provided the same functionality, but with a subsequent investment in engineering to make them more convenient and more broadly available, or to add features that required access to platform codes. Our finding suggests that once broader market value of a user innovation becomes evident, incumbent firms are more likely to develop and commercialize the innovations further.

### 4.3. Relevance and diffusion of innovations

To assess the global relevance of the innovations in our sample, we also studied their diffusion. First, we looked at the direction of their diffusion, namely whether or not they diffused to developed

countries, as a measure of the significance of the innovations originating in developing countries. Although we recognize that new-to-the-world innovations are significant even when they do not diffuse to developed countries, this is an additional and more stringent criterion for novelty, especially in light of the established framework of North–South diffusion. We found that at least eight of the 10 user innovations that originated in the developing world diffused to one or more developed countries, while five of six producer innovations also diffused to developed countries.

The joint innovation from the Philippines diffused to Korea, an OECD-member country. Of the remaining innovations that have not yet spread to a developed country, three were found to have diffused to other developing countries, and one did not diffuse at all. Nonetheless, these might still spread, given that mobile banking is a relatively new industry.

Using GSMA data, we further analyzed the extent to which these services in our sample diffused. We assume that the new firm-country entries are diffusions of the original inventions, as opposed to independent re-inventions. For 16 of the 20 services, we were able to assess the total number of country deployments, where one firm-country service deployment represents one firm that introduces one commercial service in one country. Because data contains information on the commercialization process undertaken by producers, this part of the analysis looks at user, producer and joint innovations that diffuse via the producer paradigm (as studied, for example, in Gort and Klepper, 1982; Pennings and Harianto, 1992; Karshenas and Stoneman, 1993). The results are presented in Fig. 2.

Some services, such as Domestic Money Transfer and Domestic Airtime Transfer, diffused markedly more widely than others. In the top five services as ranked by number of firm-country entries, four were user innovations. Domestic Money Transfer, coded as a user innovation, has been implemented by at least 80 other service providers in more than 50 countries. Not only did most of the services in our sample emerge in developing countries, but they also diffused primarily to developing markets (as shown in Table 3). The GSMA registered a total of 113 mobile money firm-country entries, of which 100 occurred in developing countries (GSMA, 2011). Those services that diffused the most, such as Domestic Money Transfer, Merchant Payment, and Bill Payment, had the broadest application, as opposed to Mobile Insurance services, which diffused less widely. In aggregate, user innovations diffused more than twice as widely as producer innovations.

Because we know the first year of implementation of the service, we can also calculate the average annual diffusion rate for each service per firm across all countries. The GSMA Deployment Tracker (GSMA, 2011) does not include actual commercialization dates, so we were unable to calculate the actual number of firm-country entries per year. Instead, we calculate the average annual service category diffusion rates by dividing total firm-country service entries for all three categories, and dividing each by the number of years that have passed since the first year of commercial introduction. This allows comparison of the average diffusion rates between older and newer services. Using this approach, we estimated that the average annual diffusion rate of user innovations, expressed in firm-country entries, was more than three times that of producer innovations (see Fig. 3). We find that the differences in average diffusion rates between user and producer innovations are statistically significant ($p$-value = 0.0515), using one-way ANOVA.

A limitation to this data is that it does not include actual service adoption rates, but only shows in which countries and to what extent producers chose to commercialize the services.

### 4.3.1. Novel diffusion patterns

Our study of mobile financial service innovations revealed two main novel diffusion patterns: first, innovations that originated from users diffused twice as widely and more than three times

as quickly as producer innovations; second, innovations from developing countries diffused widely and were also transferred to developed countries.

As far as we are aware, our study is the first that directly compares the industry-wide diffusion rates between producer and user innovations. While our data does not explain why innovations that were pioneered by users diffuse more quickly than those that were created by firms, the literature suggests that user innovations more accurately reflect market needs. For example, Franke et al. (2006) showed that user innovators come up with more commercially attractive innovations. Furthermore, user innovators (cf. lead users) are often at the cusp of important market trends because they face needs that mainstream users will face months or even years later, and expect to benefit significantly from solving those needs early (von Hippel, 1986). These findings, together with the established notion that innovations that better address market needs tend to diffuse faster (Mansfield, 1968; Geroski, 2000), provide strong support for our findings.

We look at this in more detail in developing countries by contrasting several prominent examples from our study. In Kenya, the blockbuster success (Jack and Suri, 2011) of the Domestic Money Transfer service—which is a user innovation that was later commercialized by *M-Pesa*—was largely attributed to the high degree of latent demand for safer, more reliable, and cheaper money transfer services, especially between urban and rural areas. The diffusion of this user innovation was so successful that "*M-Pesa now processes more transactions domestically within Kenya than Western Union does globally*" (IMF, 2011, p. 50). That adoption of mobile financial services was driven by a need that can be also be seen outside of Kenya too: Pickens (2009) found that 50% of mobile money users in the Philippines did not have bank accounts, and 26% were living below the poverty line, which reflects latent demand for improved financial services.

The successes in the Philippines and Kenya contrast with the failures of several prominent mobile banking initiatives that were launched in Europe between 2000 and 2002, such *Visa Movíl*, *Mobi-Pay* and *Paybox*, which linked a customer's credit card and mobile phone number (BIS, 2004). None of these services saw wide adoption in the market, and were soon discontinued due to the large number of alternative payment methods available to the consumer (Karnouskos and Vilmos, 2004; Rotman, 2008). Having combined what we know about drivers of diffusion with the findings from our study, we have strong reason to believe that faster diffusion rates of user innovations are driven by the fact that they more accurately address latent demand.

The second finding related to diffusion, namely that developing countries are sources of new technology is at odds with much of the development economics literature. The building blocks for many of the innovation and technology transfer models assume that only countries in the North innovate, and that trade is a consequence of the lag in adoption of new technology by the South (Krugman, 1979). Yet, most of the mobile financial services developed in the so-called South trickled up to the North. One important example is Merchant Payment, first pioneered in the Philippines at the turn of the century. A decade later, a variety of producers (such as Google Wallet and Square) now offer the same service in North America. Another prominent organization that adopted this service is the MCX (Merchant Customer Exchange), a new mobile payments platform created by a consortium of the largest retailers in the United States. This same pattern is repeated for many of the services in our sample. In particular, some of the financial services in the Mobile Money category that originated in developing countries, such as Domestic Money Transfer, G2P, Microfinance Loan Disbursement, and Salary Disbursement were just as revolutionary as the credit card at the time of its invention. A testimony to their importance and pioneering nature is the fact that there are now large initiatives
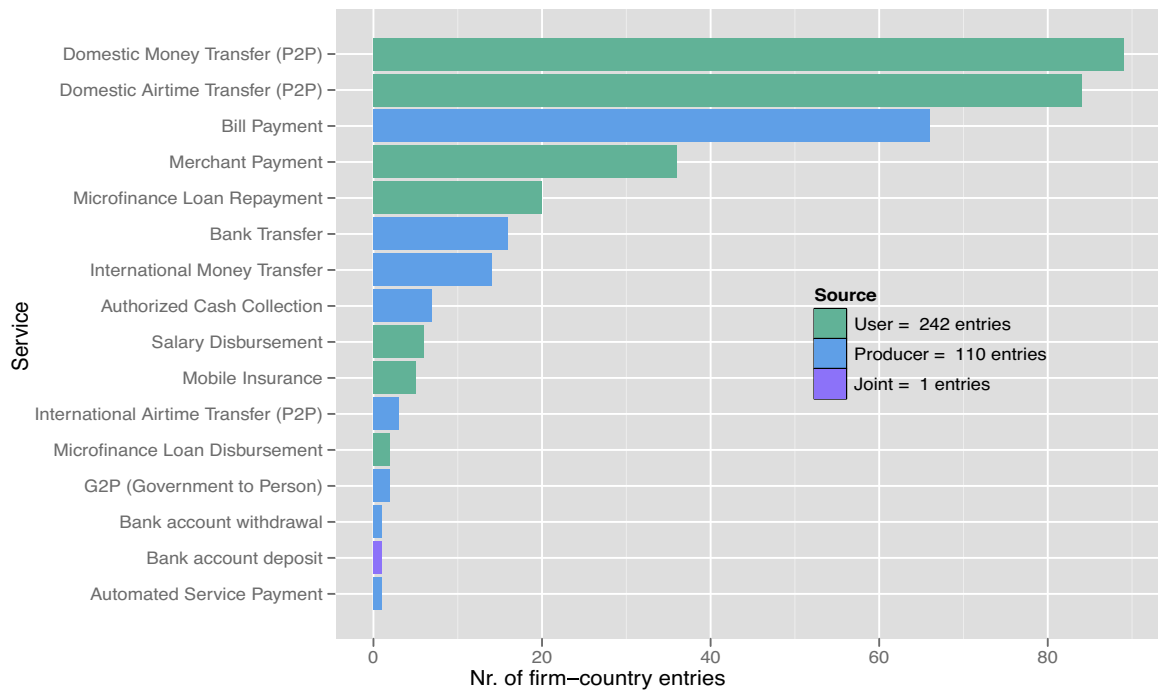
**Fig. 2.** Aggregate diffusion of mobile financial services.

**Table 3**
Total number of commercial service entries per innovation source per region (as reported by the GSMA; one unit represents one firm-country entry).

| Innovator | Africa | Americas (without USA and Canada) | Asia Pacific | Europe | Middle East | USA and Canada | Total | Avg. diffusion[a] (entries/year) |
|-----------|--------|-----------------------------------|--------------|--------|-------------|----------------|-------|----------------------------------|
| User | 118 | 17 | 68 | 16 | 16 | 7 | 242 | 26.52 |
| Producer | 54 | 6 | 30 | 9 | 6 | 5 | 110 | 9.72 |
| Joint | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0.20 |
| Subtotal | 172 | 23 | 99 | 25 | 22 | 12 | 353 | 36.44 |

[a] Adjusted for years passed since first commercial introduction of the service by a producer.
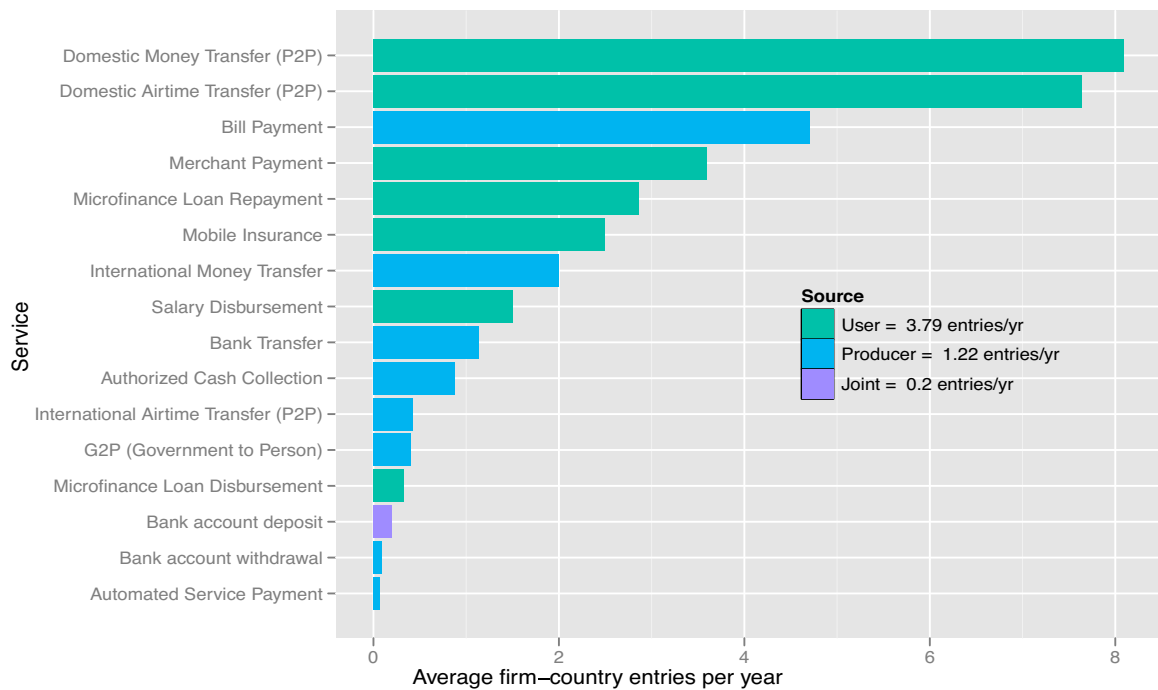


**Fig. 3.** Annual diffusion rates per service.

in developed countries to make mobile wallets the new standard of payment. Needless to say, there are also services originating in the North that followed the traditional direction of technology diffusion to the South: Bill Payment, which is the third most-diffused service, originated in the Finland and was later adopted in many developing countries.

Our findings in the mobile banking industry challenge the assumption that the North is unequivocally the source of new technology. We find that the main factors contributing to these novel patterns of diffusion are those discussed in the preceding sections: high levels of need and flexible platforms, in combination with increased access to information and communication technology, provide ample opportunity for novel innovations to originate in developing countries. From this standpoint, the wider diffusion of these innovations in the market should not come as a surprise, yet this challenges the assumption that innovations in the South are of lower quality and less value (Flam and Helpman, 1987; Trouiller et al., 2002).

## 5. Conclusions and implications

This paper contains the first quantitative empirical study of the sources of innovation in mobile financial services. We find that user-innovators in this field come from less-developed countries with a long-standing unfilled need for inexpensive banking services for the poor. We combine quantitative analysis with extensive qualitative research to show that, in half of the cases, users developed a mobile banking service prior to its commercial introduction by a producer. This claim is made on the basis that the services that users provided for themselves were new-to-the-world (OECD, 2005), and is consistent with previous findings on the role of users in banking-sector innovations in the developed world (e.g., Oliveira and Hippel, 2011; Skiba and Herstatt, 2009; Repo et al., 2004).

The type of user-innovation that was observed in our sample—novel applications of existing functionalities—is likely to be observed in other cases in which a technological platform is sufficiently pliable and in which modification does not require very advanced skills or costly resources. In most cases, the user is better-qualified than the producer to identify unmet needs, and finds ways to respond to these by repeatedly manipulating the platform's functionalities beyond the intended range, sometimes illegally, or unbeknownst to the producer. On the other hand, the role of the producer is especially valuable in pushing the regulatory boundaries, implementing complex software platforms, ensuring commercial services are reliable, and diffusing the innovations across markets.

While the empirical observations in this paper are limited to one industry, we think that the conclusions and implications of this study are informative beyond the mobile banking sector because the financial sector is often the vanguard of service innovation (Barras, 1990).

Our research suggests that perceived need and the flexibility of the technology platform are enabling dimensions affecting the proportion of user-innovation in new services. In general, as users in developing markets, who have different needs, increasingly have access to many of the same technologies as users in OECD countries, the domain of possible innovation loci is expanding on the side of the user. As a result, there is a decrease in costs for both producers and users to obtain the capabilities required to deal with unmet needs. Therefore, we expect our findings to be relevant to other industries in which information technologies are similarly pervasive.

We find that rapidly diffusing general-purpose technologies, such as the mobile phone, have tremendous potential to expand the arena of relevant service innovation beyond OECD countries. If

innovation policy aims to encourage such types of user innovation, it needs to be sufficiently flexible and support open standards to allow for trial and error. These policies should also acknowledge the role of producers in the diffusion of innovation, as users usually have no strong incentives to diffuse their innovations after having met their own needs. Innovation policies for developing countries should no longer recommend an exclusive focus on adoption and imitation, but also recommend allocation of resources to innovative activities.

For management practice, the findings in this paper suggest that innovations may increasingly originate in the South, especially in areas in which a technology is prevalent in both developed and developing countries. Other evidence supports these findings and argues that they are not contingent on the mobile banking industry. New-to-the-world innovations from both users and producers in developing countries are becoming increasingly common. For example, the Nano car, developed by Tata, bears many similarities to what Globe and Smart did with mobile banking in the Philippines, or Wizzit in South Africa. Furthermore, there is anecdotal evidence that reverse-innovation and -diffusion are occurring beyond mobile banking, with products such as NOKIA's 7100 dual-SIM capabilities, GE's Mac 400 system that incorporates electrocardiogram (ECG) measurements (Immelt et al., 2009), and others (Govindarajan et al., 2012).

Thus, firms may leverage the versatility of general-purpose technologies to address specific needs in the market, or seek to deploy pliable platforms that function as tools with which users can solve their needs in ways that do not require further technology and technological expertise. At the same time, firms may actively choose to search externally (potentially via those platforms) to identify successful and more radical (Roberts and Berry, 1985) user innovations, and internalize these in ways that are not unlike many of the practices put forward by the open-innovation literature (Chesbrough, 2003, 2006). Following Chatterji and Fabrizio (2013), firms may choose to engage in inventive collaborations with users early on, as the benefits of doing so decrease with the age of the technology area.

Furthermore, this paper has shown that service industries can originate in the South. Traditional views on the location of innovation (Krugman, 1979) present a variety of reasons that can prevent less-developed regions from being sources or originators of innovation at a global level. Yet we find that people in developing countries can develop a knack of filling such gaps using existing technologies in novel ways. Often these services are created to solve market needs in the South, and although thus far diffusion has been greatest in developing countries, many of the service innovations have trickled up to the North. Therefore, firms that want to compete in developing markets should also pay attention to the innovations that originate in those markets, as these tend to serve local market needs better than innovations from the North that are transplanted to the South. This can also be seen in the entirely new field of m-health (mobile health), created around the use of the mobile phone as a medical diagnostic tool (Istepanian et al., 2007), which has been especially significant in remote areas where patients do not typically have access to medical devices.

Future research should investigate the reverse-diffusion of innovation to promote better understanding of how such phenomena can maximize benefits across regions, especially in light of the limited resources for innovation. Also, further research is necessary to study the relationship between need as a driver for innovation and the technological platform as the enabler. The variables that determine where an innovation occurs and whether it is user or producer-driven are not limited to the marginal benefit for the user, or the flexibility of the available platform. In our research, we observed that the probability of user- or producer-innovation in mobile banking services is likely to be influenced by the regulatory

environment as well as the number of financial services available in the market. Data on these variables is difficult to obtain, yet it is important to acknowledge that unmet need, available technology, friendly regulatory conditions, pliable technology platforms, and astute users are necessary but not sufficient conditions for user innovation to occur, and the present findings suggest this area will provide important opportunities for further research.

Finally, the multi-method approach of combining historical methods with expert interviews and independent inter-rater validation that we used here has proven to be effective in providing insights into the sources of innovation in data-scarce situations and should be considered in future research. Using external non-experts for coding is not only a good way of validating the author's coding, but it also forces researchers to employ clear and systematic rules for classifying the sources of (service) innovations. Applying a consistent benchmark for the classification of different sources of innovation has proven a challenge in the past, and we hope hereby to have provided a possible recourse, with the hope of benefiting future research.

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## Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.respol.2014.05.003.

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