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Abstract

This dissertation explores the conditions and the extent to which innovations, by both users and by firms, can originate in developing countries and diffuse to the rest of the world. The primary setting for these studies is the mobile financial services industry. Additionally, this dissertation looks at the overall significance of user innovation at the country level in order to discern drivers of user innovation diffusion. Finally, it investigates implications for innovation policy. These topics are addressed in three studies.

The first study examines two main research questions. First, to what extent can users play a role in innovation in developing countries? Second, what is the global relevance and diffusion of innovations that originate in developing countries? This study finds that users pioneered over half of mobile financial services and that 85% of the services originated in developing countries. A comparison between all innovations in this industry shows that user innovations diffuse at more than double the rate of firm innovations. Additionally, three-quarters of the innovations that originated in developing countries diffused to OECD countries. This study also proposes a new methodology to analyze the sources of service innovations, which can be used in future research.

The second study tries to answer the following research question: Under what conditions can industries emerge in the economic 'South'? In addition, what firms are successful at entering in the South? This study uses a hand-collected dataset from the mobile financial services industry. We find that latent demand is an important driver for firm entry in developing countries, as is market share. Furthermore, previous entry in the industry leads to industry-specific knowledge accumulation, which spills over within firms and increases the likelihood of subsequent entry into other countries.

The third study examines the characteristics of diffusion of user innovations using data from a large-scale national survey conducted in Portugal. It looks at differences between market and non-market channels of diffusion for professional-user innovators as well as end-user innovators. The main findings are that although most user innovators are willing to share their innovations for free, they do not actively inform other people about their solutions, which negatively affects diffusion. Furthermore, this research concludes that professional-user innovators are significantly more likely to protect their intellectual

property than end-user innovators, which increases the likelihood of commercialization of the innovation.

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Chapter 1 Introduction

The rapid global diffusion of information and communication technology has greatly improved access to knowledge. At the same time, communication is cheap, information is a commodity, and global trade increases technological diffusion. As a result, firms and users, including those outside of industrialized nations, get early exposure to the latest technologies and information. General-purpose technologies such as mobile phones and 3-D printers enable individuals to solve local needs and customize products. The combined effect of these changes is having a profound impact on the innovation landscape. The locus of innovation is no longer unique to firms in Western countries and is opening up to users and firms in emerging markets; these technologies have spurred new types of innovation such as user innovation (von Hippel, 1976), frugal innovation, and innovation in the economic 'South', and has led to flows of technology in new directions (Govindarajan and Trimble, 2012). These forms of innovation are not well explained by the traditional economics and innovation literature, which has assumed that innovation is reserved for firms in industrialized nations because these firms have access to the resources required for innovation. Recent evidence suggests that these assumptions may require revisiting.

In the South reduced costs of information in combination with low product quality and lack of diversity spur innovative solutions, which often are of equal or greater quality than innovations already in the market. There is an abundance of examples of novel products that originated in developing countries that were then adopted in Western markets, such as Tata's Nano, the ultra-cheap 4-wheeler, and General Electric's MAC 400, a portable ultrasound device developed in India. The business community and industry coined the term 'reverse innovation' (Immelt et al., 2009) for this phenomenon more than a decade ago. Frugal innovation (Economist, 2010), or grass-roots innovation (Gupta et al., 2003), describe low-cost innovation that is often done by those with access to fewer resources.

These new forms of innovation merit closer analysis, in particular with respect to their economic impact. An important condition for innovation to be able to have a broad economic significance is its diffusion (Rosenberg, 1972). Therefore, a main theme in this dissertation revolves around understanding the mechanism that governs the diffusion of

novel forms of innovation, such as user innovation and innovation conducted in developing countries. In some cases (such as with mobile banking services, which will be discussed in this dissertation), higher latent demand in developing countries made these novel products diffuse rapidly, and sometimes these technologies leapfrog those in the 'North', such as ATM cards and conventional bank accounts. This dissertation comprises three studies that aim to uncover the mechanism of these new sources of innovation and their diffusion patterns as well as provides insight into the drivers of entry and success in an industry in the South.

In the first study, we use hand-collected data on innovations in the mobile banking industry with an aim to understand whether users (as opposed to firms) play a role in service innovation in emerging markets and whether those innovations are globally meaningful. The user innovation literature predicts that those users with the highest needs will seek to provide their own solutions. In a market where many people are unbanked yet own a cell phone (2.5 billion people in the world are unbanked, while 4.5 billion have access to mobile phones), we seek to understand if and how users innovated in financial products and services use available technology to solve their needs. As there is no adequate conceptual and empirical toolkit to study and understand these phenomena, we develop our own methodology and set out to systematically analyze the financial services currently offered through mobile phones.

In the second study, we expand on the same hand-collected dataset on the mobile banking industry and look at which firms were able to enter and successfully commercialize their mobile financial services. The large latent demand in emerging markets, which results from high need and a sparse offering of products and services, is a reason to expect increasing innovation and entry in the South. Having identified that 85% of innovations and 80% of firm entry into the mobile banking industry happened in non-OECD countries, we conduct an empirical investigation to evaluate the global relevance of innovations that originate in the South. We try to answer which firms (from the North or the South) entered the industry, what role market size played on the firms' decision to innovate and enter, and analyze the subsequent technology diffusion patterns. Our analysis shows that firms with higher market share are more likely to enter mobile banking, and when they do, they choose markets in which they have highest dominance. By doing this, firms reduce the risk of failure when diversifying in Southern markets. We

find that experience increases the likelihood of entry. We also investigate country-specific effects and find that lack of access to financial services, as measured by the number of commercial bank branches per 100,000 adults, negatively affects entry. Furthermore, Southern countries often require a long time to adapt their regulations to allow non-banks to acts as financial intermediaries. The first-mover incurs costs to overcome initial regulatory barriers—which benefits potential followers—and once this is done, other firms are more likely to follow. The adoption of a firm's services in the South is positively affected by Northern ownership, and growth in Southern markets depends on market share at entry. Finally, we find that when firms offer more diverse portfolios of products, overall intensive adoption of technology increases. We abstract from the empirical evidence in the mobile banking industry and suggest implications of the findings for innovation policy and the economic development literature.

In the third study, we aim to answer questions related to the diffusion of user innovation. Policy makers in particular are interested in the ways that user innovation contributes to social welfare and what role it plays in innovation policy (Gault, 2012). The majority of empirical research to date has focused on understanding the characteristics of user innovation and its role in the development of a single product- or service category and has not yet looked at what this means for innovation on a national level. To address some of the questions pertaining to the measurement of user innovation and innovation policy, large-scale national surveys in the UK, the Netherlands, Japan, and Denmark have attempted to measure innovation by individuals on a national level. These surveys demonstrated that consumers spend significant resources on innovation. For example, in the UK, consumers' annual product development expenditures were found to be more than 1.4 times larger than the annual consumer product research and development (R&D) expenditures of all firms in the UK combined (von Hippel et al., 2012). These findings have a profound impact on innovation policy and underscore the importance of gaining a more thorough understanding of the role of user innovation in the economy.

In particular, we attempt to answer two research questions: Which user innovations diffuse and what are the main drivers for diffusion? We compare market and non-market forms of diffusion, such as commercial diffusion, peer-to-peer diffusion, and user entrepreneurship and look at whether intellectual property is used.

The remainder of this dissertation is divided into four chapters. The next chapter details a study on user innovation in developing countries and looks at how those innovations diffused. Chapter 3 describes a study of the mobile banking industry and how it became so successful in the South. Chapter 4 contains the research conducted on the diffusion of user innovation in Portugal, and the last chapter provides a summary and conclusions.

Chapter 2 Users as innovators in developing countries: The global sources of innovation and diffusion in mobile banking services

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.

2.1. 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 7,100 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., den Hertog, 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 and Helpman, 1995; 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 and Helpman, 1995; Saggi, 1999).

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 two lays out the literature that is pertinent to our research question. The third section 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 four 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 five contains a brief discussion of these results and their implications, and offers conclusions together with suggestions for further research.

2.2. 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.

2.2.1. 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 von Hippel, 1992; Jeppesen, 2004; Shah, 2006; von Hippel, 2005) have concluded that user-innovation is gaining importance (see Bogers, 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, 2000; Franke and von 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 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.

2.2.2. 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 towards 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 lifesaving solutions and improved safety.

Franke and von 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, 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.

2.2.3. 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 and Helpman, 1995). 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, 2009; Govindarajan and Trimble, 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 von Hippel, 2009; von Hippel, et al. 2012). 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.

2.3. Research design

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

The telecommunications industry is known for its fast technological progress (Godoe, 2000) 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

[1]Some examples of technological innovation include Near Field Communication (NFC) for proximity payments; software functionalities that integrate mobile "wallets"[1] 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.

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. 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.

2.3.2. Methods and data collection

Our study follows previous work (e.g.: von Hippel, 1976; Morrison, 2000; Franke and von Hippel, 2003; Franke and Shah, 2003; Luthje, 2004; Oliveira and von 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

[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.

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.

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 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). 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 2-1) 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).

2.3.3. 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 von 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.

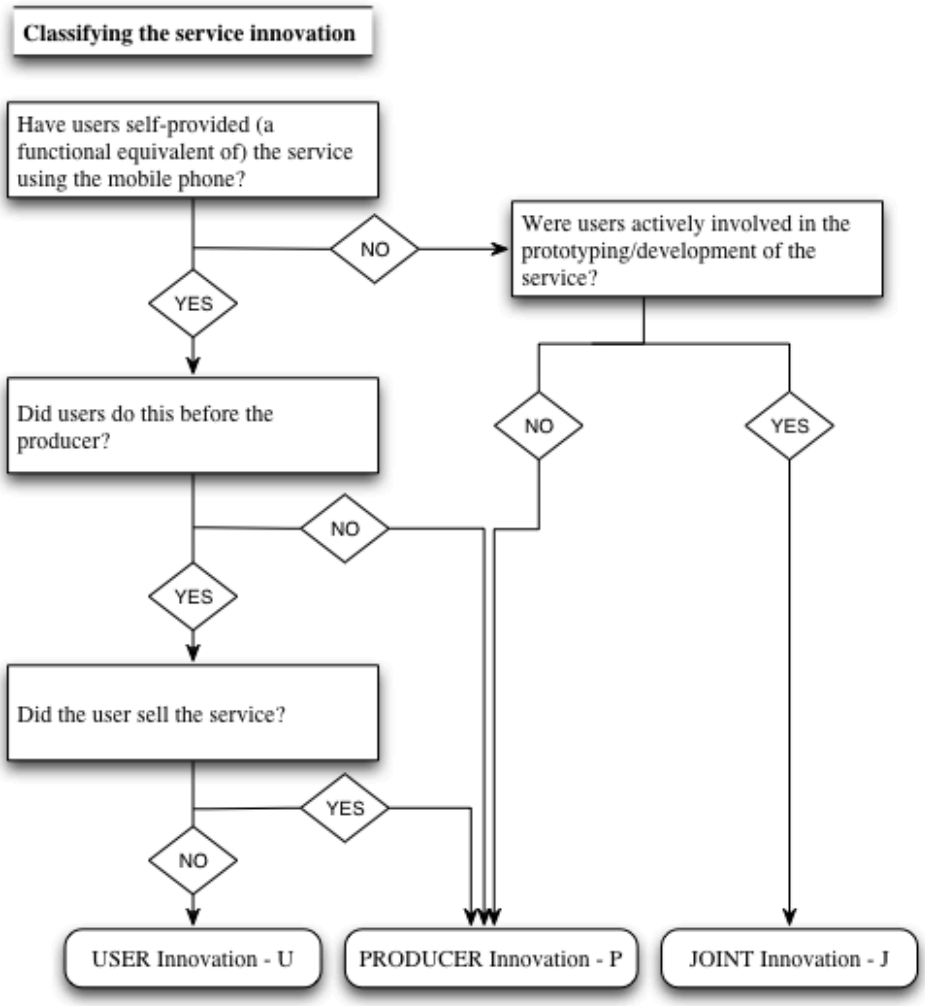

Figure 2-1: Decision tree used to classify the innovations.

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

[4]Many users were using the functionalities provided by the producer, such as airtime transfer, for alternative purposes. Comninos (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

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. 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 Figure 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). 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 2-1, which includes the 20 services that represent the entire portfolio of financial services for the mobile phone.

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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.

2.4. 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.

2.4.1. 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 2-1). 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, pp. 20). However, they are in line with those of Oliveira and von 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.

		Innovation Source						
	Service	**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**

Table 2-1: Coding of the innovations as U= user, P= producer or J=joint.

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's kappa (1960), which is 0.73 (SD=0.23). More importantly, Table 2-1 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 Appendix A and Appendix 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), 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.

	Origin of innovation	
Source 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		

Table 2-2: Sources of innovation and origin of mobile financial services

2.4.2. 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.

2.4.2.1. 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 Kenya, 2009; Morawczynski and Pickens, 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., 2010; FSD Kenya, 2008; Mas and Kumar, 2008). 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 (FinAccess, 2006; FSD Kenya, 2007, 2008; Central Bank Kenya and FSD Kenya, 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

[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.

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.

2.4.2.2. 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, 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, 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).

2.4.2.3. 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; Henkel, 2006).

Users are known to devise their own solutions by building on existing platforms (Franke and von 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.

2.4.3. 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 Figure 2.

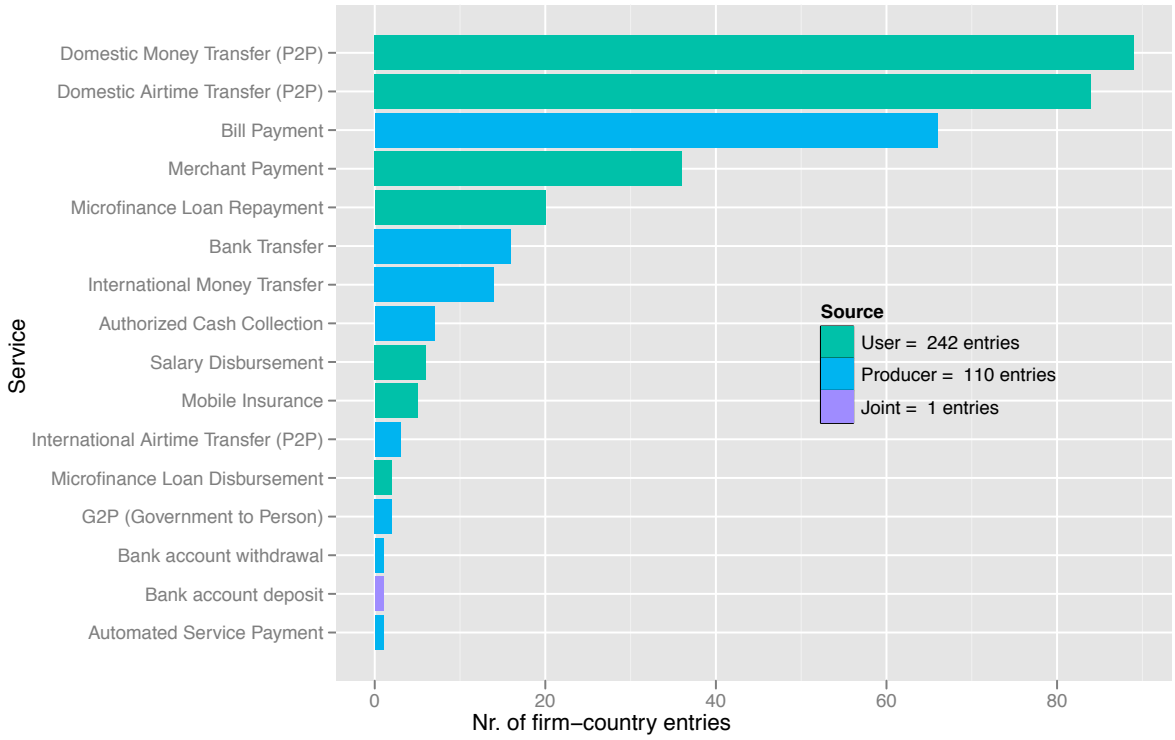

Figure 2-2: Aggregate diffusion of mobile financial services

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 2-3). 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.

Innovator	Africa	Americas (without USA)	Asia Pacific	Europe	Middle East	USA & Canada	TOTAL	Avg. diffusion* (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**

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

Table 2-3: Total number of commercial service entries per innovation source per region (as reported by the GSMA; one unit represents one firm-country entry)

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 Figure 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.

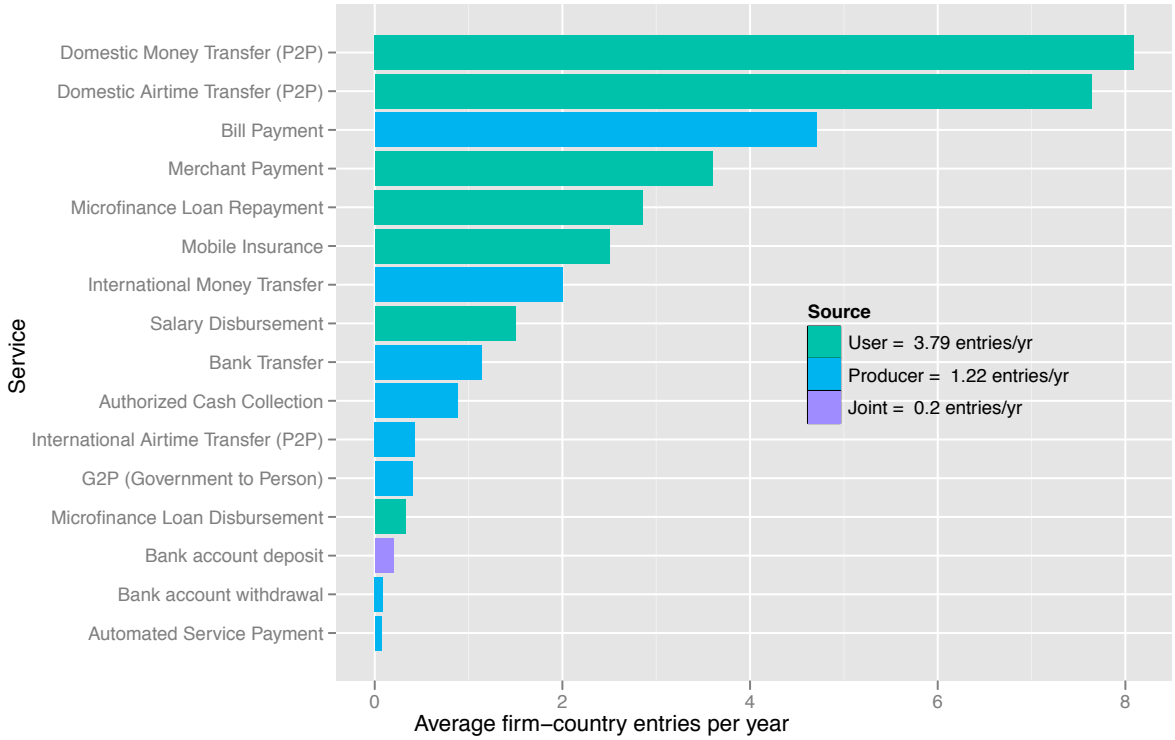

Figure 2-3: Annual diffusion rates per service

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.

2.4.3.1. 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 (Morawczynski and Pickens, 2009). 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*, *MobiPay* 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 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, 2002).

2.5. 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 von 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 & Trimble, 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; Vernon, 1966) 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., 2010), 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.

Chapter 3 The Birth of an Industry in the South: Evidence from Mobile Financial Services

Abstract

Digital-age technology makes key knowledge capital accessible to both developing and developed countries. Therefore, firms in the South are increasingly able to experiment independently without having to wait for Northern inventions to 'trickle down'. Yet, market needs are very different in the North and South, and therefore the types of innovation firms in the South are different from the onset, which affects industry growth and knowledge accumulation. Investments by early entrants in the South lead to accumulation of knowledge capital. Thus, developing countries play the role of ground-breakers whose accumulated know-how leads to global adoption of innovation, questioning the roles traditionally assigned in the literature to 'Northern' and 'Southern' countries. We use a comprehensive, hand-collected dataset to examine the case of mobile banking to investigate determinants of Southern entry. We use extensive and intensive measures of technology adoption to look at the conditions that affect firm performance in the South and analyze the transformative effect of the mobile financial service industry on Southern economies. We find patterns that are consistent with the theory and suggest that the South could play an important role in digital-age innovations in the future. We also find that heredity and knowledge spillovers are important determinants for success in the South.

3.1. Introduction

Traditional growth theory has assumed that innovations are first introduced in advanced countries (North) and later diffuse through imitation to the developing world (South) (see, e.g., Grossman and Helpman, 1991; Krugman, 1979). Accordingly, the focus of the 'North–South' technology diffusion literature has almost exclusively been on the conditions that could make this process smoother and allow developing countries to catch up faster with developed countries (e.g., Chen and Puttitanun, 2005; Gustaffson and Segerstrom, 2009).

The situation may have started changing with the advent of the digital technology age. Comin, Hobijn, and Rovito (2008) found that many developing countries lag behind

the US and other advanced countries much less in the use of 'digital age' recent technologies such as cell phones or the Internet than in older technologies such as electricity or cars. In several cases (such as the case of mobile banking examined below) it appears that by introducing globally important innovations early on, firms with deep roots in developing countries actually become global industry leaders.

At the turn of the century several firms began experimenting with new mobile financial services. Mobile banking schemes such as Simpay and MovilPago were tried in Europe (Spain, France) and offered basic services such as mobile payments and bank account management but eventually failed due to lack of market uptake. Soon thereafter, however, mobile banking initiatives spawned in countries with much less-developed financial service markets such as the Philippines, Zambia, and Kenya.

In contrast to previous benefits resulting from mobile phones in developing countries, such as reducing prices for grain (Aker, 2009) and fish (Jensen, 2007), the introduction of mobile financial services has been truly disruptive (Bower and Christensen, 1995). M-Pesa, one of the world's most successful mobile money platforms, originated in Kenya and has fundamentally changed the landscape of financial services, especially for the unbanked. The money transfer services M-Pesa offers almost entirely displaced informal methods such as post office products, bus companies, and formal channels such as Western Union and banks (Mbiti and Weil, 2011). There is also suggestive evidence that M-Pesa has increased the efficiency of the Kenyan banking system, increased employment, reduced the informal economy, and increased the velocity of cash (Mbiti and Weil, 2011). At the time of writing, approximately 200 mobile banking platforms have been commercialized worldwide, of which the vast majority operate in developing countries and are trying to disrupt the financial services landscape for the unbanked in ways similar to M-Pesa. Both local and multinational firms in those countries developed an array of new financial services for the mobile phone. Over 20 financial products are offered as part of the mobile banking portfolio; those include mobile insurance, merchant payment, international remittances, bill payment, and mobile savings accounts.[6] More than a fifth of these innovative products were first tried and introduced in the South, and most firms operating mobile banking platforms are from the

[6] As classified by the GSM Association in their Mobile Money Deployment Tracker available at http://www.wirelessintelligence.com/mobile-money/. Accessed October 2013. Other organizations such as ShiftThought have used different service classifications and are discussed in more detail in later sections.

South. Higher latent demand in developing countries helped these novel financial products diffuse rapidly and in some cases leapfrog technologies that were prevalent in the North, such as ATM cards and conventional bank accounts. A recent report estimates that over $1 trillion will soon pass through mobile banking products (Swift, 2012), and already the number of mobile money[7] transactions in Kenya alone exceeds Western Union's transactions globally (IMF, 2011). All this makes the mobile banking industry an important case to study patterns of innovation and industry growth in developing countries.

Endogenous growth theory offers at least two potential reasons that could in principle lead us to expect innovations and entry to happen first in the South and subsequently diffuse to the North rather than vice versa. First, many developing countries have large and diverse populations, which should trigger the well-known scale effect on the supply side (Jones, 1995; Romer, 1990). Second, consumers' needs (and hence, other things equal, their willingness to pay) are often more urgent than in developed countries. A string of recent literature suggests that larger market size should also lead to more innovations (e.g., Acemoglu and Lin, 2004; Desmet and Parente, 2010). Of course, the conventional view (solidly grounded in past experience) is that these latent reasons are more than offset by various barriers to technology development and diffusion, such as poor institutions, corruption and rent seeking, bad policy, low education, and poverty (Hausman and Rodrik, 2003). Nonetheless, the neo-classical economic models of growth predict rapid convergence once poor countries get access to frontier technologies, given the presence of stable and transparent governing institutions that lower the aforementioned barriers to growth (Barro and Sala-i-Marin, 1992).

Mobile banking represents perhaps one of the first instances where the balance of larger market size versus various barriers to growth in the developing world seems to have shifted in favor of the former. Mobile phone technology itself as well as the more specific technology that made feasible the commercial launch of secure peer-to-peer money transfers through mobile phones were developed by IT firms (technology vendors), some of which operated in the developed world but some (such as Fundamo, the earliest and most important vendor) emerged in the developing nations. Regardless, when mobile network operators (MNOs) and other firms in developing countries

[7] Mobile money = money that is stored on the mobile wallet.

launched mobile banking services for the first time, they at the very least implemented an important 'new combination', which according to Schumpeter (1912/1949), lies at the heart of entrepreneurial innovation.

Our analysis of the factors behind entry and success in the mobile banking industry highlights the importance of large potential market size, including higher willingness to pay for alternatives to traditional products and services (such as banking). This is what makes it more attractive to introduce important innovations (e.g., mobile banking) in at least some developing markets first. We show how the initial innovations by early entrants lead to accumulation of more knowledge capital, which spurs further entry in even more countries and also spills over globally, making it profitable for producers to enter in other countries, eventually also including developed nations. Throughout this process, developing countries play the role of ground-breakers whose accumulated know-how leads to global adoption of innovation, making the South a genuine source of innovation and knowledge that actuates the diffusion process.

The rest of the chapter is organized as follows. In the next section, we describe the data. Then we look at the early entrants and highlight representative firms and their innovations. The next section conducts an in-depth analysis of the determinants of firm entry in the phase of rapid industry growth. After this, we discuss the impact mobile financial services, particularly in developing economies. The chapter concludes with findings and discussion.

3.2. Data

To analyze innovation and diffusion patterns in the South, we use data from the mobile banking industry. We use the term 'mobile banking' in a broad sense, encompassing mobile money, mobile commerce, and other financial services executed with a mobile phone.

3.2.1. Mobile Banking Industry Data

The mobile banking industry consists of a complex ecosystem that includes telecommunications firms, financial intermediaries, technology providers, and others—all of which operate in distinct regulatory environments to provide mobile financial services. These services are provided by banks, MNOs, or third-party firms, often with the help of

technology vendors that supply the software and other technology. In a few cases, however, the banks or MNOs develop their own software.

For the purpose of this study, we start by looking at the mobile banking platform as the unit of analysis. Each mobile banking platform has its own defining characteristics: year of entry, country of operation, a list of services that it offers its customers, the MNO involved, partnering banks, technology vendors, which firm leads the platform, etc. For example, M-Pesa (the name of mobile banking platform) was launched in Kenya by the firm Safaricom (the mobile network operator), which belonged to the Vodafone group and initially offered peer-to-peer (P2P) transfers (the name of service) to its customers.

We use the Global System for Mobile Communications Association's (GSMA) data on firms in the industry as a starting point and expand on this to obtain the above information for each mobile banking platform. The GSMA data are largely focused on developing countries and include information about the early players in the industry, starting in the mid-nineties up until 2012. These data were obtained at multiple points in time and were converted into four data panels that are approximately a year apart: April 2010, March 2011, May 2012, and February 2013. Over that period, the GSMA renamed some services and bundled several together. As a result, we had to come up with a systematic way to match new service names and the names in previous panels. Details on this matching process can be found in the Appendix F.

We build on the GSMA's records of firms in the industry and their different services available today and then conduct a detailed investigation of the origins of these services to better understand the key decision factors affecting firm entry and subsequent performance. Specifically, for each service, we identified the date and location of first commercialization based on analysis of the detailed developmental histories of the firms and the service innovation process. To uncover these histories, we used primary and secondary sources, including company reports, news articles, case studies, vendors' documents, 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 from the original firms. Interviews were held with industry leaders and researchers to better understand how the industry emerged. Through this process, we identified the histories of firms and their services and

understood the source of innovations in addition to where and when they had been pioneered. We also supplemented the GSMA's list of mobile banking firms with information on firm entry and firm growth.

The data were cleaned and matched to ensure consistency. For those cases in which there were differences across panels—such as in the name of the mobile banking platform, entry year, or any other important variable—the values in 2013 are used as the reference values. After cleaning, the panels were balanced, where possible. In some years the number and type of services were not available; therefore, for firms that had entered and had missing data, we classify services as 'unknown'. The GSMA data might be biased with regard to firm survival because they include only firms in existence as of 2010. Known failures in the industry were added to the data manually, yet there may be some that we missed. Nonetheless, the industry is relatively young (large-scale entry only started around 2010, as we show below), so this introduces little bias to our analysis.

We also supplemented the above data with the data provided by ShiftThought, a data-collection and consulting firm that specializes in digital money. ShiftThought provides data for many prominent organizations that conduct research in mobile financial services, such CGAP and the World Bank. Although ShiftThought's data were only available for 2012, they provided a way of validating GSMA's data and offered several new variables such as traction (a measure of success), a different classification of services, qualitative data on the regulatory context, and so on.

In the end, our sample in this industry is comprised of more than 240 mobile platforms, which were introduced by almost as many different firms in 85 different countries. We are reasonably sure that we have covered almost all such platforms available, at least in the developing world (that is, not in countries that are members of the Development Assistant Council of OECD). The 20 services into which mobile banking is classified were introduced more than 640 times. Chapter 2 shows that the three services that diffused the most are P2P (peer-to-peer) domestic transfer, Bill Payment, and Airtime Top Up.

3.2.2. Telecom Industry

To analyze factors determining entry, we ideally would like to identify all potential entrants into mobile banking and compare non-entrants to those that did enter. However, this is impossible in practice because, in addition to MNOs, firms from other industries

can also enter, such as banks or third-party providers, which is a large and ill-defined pool. MNOs, on the other hand, are a well-defined category of potential entrants, which are particularly important for developing nations. In fact, as noted above, the opportunity to use MNOs as alternative providers of financial services (alternative to banks) is what made the emergence of the independent industry of mobile banking in the South possible in the first place. Furthermore, as will be discussed in this chapter, the most successful mobile banking platforms were indeed led by telecommunications firms. We thus focus our analysis of entry on the factors that led some but not other telecom firms to launch mobile financial services and create a new industry in the South.

To conduct our analysis, we used data from Blycroft Ltd., a UK telecommunications publisher with a special focus on emerging markets. The Blycroft database contained the list of all active MNOs worldwide, along with a large list of their characteristics, such as ownership structure, number of subscribers and market share per country, and so on. The data cover nine years, from 2005–2013, on a total of more than 980 firms. We then cleaned these data to create a balanced panel, and we then matched this panel to our database on entrants into mobile banking.

Many MNOs across different countries are owned by the same groups (holding companies), and these links are an important factor in both entry and success in mobile banking. We thus undertook an extra data collection effort to collect a variety of publicly available sources on such links and connections between ostensibly different MNOs across countries. The collected data were used to identify links based on common or overlapping ownership and membership in conglomerates as well as changes in links over time through mergers and acquisitions. To identify the firms that country-specific operators belonged to, we combined ownership (from MNO Directory and complemented with hand-collected data) and telecom group affiliation (in 2007 from MNO Directory and in 2012 from ShiftThought). These data were then cleaned and duplicate entries were eliminated (for more details on this process see **Error! Reference source not found.**. We also assigned country of origin (defined as the country where the most important founder came from) and country of ownership (location of headquarters) to each firm owning MNOs in our sample, whenever possible. In total we could identify approximately 1,150 firms or holding companies with full or partial ownership of at least one telecom operator in our data, of which 12% are state-owned. The data from the

telecom industry were combined with the longitudinal data on mobile banking platforms so that all MNOs that entered were matched with their respective mobile banking platforms.

3.2.3. Technology Vendors

Technology vendors (usually software companies) are of interest because they supply the software and security systems required to operate mobile banking platforms. The vendor plays an important role in mobile banking entry because they can bring the knowledge and experience. We thus spent considerable time and effort on identifying which technology vendors supplied which mobile banking platforms to the best extent possible. The information is not easily available, but we were able to definitively assign technology vendors to about two-thirds of all mobile banking platforms in our data. Many platforms involve multiple vendors (such as when one vendor provides the software solutions and another provides security protection). The total number of vendors identified is 63, which were linked to mobile banking platforms 221 times. For all of these technology vendors, we once again collected data on their ownership and geographic origin and whether they had partnerships with Northern or Southern firms. The founders of these firms were traced to see whether they were *de-novo* entrants, spin-offs, or diversifying firms as well as whether the founders brought relevant knowledge with them from previous employment. A firm was designated 'Southern' only when its head office was not located in a country that is a member of the Development Assistance Committee in the Organization of Economic Co-operation and Development (OECD-DAC) and when there were strong ties to the country, either because the founder was born there or because it received local financial support, etc.; otherwise, it was designated as Northern.

Significantly, the 20 most prolific technology vendors are almost equally divided between those originating from the North and South, and together they account for 171 (out of the total of 240) entries in our data (Table 3-1). In 52% of mobile platforms with known vendors, entries were supported by Southern technology vendors, 43% by Northern vendors, and in 5% of cases (with a few providers for which no information is available) the origin is unknown (Table 3-2).

Technology Vendor Name	Total Number of Mobile Money Platforms Supported	Country	OECD	Year Founded
1. Comviva	29	India	0	1999
2. Fundamo	29	South Africa	0	2000
3. Gemalto	22	Netherlands	1	2006
4. Utiba	17	Singapore	0	2001
5. Oberthur	14	France	1	1984
6. Homisco	8	United States	1	N/A
7. Telepin	8	Canada	1	2005
8. Obopay	6	United States	1	2005
9. Sybase 365	6	United States	1	1984
10. Vodafone Money Transfer	6	United Kingdom	1	2005
11. Taggattitude	5	France	1	2005
12. Pyro Networks	3	India	0	1999
13. eServGlobal	3	France	1	1983
14. MobiCash	3	Mauritius	0	2007
15. Creova	2	France	1	2008
16. Datanets	2	Papua New Guinea	0	1993
17. E-Fulusi	2	Tanzania	0	2004
18. Finaccess	2	Nepal	0	2009
19. Genweb2	2	Bangladesh	0	2009
20. Afric Xpress Services	1	United States	1	2007
21. Cellulant	1	Kenya	0	2004
TOTAL	171	-	10	-

Table 3-1: The 20 (known) most active technology vendors.

Geographic Origin	Total Number of Mobile Money Platforms Supported
Northern Vendors (from OECD countries)	85 (43%)
Southern Vendors (from non-OECD countries)	103 (52%)
Unknown	14 (5%)
TOTAL	202

Table 3-2: Origin of technology vendors.

3.2.4. Country-specific Variables

A distinctive feature of the mobile banking industry in developing countries is its role in alleviating financial (and overall) underdevelopment. We thus collected and matched with our MNO entry and service launch database some important country-level variables, especially financial access indicators available from the IMF and the World Bank. Many of these measures are available for multiple years and across countries. Other variables such as GDP, ease of doing business, and so on were also added and used as controls in the analysis below. ShiftThought provides a classification of the extent to which the regulatory environment in each country favorable to mobile banking services (based on various parameters—for example, whether a special license from the country's Central Bank is required and so on); ShiftThought experts aggregated this information

and put countries into one of three categories, which we also used as controls whenever appropriate. Finally, OECD-DAC member countries were classified as 'North,' while non-members were classified as 'South'.

3.3. Southern Market Needs and Technological Availability

Previous research (see, e.g., Caselli and Coleman, 2001; Stoneman and Diederen, 1994) has inevitably found that industries spawn first in the North before diffusing through trade and imitation to the South. As already mentioned, mobile banking is perhaps one of the first cases where this pattern does not necessarily hold. An important condition that enables a global industry to emerge in the South independently from the North is the technological availability that follows from unprecedented diffusion of digital technology in general and mobile phones in particular (see Comin et al., 2006; Hobijn and Comin, 2004).

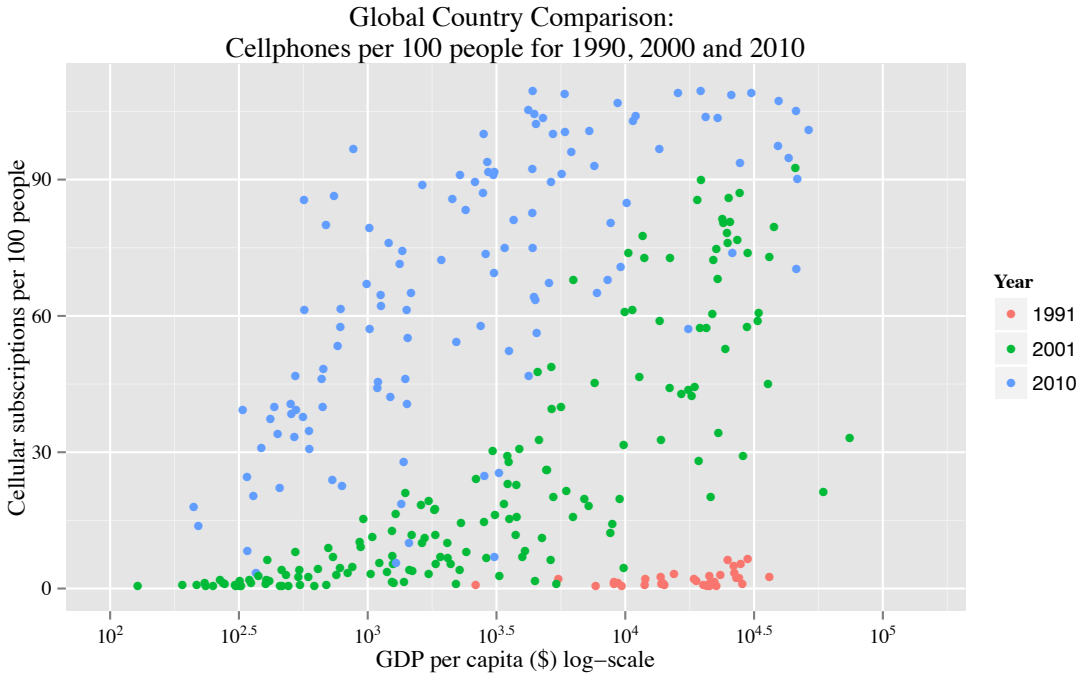

Figure 3-1: Cell phones/100 people plotted against GDP/capita. The grey band is the 95% confidence interval.

Indeed, mobile phones saw an exceptionally rapid worldwide adoption, with 75% of mobile phone subscriptions currently in developing countries, up from almost none barely a decade ago. In 2000, only a few countries in Europe and North America had substantial cell-phone penetration. By 2010, the majority of countries that 10 years earlier had near-zero cell phone penetration were close to or above 50% penetration (Figure 3-1).

Mobile phones diffused so rapidly in the developing world that they leap-frogged landlines.

With little to no technological gap between countries in the North and South, firms in both regions are able to experiment with new products and services at the same time. However, because needs across markets differ, the type of experimentation that will occur will not be the same. For example, Figure 3-2 and Figure 3-3 show that in terms of financial access, there is a significant difference between Northern (OECD) and Southern (Non-OECD) countries.

More than 4.5 billion of the 6 billion mobile phone subscriptions worldwide are in developing countries as of 2012, yet 2.5 billion people in those countries are unbanked (i.e., do not have access to a bank account).[8] Of these 2.5 billion, approximately 1.7 billion people have access to a mobile phone; that is, more than two-thirds of the unbanked population has a mobile phone. Already in 2007, almost every country in the developing world had higher levels of mobile phone penetration than of formal financial services (Figure 3-2). This means that conditions were ripe for exploring the functionalities of the mobile phone for the purpose of financial transactions, and the introduction of mobile financial services has been a truly disruptive event (Bower and Christensen, 1995). Whereas it took the regular banking sector in Kenya 115 years to provide customers with over 40 licensed banks and little over 1,000 bank branches and ATMs, it took M-Pesa—the country's most prominent mobile banking initiative—just four years to have 30,000 mobile money agents[9] who can transfer e-money into cash and vice versa.[10] In 2011, 42% of Kenyans above the age of 15 had access to a formal bank account, whereas in the same year, over 60% of Kenyan adults used M-Pesa.

[8] ITU World Telecommunication /ICT Indicators database. See http://www.itu.int/ict/statistics (accessed February 2012).
[9] mobile money agent definition
[10] Data from World Bank and Safaricom

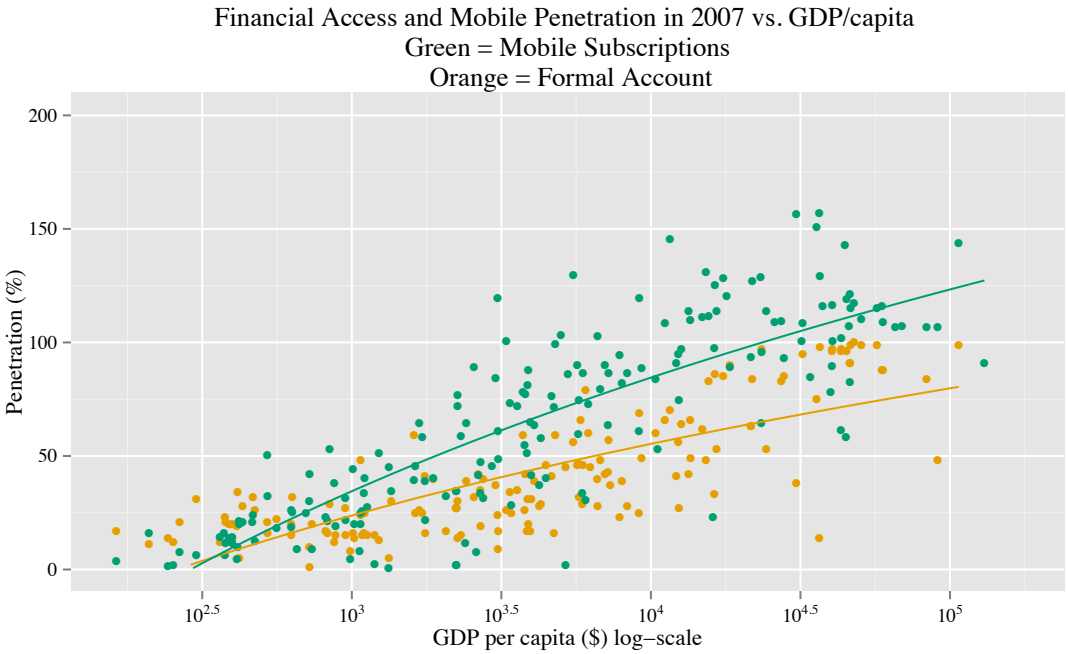

Figure 3-2: Financial access and mobile penetration in 2007 vs. GDP/capita.

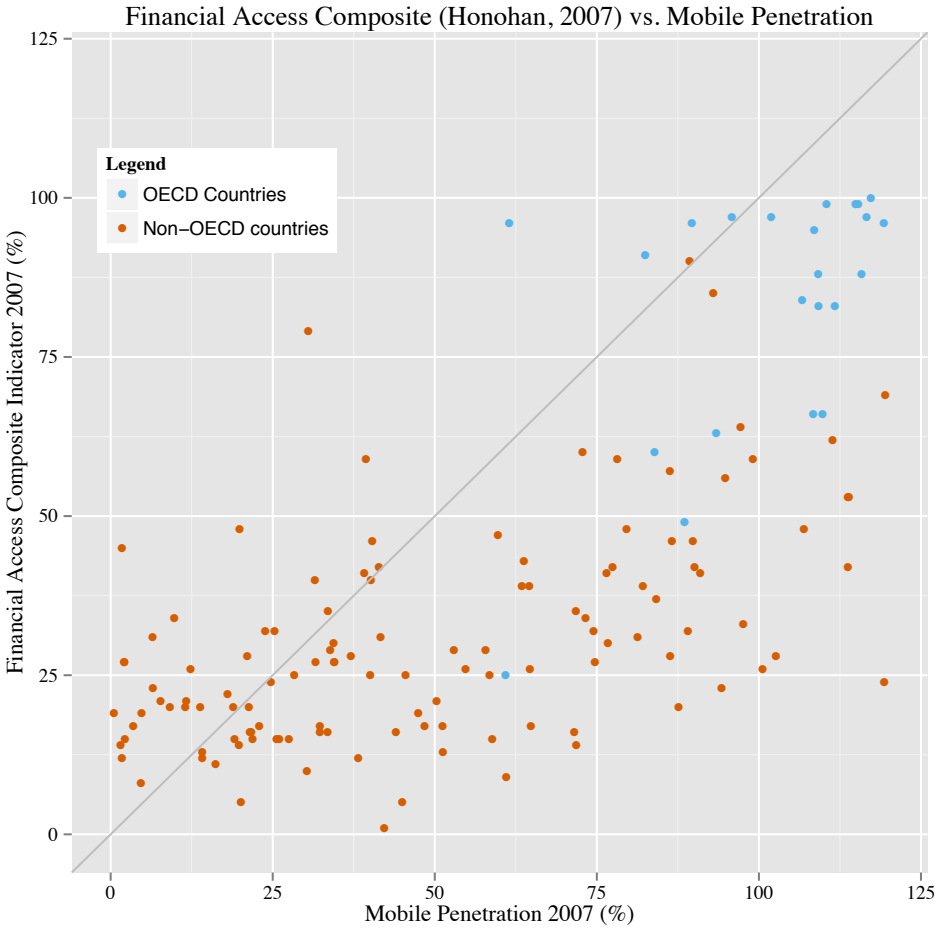

Figure 3-3: Financial access vs. mobile penetration in 2007.

3.4. Early Entrants and Diverging Paths

The literature suggests that (firms in) developing countries should focus on imitation rather than invention because they lack resources and depart from a lower technological base with knowledge that is not at the global frontier. Attempts to innovate will therefore yield lower quality products that can be imitated at a lower cost. However, the observations in the mobile banking industry lead us to believe that under certain conditions, such as reduced technological lag, firms in the South can innovate and become leaders in the industry.

The following section provides a qualitative description of the early entrants (pre-2008) into the industry, and in particular we distinguish between efforts conducted by the South and North, respectively, and how this led to diverging paths in the industry.

3.4.1. Two Roads Diverged

From the onset, there were important differences between developments in the South and North that led to diverging trajectories. Market needs for financial services in more developed countries weren't the same as they were in developing countries; these disparities resulted in sharp distinctions between the innovations introduced by early entrants. These factors, in combination with other significant differences in the regulatory environment and the experience of the firms, led to big differences in performance between Southern and Northern mobile banking platforms.

The types of new services that were commercialized in the North contrasted with those introduced in the South. The first firms in the North focused primarily on one of two things: extending existing banking services through the mobile phone or various types of m-commerce (short for mobile commerce) that allowed payments for goods using the mobile phone (such as Paybox in Austria). These types of services are also known as *additive* services, in which the mobile phone is merely another channel to an existing bank account (Donner, 2007); additive services were appealing to banks because they provided an opportunity to reduce service delivery costs. Firms in the South, however, introduced *transformational* services in which the mobile financial service is aimed at the unbanked and is linked to a mobile phone (Donner, 2007). The marginal benefit of financial services was greater in countries where people were accustomed to the unreliable and expensive informal banking system and often had to set up their own savings clubs, use informal micro-financing, and develop elaborate savings mechanisms

(Collins et al., 2009). Hence, in countries with a more advanced banking system, mobile phones had less potential to fundamentally transform the financial services industry.

In Finland, where the banking system was highly developed, firms began introducing financial services through the mobile phone in the late 1990s. At that time, Finnish banks, with Merita Bank at the lead, offered basic information services such as checking bank account balance alerts via SMS[11] as well as telephone banking, which allowed banking customers to perform basic banking operations through the phone. The function of these early mobile financial services in the North was largely to extend service delivery of existing banking customers.

In the traditional model of technology diffusion, firms in the South would wait for these new services to 'trickle down' through trade and other forms of international knowledge transfer before they could imitate the services, usually years later. However, global ubiquitous access to mobile phones created almost equal technological opportunity in many developing countries. As a result, firms in the South were also beginning to launch new mobile financial services in the same period that Finnish banks were. Nonetheless, the aim of these services was different. The earliest example was a partnership created in 1999 between a Filipino mobile operator and Banco de Oro, the largest private bank in the Philippines that would later become one of the most successful mobile money products in the industry. Led by SMART and in partnership with MasterCard Worldwide, they launched SMART Money in 2000, the world's first reloadable e-wallet account, later known as the 'mobile wallet'. The chief difference with attempts in developed countries was that SMART Money was accessible to the unbanked—that is, individuals without accounts in formal banking institutions (although initially it was limited to people with accounts at Banco de Oro, but this was changed shortly after). The system gave such individuals an opportunity to open a surrogate banking 'account' using their mobile phone, which allowed for retail payments as well as 'over-the-air' transfer of airtime credit and mobile money between mobile wallets.[12]

In the meantime, Finnish telecom provider Sonera launched the first services in the area of m-commerce. The earliest example was 'Dial-a-Coke', which was launched in

[11] SMS = Short Message Service

[12] A mobile wallet is a virtual wallet, or electronic account, associated with a mobile phone number, which can hold a monetary value. It is similar to a bank account but is associated with the mobile phone number. It can be accessed through the phone and can be used to store and transfer value.

1997 by Sonera in partnership with Coca-Cola. The beverage producer initially incorporated mobile phones into their vending machines so the machines could call the distributor when the machine was nearly empty. However, that functionality alone wasn't worth the investment, and Coca-Cola tried to expand the range of applications of its mobile-phone-equipped vending machines and partnered with Sonera to allow customers to buy from their vending machines and have the purchase charged to their phone bill. They hereby pioneered the service 'Automated Service Payment'.[13] By 2000, firms had begun introducing more creative uses of mobile phones for financial services and payments such as paying with phones at Norwegian parking meters, paying for passes at Finnish ski-slopes, buying train ticketing in Austria, and mobile purchasing of airline tickets in Japan.

News about entries in the Philippines and Finland was spreading and reached Celtel International, an MNO based out of The Netherlands with operations in more than a dozen African countries that was soon to become another pioneer in mobile banking. Celtel partnered with African banks and MNOs to launch Celpay in 2001 in Zambia and subsequently in 2004 in the Democratic Republic of Congo. Tsega Gebreyes (Ethiopian) championed the idea together with Celtel's CFO, Kamiel Koot (Dutch) and Celtel's founder Mo Ibrahim, a well-known Sudanese-British mobile communications entrepreneur. Celtel decided to invest in Celpay because it seemed like a good way to reduce churn[14] and increase average revenues per user (ARPU). Celtel invested $10 million in the creation of Celpay and contracted South African Fundamo to supply the software to operate the mobile platform. The decision to enter first in Zambia was made because this was the country in which Celtel had the largest market share—80%—which decreased risk of failure.

Similarly, other firms in Western Europe were trying to leverage their existing wireless customers to introduce new services; doing so decreased risk of failure by ensuring wide-scale reach. In particular, following concurrent Finnish developments were various high-profile attempts at launching more widespread mobile payment schemes. A consortium by four major MNOs—Orange (French), Telefonica (Spanish), Vodafone

[13] Automated Service Payment is defined as "using the mobile phone for services such as vending machines, public transport or parking."

[14] Churn rate is a measure of the fraction of subsribers that cease to be a client of the MNO over a specific period of time. A lower number means higher customer retention.

(British), and T-Mobile (German)—who jointly represented 280 million customers across Europe, created Simpay. In Spain, Telefonica and BBVA—two large multinational firms —were joining hands to launch MovilPago. Both MovilPago (launched in Spain in 2002) and SimPay (launched in 2003) were designed to become mobile payment platforms.

By 2004, other early entrants were evolving from simple payment methods to pay for parking and soft drinks, into large-scale mobile commerce initiatives. In Finland, for example, Sonera had installed over 800 mobile payment-enabled vending machines by 2002. Yet, the company announced it would stop marketing this service in favor of its new SMS-based Sonera Shopper service, which expanded its presence in m-commerce.[15] In Japan, NTT DoCoMo introduced its mobile wallet under the name Osaifu-Keitai (Japanese for 'Wallet Mobile') in 2004. This comprehensive mobile wallet used Sony's Felica chips for near-field communication (NFC) and now is not only used for mobile payments, but also for loyalty cards, as a credit card (under the name DCMX, launched in 2006), for identification purposes, and for other functions of 'conventional' wallets. Because it is supported across operators, its uptake has been quite large with many businesses, including airlines accepting it as a form of payment as well as identification.

Meanwhile, Vodafone executive Nick Hughes, whose task it was to help Vodafone understand its role in addressing issues like the Millennium Development Goals, laid the groundwork for M-Pesa in Kenya. Funding for M-Pesa came from the UK, with a £ 1million DFID grant, matched equally by Vodafone.[16] The two people at the helm of the initiative were Susie Lonie and Nick Hughes, both Vodafone employees who were dispatched to Kenya to spearhead the project, which was conceptualized to use mobile phones as a tool to re-pay microfinance loans in Kenya. From the start, M-Pesa was conceptualized to serve the unbanked, which meant that it should function without a consumer bank account.

M-Pesa, probably the most widely publicized mobile money platform, was piloted in Kenya in 2005 and launched in 2007 by Safaricom (part of the Vodafone Group). Initial adoption was high:

[15] http://www.themultichannelretailer.com/item.php?news_id=1535
[16] DFID = UK's Department for International Development.

> *Within the first month Safaricom had registered over 20,000 M-PESA customers, well ahead of the targeted business plan. This rapid take-up is a clear sign that M-PESA fills a gap in the market. The product concept is very simple: an M-PESA customer can use his or her mobile phone to move money quickly, securely, and across great distances, directly to another mobile phone user. The customer does not need to have a bank account, but registers with Safaricom for an M-PESA account.* (Hughes and Lonie, 2007, p. 63)

M-Pesa's earliest adopters were well-educated, high-income males (a typical profile for early technology adopters) living in the urban areas who wanted to send money to their less-wealthy unbanked family members in the rural areas, which forced them to learn how to use M-Pesa. Its mobile remittance service offered a much improved alternative to the two-day bus trips previous required to deliver money to their relatives in the provinces and was the biggest reason for the success of M-Pesa soon after its launch.

By that point in time, the differences between initiatives in the North and South in terms of the types of services and the value they provided had become apparent. Early mobile banking platforms offering balance updates and other informational services via mobile phones to existing banking customers in the North had developed into integrated mobile commerce platforms. Osaifu-Ketai (Japan), Paybox (Western Europe), and Sonera Shopper (Finland) had all instituted advanced payment methods, and in some cases, embraced advanced technology such as Near-Field Communication (NFC). However, in the South, many of these services were aimed at substituting the broken banking system and informal methods of transferring money. In contrast to the hi-tech initiatives in Japan, the challenge in Kenya was not a technological one. As stated by Hughes and Lonie (2007): "This wasn't about new technology, it was about a new application of existing technology." Many of the services built upon the 'mobile wallet', a breakthrough innovation pioneered by SMART in the Philippines. Because the mobile wallet was a substitute for a regular bank account and was usable with 'non-smart' phones, it offered financial services to the unbanked, which were often excluded from the formal banking systems because of stringent requirements (such as regular income, identification barriers, formal paperwork, etc.). For example, Globe, another leading Filipino telecom

provider, followed suit in 2004 and launched G-Cash. Globe also introduced a range of new and innovative services such as international remittances and salary disbursement into the mobile wallet called 'Text-a-Sueldo'. Any voice subscriber who had an account with either Globe or SMART could make use of these services, and many did.

It had also become clear that the difference in market needs and the types of services that these firms introduced had a decisive effect on their respective performance. European initiatives received a lukewarm response from the market. Neither Simpay nor MovilPago saw any widespread adoption, despite being launched by industry bulwarks. In the first year, MovilPago took up 17,000 users, and after six years only grew to a total of 400,000 registered customers, many of which were not active (Mas, 2008). This dismal performance was largely attributed to Spain's high penetration of banking services. Simpay suffered a similar fate; its original plan was to enable low-priced purchases through a person's mobile phone bill. Nonetheless, the initiative never took off and the alliance was disbanded in 2005. Launched in 2001, Paybox was a somewhat more successful initiative in Austria, Germany, Spain, the UK, and Sweden. Paybox was an independent mobile payment provider funded by Deutsche Bank. Its services included the processing of direct debits for consumers when they wanted to pay for e-commerce, person-to-person transactions, and payments to bank accounts via their mobile phones. The Paybox service was available to mobile phone owners with a bank account who registered for the Paybox service. While Paybox was one of the most successful schemes (with 700,000 active users in Germany and 200,000 in the other four countries), Deutsche Bank withdrew its support in 2003, and Paybox was disbanded in all countries except Austria.

These stories of failure were not exceptions; adoption of early mobile services was modest, and many early initiatives in Europe were abandoned (Rotman, 2008). The examples above were some of the most successful and creative initiatives in the North. However none saw sufficient adoption, and most failed to reach scale. In contrast to botched attempts in Europe, mobile banking services in the Philippines were an instantaneous success. By the end of 2005, SMART Money had approximately 2.5 million users and Globe had 1 million; this was multiple times more than what Simpay or MovilPago were able to reach over their entire product life. Most importantly, both these systems introduced a large variety of new financial services using mobile phones,

something that contributed to both their success and to subsequent development of the industry, including more recent entry in developed countries. The most successful services were Domestic Money Transfer (peer-to-peer), Bill Payment, and Airtime Top-up. Both SMART Money and Globe still keep growing at a very fast rate: for example, SMART reported 61% growth in 2011 and currently boasts 10 million SMART Money accounts.[17] Both Globe and SMART are local Filipino network operators, even though Globe's G-Cash was supported through USAID's RBAP-MABS[18] program, which focuses on improving access to finance.

In its initial years, Celpay was not as successful as the early entrants in the Philippines because regulatory hurdles hampered it. When Celpay introduced the new service in Zambia, it faced difficulty with initial uptake of peer-to-peer transfers because the Zambian central bank required mobile banking customers to own a regular banking account due to Know-Your-Customer (KYC) regulations. This stood in sharp contrast to Kenya's central bank, which was much more forthcoming in allowing M-Pesa to serve the unbanked without stringent KYC regulation. Additionally, Celpay's service offering was payment at supermarkets, restaurants, and for satellite service, which were transactions largely limited to expats and rich Zambians. These people already had credit cards and saw little added value to another payment product. Therefore those who would have really benefited, the unbanked, had no access to the mobile money transfer product as a consequence of regulatory requirements. Celpay became successful when it began offering business-to-business transactions with customers such as Zambian Breweries PLC, Zambia Bottlers Ltd. (Coca Cola), Heineken, Total, BP, MNOs for token-less airtime, etc. Early adoption was not by the unbanked population but by businesses such as Coca Cola, Heineken, and other breweries whose truck drivers were being robbed and/or misplacing cash regularly[19]. These firms faced a large need for mobile banking services due to the lack of more reliable and safe ways to pay for goods. Celpay's role was particularly useful in bringing previously unbanked informal traders into the banking system, mostly for use of cash collection and payouts from business-to-business and

[17] http://www.philstar.com/Article.aspx?articleId=784164&publicationSubCategoryId=74
[18] RBAP-MABS = Rural Bankers Association of the Philippines—Microenterprise Access to Banking Services
[19] Kamiel Koot, former CFO at Celpay Holding

person-to-business (B2B and P2B).[20] Allowing these instantaneous payments removed the risks and time associated with cash. Only later did individual consumers adopt Celpay for money transfer services. Celpay was also the first firm to employ government-to-person (G2P) payments by using its payment platform to pay out approximately $45 million in cash to 75,000 demobilized combatants in the Democratic Republic of Congo. Its story shows that the road to the adoption of these novel services is not usually smooth, yet when they are matched to serve unmet demand, they can serve as a substitute for a broken banking system.

In Kenya however, M-Pesa's success exceeded Safaricom's expectations, mostly because there was large unmet demand in the market, especially by those who owned mobile phones but had no access to formal bank accounts. The market needs were so large that in some cases new uses were pioneered by the users themselves (van der Boor et al., 2014). Although M-Pesa was conceived as a tool to enable microfinance payments and loan disbursement through mobile phones, Safaricom realized during the pilot that users were sending each other money instead. M-Pesa was therefore launched as its domestic money transfer product with the slogan "Send Money Home." While initially M-Pesa was merely an attempt to improve financial inclusion in a developing country, it had reached 6.5 million subscribers within two years. Safaricom then proceeded to add several innovative services to the M-Pesa platform, such as M-Kesho which allows emergency loans and includes a mobile savings account as well as bill payment, which substituted for expensive and wasteful travel as well as long lines. Through these services, M-Pesa has become the blockbuster example of successful firm entry into mobile banking (Jack and Suri, 2011). Today M-Pesa has approximately 15 million subscribers, moves $24 million a day, and processes more transactions within Kenya than Western Union does globally and provides mobile banking services to more than 70% of the adult population nationally (IMF, 2011).

The North's most successful mobile banking initiative to date has been NTT DoCoMo's Osaifu-Ketai. Reasons suggested are that ATM fees were high, which made it expensive to transfer money and withdraw cash and even for limited retail payment. Therefore, cheaper payment solutions received more traction in the market. The Japanese mobile wallets not only focused on money and payments but also included a diverse set

[20] Miyanda Mulambo, General Manager: Sales & Marketing at Celpay

of other services. EDY and Suica, two mobile money products that were launched and make use of NTT DoCoMo's Felica chip, have 12.5 and 2.3 million users, respectively (Amoroso and Magnier-Watanabe, 2012). EDY and Suica were designed as cards that were reloadable with e-money. These e-money accounts were later made accessible via the Felica NFC chip—that is, via mobile phone— as another way to access stored value.

3.4.2. Important determinants for early entry in the South

Following standard international diffusion theory, we would expect to see this industry take time before gaining traction in the North (which it still hasn't fully accomplished) and then gradually trickle down to the South. However, something very different happened. Southern and Northern firms were experimenting simultaneously, yet independently, and were able to become successful industry leaders. Below we explore the role of the technological availability and knowledge transfer that enabled this process.

3.4.2.1. Availability of technology

The aforementioned cases of early entrants and their failures and successes with different mobile banking services contain several suggestive facts. Market needs and conditions were very different between Zambia, the Philippines, Japan, and Finland, yet the opportunity to address them was almost equal. Financial access rates as well as other economic indicators were much lower in the latter two than in the former two, yet mobile penetration rates were almost similar. In the Philippines, for example, mobile phones were ubiquitous; by 2008, 75% of the population had a mobile subscription.[21] Indeed, the country has been referred to as the 'Texting Capital of the World' (Mendes, 2007). Since the introduction of SMS in 1994, the Filipinos were among the first nation to fully embrace the service and, by 2002, a total of 120 million SMSs were already being sent each day (Celdran, 2002). The financial infrastructure in the Philippines, on the other hand, is not well developed at all, and traditional financial services were not available to a lot of people, especially the poor. The fact that the country is made up of a 7,100 small islands made physical movement of cash expensive and difficult and created a huge demand for mobile money transfers, which were much safer and faster than the existing alternatives. Similar value propositions hold for many of the other developing countries in which early entry occurred.

[21] Source: International Telecommunication Union, World Telecommunication/ICT Development Report and database, and World Bank estimates.

3.4.2.2. Knowledge transfer and accumulation

High penetration levels of mobile phones resulted in near-equal technological access, which meant that firms in the South did not have to wait for the innovations to spill over from OECD countries (Coe and Helpman, 1995). However, it begs the question: Where did the knowledge and technology come from for Southern firms to become successful? We find that often knowledge and resources were obtained through partnerships with Northern firms or through people that brought knowledge from their experiences during employment or education in the North.

M-Pesa is an example of how Northern resources are key to the entry process. M-Pesa's early services are considered African innovations because "the concept was tested, honed and commercialized in Kenya and has succeeded like nowhere else" (Omwansa and Sullivan, 2012). Nonetheless, the financial resources, the technology, and the industry know-how used to set up M-Pesa came from the UK. Vodafone was heavily involved and contributed human resources in the form of two British team leaders, Susie Lonie and Nick Hughes. Furthermore, half of the initial investment came from the UK agency of international development (DFID), and the other half was matched by Vodafone, much in the form of human resources. The software that was used to operate M-Pesa was provided by Sagentia, a Cambridge-based (UK) technology firm.

In other cases, the knowledge and other resources were contributed indirectly and were less clear-cut as to whether they were from North or South. For example, Celpay was funded by Celtel, which was based in the Netherlands. However, Celtel was founded by Sudanese-born Mo Ibrahim, who had extensive industry experience in the US and the UK, which stemmed from his tenure at British Telecom. Nonetheless, the technology supplier was Fundamo, a South African firm. Tsega Gebreyes, the Celtel employee that was assigned to lead Celpay, was Ethiopian and had extensive working experience in the North working for firms including McKinsey & Co. yet also spent time working in South Africa.

The early entrants in the North were often well-established and mature telecom operators or banks with operations in multiple countries and diverse industry experience. Entrants in the South were a combination of local firms that sought out strong international partners such as MasterCard Worldwide and local firms that relied more heavily on partners in the South. And example of the latter is Celtel, which mainly had

operations in Africa and was powered by South African software yet was based out of the Netherlands.

We traced the origins of the technology companies that provided the software for the back-end of the mobile banking platforms of early entrants and ranked them according to how many early entrants they supported; see Table 3-3.

Technology Vendor Name	Total Number of Mobile Money Platforms Supported	Country	OECD	Year Founded
Oberthur	19	France	1	1984
Comviva	9	India	0	1999
Fundamo	3	South Africa	0	2000
Utiba	3	Singapore	0	2001
Vodafone Money Transfer	3	United Kingdom	1	2005
Visa	2	United States	1	1958
Obopay	2	United States	1	2005
Pyro Networks	2	India	0	1999
Sybase 365	1	United states	1	1984
Gemalto	1	Netherlands	1	2006
inov8	1	Pakistan	0	2004

Table 3-3: Technology vendors associated with early entrants in the South.

The majority of early entrants were supplied by software vendors originating in the North. However, there are some notable exceptions, such as Comviva and Fundamo based in India and South Africa, respectively; both firms originated in the South and were financed by local resources.

Contrary to the significant contributions of knowledge between technology vendors, banks, and telecom firms that were collaborating on the same mobile platform, like Safaricom and Vodafone, there was no deliberate knowledge sharing across early entrants. Although early entrants were aware of the many other initiatives that were going on in the North and South, no active collaboration took place either.

3.4.2.3. Market share

Firms are more likely to introduce novel services in countries where they have existing operations. Not only can they use the already-installed infrastructure and equipment, but they can also leverage the country-specific knowledge that was gained through experience. Firms rarely, if at all, introduced novel mobile financial services first in countries where they had no existing wireless operations. Firms that had operations only in one country had no other markets to consider for entry. However, given that 93%

of firms had operations in more than one country—with an average of 6.45 countries per firm—we are compelled to ask: What factors did firms consider when choosing which country was most favorable for the entry of mobile financial services?

Our qualitative analysis of early entry suggests that MNOs are more likely to enter countries in which they have the highest market share. For example, Celpay decided to enter first in Zambia, the country in which they had 80% market share, the highest of all countries in which they were active at the time. Similarly, Vodafone launched M-Pesa in partnership with Safaricom, which had almost 80% market share at the time of entry. When we asked the firms, they said that higher market share reduced the risk of losing market dominance.

On top of reducing the risk associated with entry, higher market share also provided a large customer base that could be leveraged for adoption of the mobile financial services. A firm's existing voice subscribers could also easily enroll to get a mobile wallet and were more likely to do so with brands of which they were already customers. For example, the consortium formed by four major European operators, Telefonica, Vodafone, Orange, and T-Mobile, with a combined subscriber base of 280 million people, created Simpay in 2002.

Furthermore, most mobile financial services required a sender and a receiver, like money transfer services or retail payments, and therefore network effects played an important role. Especially in those cases where mobile financial services were not interoperable across mobile networks, more existing wireless subscribers meant stronger effect of network externalities. The combined effects of having a large market share was that many early entrants chose their first entry in markets in which they had the largest customer base.

3.5. Expansion of the Industry— Adoption and Diffusion in the South

After the initial firms experimented with trial-and-error, a time of high entry followed in developing countries. Safaricom's success with M-Pesa was evident to its competitors: Safaricom was the most profitable firm in East Africa in 2009, with M-Pesa accounting for 10% of its revenue and 20% of its profit. The alluring idea of profit in combination with low entry costs spurred a wave of industry entry, especially in the South. M-Pesa's blockbuster success spurred many of the large multinational operators to implement similar models; among these were some large African players such as

Vodafone/Vodacom (who were closely involved with M-Pesa's creation), MTN (South Africa), Bharti Airtel (India), and Orange (France). These firms already had a large customer base and market presence through wireless voice and data services and simultaneously added mobile money to a multitude of existing markets. A period of widespread emulation followed, concentrated in markets in the South. In this section, we discuss the new services that were introduced, look at the most successful firms, and discuss knowledge flows between South and North.

An important difference between the phase of early entry and experimentation compared to the subsequent rapid industry expansion growth was that many early entrants could now rely on their own learning through experimentation, while also learning from the experience of other pioneers. Early entrants and their strategic partners as well as the technology vendors accumulated knowledge specific to the nascent mobile banking industry. In particular firms such as Vodafone, which had operations in many other countries, had the potential to apply this knowledge when introducing mobile financial services in other markets.

Diffusion of this knowledge to firms that had not yet entered was facilitated by organizations that were set up to promote best practices. For example, the GSMA, which is the worldwide association of wireless telecommunications firms, created a program named Mobile Money for the Unbanked as part of their 'Mobile for Development' group. Industry conferences were organized annually to assemble industry leaders share lessons from the field, and create partnerships for future entry. Furthermore, international aid organizations such as the Bill and Melinda Gates Foundation, the UK's DFID , USAID, the Aga Khan Foundation, and others became interested in enabling 'financial inclusion' through mobile banking platforms. Funding was provided to expand existing initiatives or replicate them in other countries. Roshan in Afghanistan was partially funded by the Aga Khan Foundation and launched with the help of Vodafone, which provided the same software that was used by M-Pesa in Kenya. On some occasions, international aid money also allowed vendors from the North to partner with firms in the South to provide knowledge and assistance. For example, the Africa Enterprise Challenge Fund (AECF) provided $1.5 million to Monitise, a UK-based technology vendor, so that it could partner

with E-Fusili, a local software development firm in Tanzania, to roll out mobile transaction services in the country.[22]

Given that most mobile banking services use existing network infrastructure and can leverage any firm's (whether it is an MNO or a bank) existing capabilities—that is, the monetary costs of adding mobile banking were not that high. Industry sources estimate the initial implementation costs between $5–30 million, which is within reach for most MNOs and banks, given that annual revenues are usually in the order of billions of dollars. For example, Safaricom's investment in M-Pesa was estimated at $30 million (Omwansa and Sullivan, 2012), while its revenue was just over a billion dollars. Furthermore, intellectual property is not a prominent barrier to entry in this industry since most services are not patentable and the technology can easily be bought or licensed.

More important than entry costs are other, non-technical, barriers to entry such as regulatory hurdles. Once the first firm offered mobile banking services in a country and cleared the regulatory requirements, it was very easy for followers to do the same.

During this large wave of entry, some of the original Southern pioneers were reaching scale and came up with several more innovations, often adding functionality to the 'mobile wallet'. At the same time, many of the Northern pioneers never reached scale and were either abandoned or, in the case of banks, continued to be pushed to reduce service costs. The lack of adoption in the North also resulted in a lack of further innovations during this period of the industry and, as a consequence, the South began taking the lead in number of firm entries, innovations, customer adoption, and also industry knowledge.

In the period between 1997 and 2005, firms in both the North and the South had been experimenting with new services for the mobile phone. The outcome of this period of experimentation was almost two-dozen new services. Table 3-4 shows all novel services in the industry introduced since the beginning until early 2012, the date of their first commercialization, and the country and the firm behind the initiative. A clear distinction between transformative and additive services cannot be made on the basis of this list because this depends on how the firms introduced the service per country: if they targeted the unbanked population and whether regular bank accounts were required or not. Nonetheless, the table shows that 75% of novel services were introduced by firms in

[22] http://www.finextra.com/News/fullstory.aspx?newsitemid=19668

the South and that the vast majority was related to the mobile wallet, which in most cases functioned as a substitute to a regular bank account. Furthermore, most novel mobile financial services were introduced by MNOs.

		Producer				
	Service	**First Known Introduction by Producer**	**Country**	**Firm Name**	**Firm Type**	**Mobile Wallet-based**
	Category: Mobile Banking				Bank/MNO/3rd	Yes/No
1	Bank Account Balance Alert	1995	Finland	Merita Bank	Bank	No
2	Bank Account Deposit	Sep-06	Philippines	Globe Telecom	MNO	No
3	Bank Account Withdrawal	Dec-00	Philippines	Smart + Banco de Oro	MNO + Bank	No
4	Bank Transfer	1997	Finland	Merita Bank	Bank	No
5	Storage of Savings	Mar-10	Kenya	Safaricom + Equity Bank	MNO + Bank	Yes
	Category: Mobile Commerce					
6	Automated Service Payment	1997	Finland	Sonera	MNO	No
7	Merchant Payment	Sep-01	South Korea	SKT + 9 big banks	MNO + Bank	No (initially)
8	Mobile Insurance	2009	Kenya	Safaricom + Syngenta Foundation	MNO (+ insurance)	Yes
	Category: Mobile Money					
9	Authorized Cash Collection	2003	Zambia	Celpay	MNO	Yes
10	Bill Payment	1999	Finland	Sonera	MNO	No
11	Domestic Money Transfer (P2P)	Dec-00	Philippines	Smart	MNO	Yes
12	Emergency Credit	Mar-10	Kenya	Safaricom	MNO	Yes
13	G2P (Government to Person)	2006	DCR	Celpay	MNO	Yes
14	International Money Transfer	Aug-04	Philippines	Smart	MNO	Yes
15	Microfinance Loan Disbursement	Oct-05	Kenya	Safaricom + Faulu Kenya	MNO + Bank	Yes
16	Microfinance Loan Repayment	Nov-04	Philippines	Globe	MNO	Yes
17	Salary Disbursement	Jul-07	Philippines	Globe	MNO	Yes
	Category: Telecom					
18	Ask a Load	8-Oct-04	Philippines	Globe	MNO	Yes
19	Domestic Airtime Transfer (P2P)	Dec-00	Philippines	Smart	MNO	Yes
20	International Airtime Transfer (P2P)	Jul-04	Philippines	Globe	MNO	Yes

Table 3-4: Table of services and their origin.

The 20 services are grouped into 10 service categories by the GSMA (see Appendix A) and their diffusion is shown in Figure 3-4.

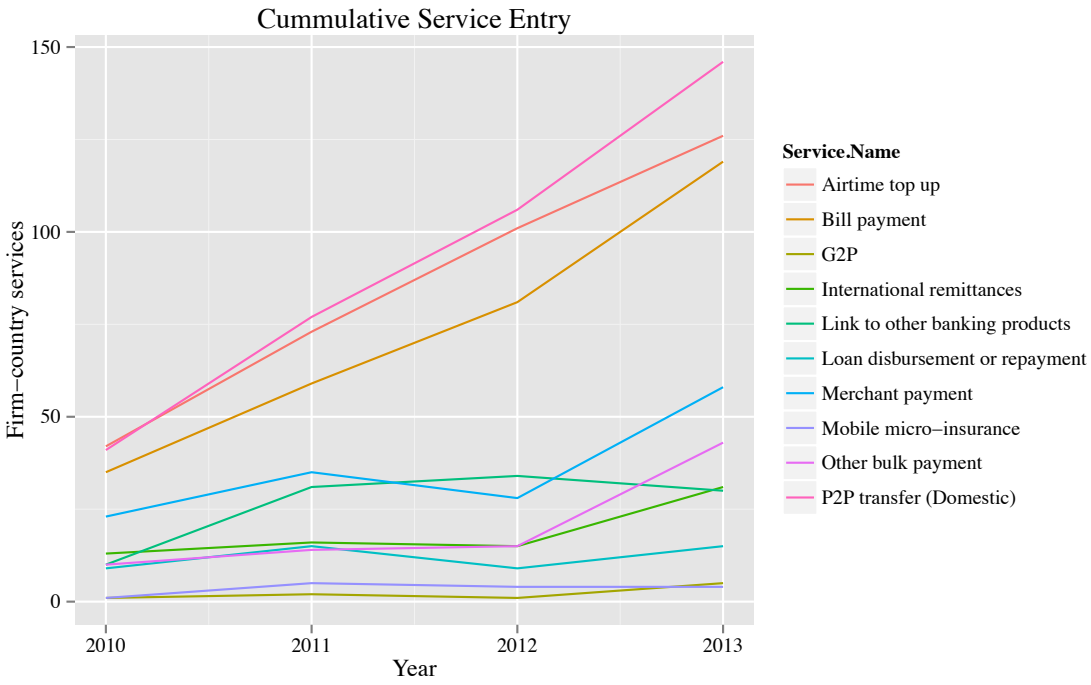

Figure 3-4: Overview of services available per year.

During this expansion phase, the most successful services became Domestic Money Transfer, Airtime Top-Up, and Bill Payment, with 113, 109, and 92 firms that adopted the innovation by 2012, respectively. The first two originate from the Philippines, whereas Bill Payment was pioneered in Finland.

Firm entry predominantly occurred in markets with low access to financial services; see Figure 3-5.

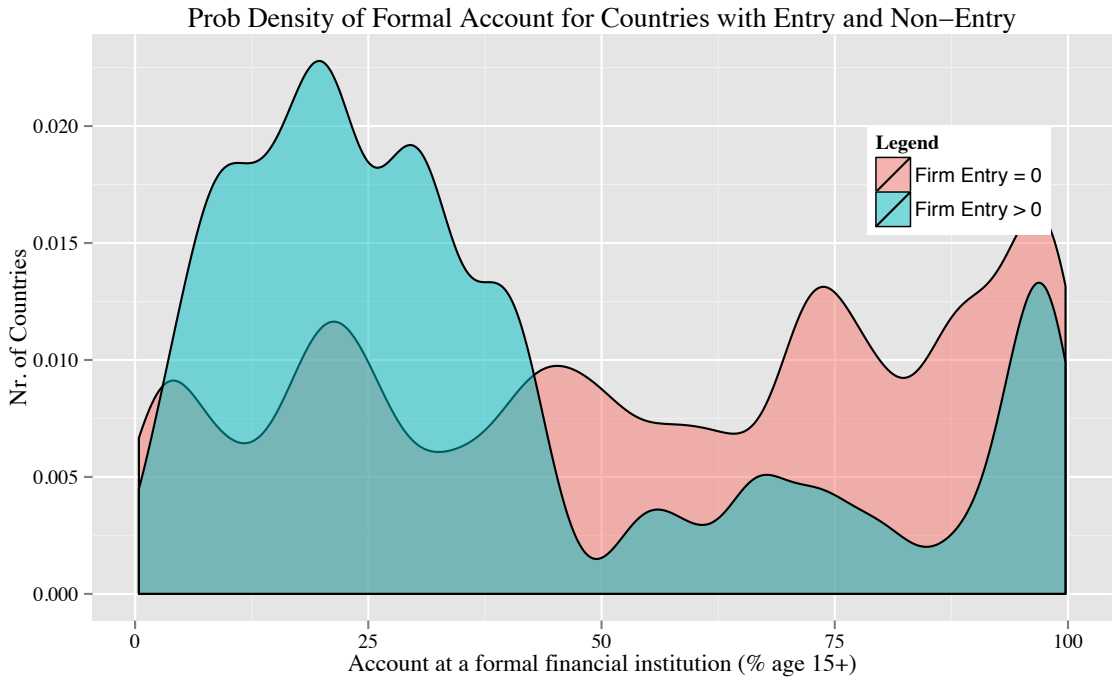

Figure 3-5: Distribution of countries with and without firm entry compared to their levels of financial access.

The choice of technology—NFC, SMS, USSD, WAP, Bluetooth, cellular technologies (GPRS, EDGE, LTE)[23], or other means—plays a role in this phase of rapid expansion of the industry, but the important dimension of differentiation appears to be primarily the business model. There are, however, some differences in the technologies used compared with the earlier innovations. The mobile wallet was pioneered in the South by SMART using simple phones and a debit card associated with the mobile wallet account. The technological services in the North are more integrated and made primarily for smart phones; nonetheless, the services delivered remain the same.

Although data on growth by number of registered customers is not readily available for all firms, we were able to find some of these data for the most successful firms. It was estimated that in 2009 there were 45 million unbanked people using mobile money (GSMA) and about 100 million active users of mobile money services worldwide in February of 2011.[24] In 2011 there were approximately two-dozen providers with more

[23] GPRS = General Packet Radio Service; EDGE = Enhanced Data Rates for GSM Evolution; LTE = Long Term Evolution; NFC = Near Field Communication; WAP = Wireless Application Protocol; USSD = Unstructured Supplementary Service Data

[24] This measurement is not perfect as there is a difference in number of active and registered mobile money customers. In a survey done by Mobile Money for the Unbanked (MMU) active accounts are

than a million subscribers; the ones with the largest number of subscribers are shown in Table 3-5. The table shows there are a handful of the most successful firms that were able to scale to several millions of subscribers. Most firms, however, are still trying to move beyond 1 million subscribers. It is noteworthy that most of the early innovators in the South are in the list of highly adopted initiatives.

	Firm Name	Product Name	Country	Entry	Leading Firm	Innovations	Subscribers 2011 (mln)
1	Safaricom	M-Pesa	Kenya	2007	MNO	MFI Loan Disbursement M-Insurance	14
2	NTT DoCoMo	EDY (via Felica)	Japan	2001	MNO	-	12.5
3	SMART	SMART Money	Philippines	2000	MNO	Airtime Top Up Domestic Money Transfer Text-a-withdrawal	8.5
4	Starbucks	Starbucks Card	United States	2011	3rd party	-	7
5	True	True Money	Thailand	2005	MNO	-	6
6	NTT DoCoMo	Suica (via Felica)	Japan	2004	MNO	-	2.3
7	Vodacom	M-Pesa	Tanzania	2008	MNO	-	2
8	MTN	MobileMoney	Uganda	2009	MNO	-	1.5
9	Telenor	EasyPaisa	Pakistan	2005	MNO	-	1-2
10	Globe Telecom	G-Cash	Philippines	2004	MNO	International Money Transfer Text-a-Deposit International Airtime Transfer MFI Payment Salary Disbursement	1 active (~2 total)
11	MTN	MTN Banking	South Africa	2003	MNO	-	n.a.
12	Telenor	EasyPaisa	Pakistan	2005	MNO	-	Several
13	Celpay	Celpay	Zambia	2001	MNO	Bill Payment Corporate Cash Collection	n.a.
14	Vodacom	M-Pesa	South Africa	2010	MNO	-	1 (includes inactive)
15	WIZZIT	WIZZIT	South Africa	2004	3rd party	-	0.75

Table 3-5: Firms with the largest adoption rates measured per country by the end of 2012.

Table 3-5 shows an indirect measure of the extensive margin of technology adoption (defined as the fraction of potential adopters that have adopted a new technology). We have no systematic data for the intensive margin of adoption of mobile financial services; this would capturing the number of units of the new technology that each adopter uses—for example, the number of services, or alternatively, the frequency of use or the amount of money transferred.[25]

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defined as "ones that had been used to perform at least one P2P payment, bill payment, bulk payment, cash in, cash out, or airtime top up from account in the last 90 days."

[25] Although we have no data for the intensive margin, our qualitative research shows that this is highly correlated to the extensive margin. Celpay, for example, has processed more than $2 billion cumulatively, to date.

It is clear that mobile banking solutions in emerging markets are leading the industry, and the industry's most successful firms operate in emerging markets. As a result, the technology and the features are also much richer. Some of the firms in this list were aimed specifically at providing the unbanked with a mobile phone. For example, MTN joined forced with Standard Bank to introduce MTN Banking; the rationale behind this joint venture was to bring a large number of the previously unbanked population into the formal banking sector (Ernst and Young, 2009). Similarly, Wizzit, a startup mobile banking provider in South Africa, also targets rural low-income consumers by offering low-cost transactional bank account to unbanked people.

3.5.1. Knowledge Flows Between North and South

The success of firms in the South was dependent not only on the availability of technology such as mobile phones but also on having access to knowledge from the North. In this subsection, we discuss the various ways in which Northern knowledge was available to firms in the South and how this was crucial for 'Southern success'. Often, this involved founders of firms with education or work experience in the North or close partnerships with Northern firms.

Many of the technology vendors that supplied the software for the mobile banking platforms were firms originating in the South. This in itself is surprising since one does not typically think of firms sourcing their software from South Africa, Tanzania, or Nepal. It makes one wonder: How can this be? Closer investigation reveals that many of the Southern firms had ties with the North, particularly through their founders. In many cases, the founders of the ideas were originally from developing countries yet were educated in OECD-DAC countries (often in top schools), or they gained work experience there and afterwards decided to return to their home countries to start new firms.

For example, Afric Xpress was founded by Nvalaye Kourouma, a native from Ghana. Nvalaye went to Harvard Business School and worked at Coca Cola and Citigroup before launching Afric Xpress. Afric Xpress incorporated in New York and has its technology center in San Francisco, yet all deployments of its product TXTNPAY are in developing countries. Another example is the technology vendor mCheck, which is the brainchild of Sanjay Swamy, who received an undergraduate engineering degree in Bangalore and a master's degree in aeronautics from the University of Washington in Seattle.

In mid-2003, Swamy, then a Silicon Valley senior marketing and business development executive, visited India. While traveling by auto rickshaw, he happened to ask the driver the time and was astounded when the man smartly took out his mobile phone to check. That was the eureka moment—Swamy realized how widespread and ubiquitous the mobile phone had become in India.[26]

Swamy used his 12 years of experience in Silicon Valley in the field of online and mobile content at places such as Xerox PARC and Portal Software to found the company mCheck, a mobile financial service provider with operations in India and Sri Lanka.

Similarly, two Zambian entrepreneurs that had both spent considerable time in the US founded Mobile Payment Solutions (MPS) in 2008 in Zambia.[27] Iris Mwanza, a doctoral graduate from Cornell, and Marcus Achiume, a graduate from George Mason University, both had access to 'Northern knowledge' that they were able to leverage in Zambia. MPS received financial support from USAID. Another example is Cellulant, which was founded in 2004 by Ken Njoroge and Bolaje Akinboro, two Africans educated at Oxford University in the UK. Cellulant has offices in Kenya and Nigeria and drives mobile commerce in over 40 mobile networks spanning 12 countries throughout the African continent.[28]

In Sierra Leone, SplashCash was launched by Daniel Osei-Antwi, a native from Nigeria with an MBA from Harvard Business School. Prior to founding SplashCash, a mobile money transfer service, Osei-Antwi worked as an investment banker with Barclays Capital in New York. SplashCash received funding from Manocap, the Soros Economic Development Fund, and the Africa Enterprise Challenge Fund (AECF).[29]

It wasn't just the technology vendors that had access to Northern knowledge through their founders—the same was often true for successful telecom firms in the South. Both Mo Ibrahim, a Sudanese-born Brit, and Iqbal Quadir, who was born in Bangladesh, utilized the experience and network they gained while working for firms in the North to found enterprises that specifically addressed market needs in the South

[26] http://nenonline.org/startup-profile/mchek
[27] http://yourstory.in/2013/06/global-forum-recognises-growing-women-power-honours-women-entrepreneurs-in-ict/ and http://www.udel.edu/udaily/2013/apr/america-africa-041813.html
[28] http://www.technology-digital.com/reports/cellulant-ltd
[29] http://awpnetwork.com/2012/11/28/from-harvard-to-sierra-leone-ceo-of-splash-mobile-money-finds-his-path/

(Chakravorty and Lane, 2010). These examples show that information-assets of a firm are frequently embedded in people.

In other cases, Southern telecom firms partnered directly with more experienced firms in industrialized nations. For example, the early pioneer in the Philippines, Smart Communications, received technology from SmartTrust, a Finnish e-commerce company and MasterCard Electronic. Both SmartTrust and MasterCard brought significant Northern knowledge and experience to the table that was essential for the SMART Money m-payment service to become successful. SmartTrust was a wholly owned subsidiary of Sonera, who had pioneered mobile payments in Finland several years earlier and was able to provide assistance with the technical and implementation aspects.[30]

After some time, the early entrants in the South had accumulated industry-specific knowledge, which in some cases was superior to that of Northern firms. The experience of introducing and improving the quality of mobile banking services in pioneering developing countries played a key role in the accumulation of global know-how and triggered wide-spread entry in other developing and developed countries alike. Safaricom for example, in the process of expanding, meeting anti-money laundering requirements and maintaining high quality and reliable service delivery, created one of the most advanced back-end systems to support M-Pesa's payments and transactions.

In some cases, this knowledge was valuable for potential entrants who acquired early entrants. This is seen in the case of 2005 Celpay's acquisition by South African banking group First Rand. Similarly, the experience gained by technology vendors was sought after and acquired by other firms. Fundamo, the South African technology vendor that provided the software for Celpay's first entry, became one the most successful suppliers in the industry (see Table 3-1) and was bought by VISA Inc. in 2011 for $110 million. Paybox, another early pioneer of mobile financial services, was bought by Sybase in 2008, which was in turn acquired by SAP in 2010 for $5.8 billion. Some Northern firms were less aggressive and sought out partnerships with firms in the South to gain access to the accumulated industry-specific knowledge. For example, Infonox, a US company that delivers financial services to ATMs and other delivery channels, partnered with PayMate, a leading mobile-commerce solutions provider in India to

[30] http://www.finextra.com/news/fullstory.aspx?newsitemid=3841

develop a suite of mobile payment products in the North American market.[31] Other firms, such as Monetise in the United Kingdom, upon realizing there was no market uptake in the North, decided to enter in markets in Asia. Paybox also shared its technology with Nigeria's Moneybox Africa in a partnership model.

The mobility of employees, partnerships between Northern and Southern firms, and acquisitions all contributed to knowledge spillovers between the North and South.

3.6. Analysis

In this section, we proceed to analyze the factors that determined entry and success in the South. MNOs normally operate on a country level but are frequently part of a large telecommunications company. For example, MTN South Africa, MTN Botswana, and MTN Cote d'Ivoire are separate corporations, yet they all belong to MTN Group, which is a South African company governed by a central board. Other examples of large MNO firm groups are Orange (France), Vodafone (UK), and Bharti Airtel (India). The multinational firms controlling country network operators often have operations in multiple countries. Decisions that concern entry of novel services, such as financial services, and subsequent expansion are made at the firm level, yet they depend on existing operations and country-level factors. Having a full picture of the industry allows comparison between the MNOs that entered into mobile banking and those that did not. The dependent variables that will be used to analyze entry, performance, and impact are shown in Table 3-6. The independent variables that were used to measure the factors that drive the dependent variables are shown in Table 3-7. Summary statistics on these variables are included in Appendix F.

[31] http://news.softpedia.com/news/Infonox-and-PayMate-Partner-to-Launch-Mobile-Payment-Applications-52381.shtml

Variable	Description
Dependent variables	
EntryMFS	Firm-country-year specific dummy of entry into mobile financial services by firm
Adoption_level	Value from 1–4 to indicate the level of market adoption the mobile banking services. Firm-country specific
Sprinter	Classification used by the GSMA for mobile banking platforms with high growth and high adoption.
MP_sendmoney_11	Mobile phone used to send money (% age 15+) in a given country in 2011
MP_receivemoney_11	Mobile phone used to receive money (% age 15+) in a given country in 2011
MP_paybill_11	Mobile phone used to pay bills (% age 15+) in a given country in 2011
Sum_Panel	Sum of services introduced by a firm via its mobile platform in country-year (as counted by GSMA)
ST_sum_services	Sum of services introduced by a firm via its mobile platform in country in 2012 (as counted by independent research firm)
Fraction of all services adopted	The number of services introduced per firm-country divided by the maximum number of services adopted by a firm in any country. The average was taken between the GSMA data and ShiftThought data.

Table 3-6: List of dependent variables.

Variable	Description
Independent variables	
HHI_Q1	Herfindahl–Hirschman Index, an index to measure competition. Measured in Q1 of each year. Ranges from 0-1, where 0 signifies a large number of small firms (high competition) and 1 is a monopoly (no competition). The formula for the index is $HHI = \sum_{i=1}^{N} s_i^2$ where s is the market share and N is the number of firms in the market.
MNO_count	Count of the number of unique network operators that are active in a country. This is not available for 2005, 2006, and 2011. We assume that 2011 is equal to 2010.
Market_Share_Av	Market share of the MNO per country per year (averaged over four quarters)
Market_Share_Av_e2	Squared value of market share of the MNO per country per year
Market_Share_Av_e3	Cubed value of market share of the MNO per country per year
Subs_MNO_Av	No. of wireless subscribers of the MNO per country per year (averaged over four quarters)
MSmax	Dummy = 1 for the country in which the firm had maximum market share in a given year
MSabovemean	Dummy = 1 for the countries in which the firm had above its firm average market share in a given year
MStopquart	Dummy = 1 for the countries in which the firm had more than 75% of maximum market share in a given year
state_owned	Dummy = 1 when the firm is owned by the state
Group_OECD_DAC	Dummy = 1 when the firm is based in the Organisation for Economic Co-operation and Development's (OECD) Development Assistance Committee (DAC)
Firms_entered	No. of firms that had entered in a given country by a given year
Total_firm_entries	Total number of entries by a firm at the end of the period (2013)
Years.since1st.entry	The years since the first entry by a particular firm into mobile financial services. Firm-year specific.
Previous_group_entry	Dummy that indicates whether a firm (or telecom group) has previously entered in another market
Previous_country_entry	Dummy that indicates whether any entry took place in a given country
First_country entry	Dummy variable that is 1 for all MFS entries in the firm's first year of entry into MFS
First_group_entry	Dummy variable that is 1 for a firm's first entry into MFS
early_entrant09	This is 1 for all firms that were involved in any early entry (i.e., before 2009).
early_entrant08	This is 1 for all firms that were involved in any early entry (i.e., before 2008).
Subscribers_ITU	Total number of mobile phone subscribers in a country/year
Act_formal_11	Account at a formal financial institution (% age 15+), country specific
Branches_com_bank_100000adults	Number of commercial bank branches per 100,000 adults, country specific

Table 3-7: List of independent variables.

3.6.1. Factors determining Entry

In the following section, the unit of analysis will be the firm that controls at least one, and usually multiple, country-level network operators. Looking at the firm level instead of at the country level makes it possible to study firms' decisions with respect to international entry. We consider the market entry decisions of firms, comparing these to all countries in which the firms had any operations in the period between 2005 and 2013.

The firm therefore decides whether or not to enter, and if it does enter, when and in which country it does so.

The data are set up as a discrete hazard model with yearly observations between 2005 and 2013. While setting the data up as a discrete hazard model, it is assumed that firms only evaluate possible entry in countries in which they had any sort of presence in the period of observation instead of choosing between all countries in the world. It is therefore implied that firms did not enter the industry as *de-novo* entrants.[32] Furthermore, we assume that firm links with country operations are static over the entire period from 2005–2013.

In total, we have over 1,100 unique firms, of which 224 entered mobile banking. Firm-year observations are associated with 189 country-specific mobile banking platform entries. We use nine panel observations, from 2005 to 2013. In total, we have 17,261 firm-country-years; firms are censored after entry. As a result of the censoring, firm-country entries before 2005 are excluded from the analysis.

We only focus on non-OECD countries in our analysis because, as previously described, this is where most entry and growth occurred. Logit models are used to estimate the determinants of entry. Broadly, we look at the following factors as determinants for entry:

- Market share and market competition: subscribers, number of other firms, Herfindahl–Hirschman Index
- Ownership: whether the firm originates in the North or in the South, state or non-state owned
- Level of financial access per country
- Firm experience: previous entry, years since first entry

Early entrants are defined as all firms that were involved in any early entry, where an entry is early when it occurred before 2008 (early_entrant08) or before 2009 (early_entrant09); approximately a third of all firms are early entrants. The dependent variable is $Entry\_MFS_{it}^{c}$, a binary variable that indicates whether or not firm *i* has entered country *c* at year *t* or not. The model is specified as follows:

[32] We did not individually verify whether MNO entrants are *de-novo* entrants (by *de-novo* entrant, we mean that they did not have any other existing activities, such as voice or data services, and are a completely new firm). Nonetheless, in our extensive data collection efforts, we did not encounter any cases in which a *de-novo* MNO entrant immediately also launched mobile financial services.

$$\begin{aligned}\text{Entry\_MFS}_{it}^{c} &= \beta_0 + \beta_1 \text{Market\_Share\_Av}_{it}^{c} + \beta_2 \text{Market\_competition}_{it}^{c} \\ &+ \beta_3 \text{ownership}_i + \beta_4 \text{financial\_access}_t^{c} + \beta_5 \text{experience}_{it} \\ &+ \beta_6 year_t\end{aligned} \quad (1)$$

where *i* denotes the firm, *c* denotes the country, and *t* denotes the year of the observation. Whether or not the firm is an early entrant is constant across time, as is the origin of the firm. The estimation equation is used is:

$$\begin{aligned}\text{Entry\_MFS}_{it}^{c} &= \beta_0 + \beta_1 \text{log\_Market\_Share\_Av}_{it}^{c} + \beta_2 \text{log\_Subscribers\_ITU}_t^{c} \\ &+ \delta_3 \text{MSabovemean}_{it}^{c} + \delta_4 \text{early\_entrant08}_i + \delta_5 \text{state\_owned}_i \\ &+ \delta_6 \text{total\_firm\_entries}_i + \delta_7 \text{previous\_group\_entry}_{it} \\ &+ \beta_8 \text{years\_since1st\_entry}_{it} + \beta_9 HHI\_Q1_t^{c} + \beta_{10} \text{MNO\_sum\_country}_t^{c} \\ &+ \delta_{11} \text{previous\_country\_entry}_t^{c} + \beta_{12} \text{firms\_entered} \\ &+ \beta_{13} Branches\_com\_bank10000 adults_t^{c} + \beta_{13} year_t\end{aligned} \quad (2)$$

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
	entry_hazard					
log_Subs_MNO_Av	1.677***	1.648***	1.326***	1.299***	1.610***	1.610***
	(0.349)	(0.352)	(0.379)	(0.377)	(0.172)	(0.427)
log_Subscribers_ITU	-0.935***	-0.900***	-0.696*	-0.638	0.469	0.469
	(0.314)	(0.315)	(0.415)	(0.416)	(0.311)	(0.641)
MSabovemean	-0.051	0.071	-0.010	0.133	-0.033	-0.033
	(0.203)	(0.198)	(0.236)	(0.228)	(0.225)	(0.246)
Previous_group_entry	0.963***		0.907***		0.950***	0.950***
	(0.196)		(0.218)		(0.205)	(0.206)
state_owned	-0.047	-0.047	-0.252	-0.246	-0.146	-0.146
	(0.231)	(0.225)	(0.225)	(0.220)	(0.261)	(0.274)
Firms_entered	1.002***	0.987***	1.120***	1.100***	1.327***	1.327***
	(0.233)	(0.237)	(0.246)	(0.247)	(0.099)	(0.300)
Previous_country_entry	-0.717	-0.679	-0.508	-0.474	-0.962***	-0.962
	(0.569)	(0.580)	(0.670)	(0.673)	(0.340)	(0.808)
log_Land_area	0.114	0.123	0.112	0.110	0.039	0.039
	(0.092)	(0.090)	(0.116)	(0.118)	(0.072)	(0.134)
log_GDP_tot	-0.779***	-0.796***	-0.589*	-0.612**	-0.657***	-0.657**
	(0.242)	(0.243)	(0.307)	(0.309)	(0.126)	(0.321)
Years_since1st_entry		0.173***		0.166***		
		(0.043)		(0.054)		
log_branches_com_bank			-0.573	-0.588	-0.538***	-0.538
			(0.383)	(0.388)	(0.197)	(0.465)
log_Sec_education_pupils_lag3					-1.362***	-1.362**
					(0.231)	(0.568)
Year effects included	Yes	Yes	Yes	Yes	Yes	Yes
Clustered SE (country)	Yes	Yes	Yes	Yes	No	Yes
Constant	-191.512	-195.105	-2.294	2.838	443.616***	443.616**
	(156.170)	(154.687)	(194.549)	(195.537)	(144.011)	(221.419)
Observations	8,417	8,417	5,966	5,966	5,098	5,098
ll	-816.7	-822.1	-605.1	-608.8	-461.4	-461.4
r2_p	0.377	0.373	0.385	0.381	0.417	0.417

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 3-8: Determinants of entry.

Our analysis shows that firms with higher market share are more likely to enter mobile banking. Experience also relates positively to entry. We find this by including different measures of experience, such as previous entry (*previous_group_entry*) and the number of years the firm has been in the industry (*years_since1st_entry*).[33] We also investigate country-specific effects and find that access to financial services, as measured

[33] As a robustness check, experience was also measured using different measures, such as being an early entrant (*previous_group_entry*), and total number of times the firm has entered (*total_firm_entries*). The results remain positive and significant.

by the number of commercial bank branches (*log_branches_com_bank*), has a negative effect on the likelihood of entry; however, statistical significance disappears when using clustered standard errors. Furthermore, when controlling for any entry having occurred in a country, the greater the number of previous entrants increases the likelihood of additional firm entry.[34] This may be because the first-mover has to incur costs to overcome initial regulatory barriers. Entry into mobile financial services often required negotiations with the central banks of countries to adapt regulations to be able to accommodate licenses for telecom operators and to establish rules for non-bank entities (Alampay, 2010). The first firm that enters incurs a significant part of the entry costs to 'break open' the market, which benefits potential followers. We control for ownership by the state, which shows no particular effect on entry, as well as other country-level effects such as geographical area, gross domestic product (GDP, measured in current $US), and total number of students in secondary education.[35]

3.6.2. Performance

Entry itself does not guarantee a firm's success in terms of adoption or growth of the mobile banking products. Hence, we are also interested in understanding what factors affect performance after entry. Various metrics have been used to assess performance—for example, in terms of diffusion; there are *extensive* measures of diffusion such as number of services introduced and fraction of the population using the services, and *intensive* measures of diffusion such as amount of money transferred and number of times per month the service is used. Others have looked at performance in terms of profitability of the mobile banking platform. Data on performance are difficult to obtain, especially for our purpose since we need to look at all firms in the industry.

We first quickly look at whatever partial evidence is available on profitability before discussing other metrics. Many mobile banking platforms have struggled to become profitable. One clear exception is M-Pesa, which is still growing, with revenue growing at 32% yearly, and is expected to constitute almost a fifth of Safaricom's entire revenue by the early 2013—this would be more than SMS and data combined. In Tanzania the service contributed 12.6% to Vodacom Tanzania's service revenue in 2012. Others took a long time to nearly break-even. For example, Celpay finally became

[34] The Herfindahl–Hirschman Index was used as an additional measure of market competition, and the results showed that the overall probability of entry increased with more competition.

[35] This is lagged by three years because no data are available after 2010.

profitable five years after its launch and has since transferred over $2 billion in payments.[36] For the remaining not-so-successful operators, profitability is difficult to obtain. The majority of mobile money initiatives are not yet profitable, yet firms keep investing in them for various reasons. First of all, many firms see potential in their large subscriber bases and expect to be able to use their existing customers to scale mobile banking, as was shown in the previous chapter. Firms may see additional benefits, which are not immediately relevant to profitability. For example, MNOs notice reduced churn rates of mobile money customers because they are more loyal compared to regular voice and data clients. Banks, on the other hand, see mobile banking as a way to reach the new market of the unbanked but also to reduce overall service delivery costs.

In the followings sub-sections, we analyze various other performance metrics.

3.6.2.1. Adoption

One way to measure performance is by using a qualitative measure of adoption, which gauges the level of diffusion of the mobile financial service within a particular country. This is considered an extensive measure of technology adoption because it doesn't measure the intensity of use of the services. Precise numbers of adoption are difficult to come by. However, ShiftThought provides a classification of mobile platforms in five levels, depending on their estimate of the number of registered users. Where data was incomplete or not available, we supplemented it with information from other sources. Information for adoption was available only for 2012 and is denoted as $Adoption\_level^{c}_{i,2012}$. The five levels are distributed as shown in Table 3-9.

Adoption_level	Freq.	Percent	Cum.
0 - Low with downward trend	7	2.10	2.10
1- Low but growing (<50,000)	61	18.26	20.36
2 - Medium (50,000 – 1m)	88	26.35	46.71
3 - High (1m – 10m)	61	18.26	64.97
4 - Very High (> 10m)	117	35.03	100.00
Total	334	100	

Table 3-9: Adoption level.

We use an ordered probit regression to estimate the following equation:

[36] Lazarus Muchenje, CEO of Celpay. Source: https://www4.gsb.columbia.edu/null/download?&exclusive=filemgr.download&file_id=7217022

$$
\begin{aligned}
Adoption\_level^{c}_{i,2012} = {} & \beta_0 + \beta_1 \log\_Market\_Share\_av^{c}_{i} + \delta_2 state\_owned_i \\
& + \delta_3 first\_group\_entry\_d^{c}_{i} + \delta_4 first\_country\_entry\_d^{c} \\
& + \beta_5 total\_firm\_entries_i + \beta_6 years\_\text{since1st\_entry}^{c}_{t} \\
& + \beta_7 MNO\_sum\_country^{c}_{t} + \delta_8 Group\_OECD\_DAC_i \\
& + \beta_9 \log\_Subscribers\_ITU^{c}_{t} + \beta_{10} firms\_entered^{c}_{t}
\end{aligned}
\qquad (3)
$$

We run this on the 2012 panel because this is when the level of adoption was measured.

	(1)	(2)	(3)	(4)
VARIABLES		Adoption_level Ordered Probit		
log_Subs_MNO_Av	0.141	0.050	0.067	0.025
	(0.117)	(0.119)	(0.141)	(0.143)
log_Subscribers_ITU	-0.064	-0.107	-0.099	-0.185
	(0.121)	(0.122)	(0.165)	(0.168)
Group_OECD_DAC	0.509***	0.481***	0.612***	0.542***
	(0.164)	(0.166)	(0.191)	(0.193)
state_owned	-0.039	-0.242	0.023	-0.200
	(0.199)	(0.204)	(0.238)	(0.246)
Years_since1st_entry		0.179***		0.162***
		(0.033)		(0.039)
first_group_entry_d	0.400***	0.792***	0.422**	0.838***
	(0.145)	(0.164)	(0.173)	(0.202)
first_country_entry_d	-0.057	-0.155	-0.015	-0.208
	(0.158)	(0.160)	(0.192)	(0.199)
MNO_sum_country	-0.007	0.021	0.030	0.056
	(0.035)	(0.036)	(0.047)	(0.048)
Act_formal_11			0.004	0.003
			(0.003)	(0.003)
Observations	251	251	186	186
ll	-345.4	-329.7	-251.2	-242.7
r2_p	0.0286	0.0726	0.0362	0.0690

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 3-10: Determinants of success, as measured by level of adoption (cuts suppressed) in the year 2012.

The ordered logit model assumes that the odds are proportional for each level of adoption. We test for assumption using the Brant test (Long and Freese, 2006) and find that the parallel regression assumption does not hold for our model. Therefore, a generalized ordered logistic model is also used for robustness, where the parallel lines constraint is only relaxed for select variables using partial proportional odds (Williams, 2006).

	Adoption_level			
	Generalized Ordered Probit (partial proportional odds)			
VARIABLES	0	1	2	3
log_Subs_MNO_Av	0.014	0.223	0.242	-0.653**
	(0.566)	(0.227)	(0.222)	(0.272)
log_Subscribers_ITU	-0.312	-0.497**	-0.338	0.680**
	(0.473)	(0.223)	(0.217)	(0.269)
Group_OECD_DAC	1.077***	1.077***	1.077***	1.077***
	(0.302)	(0.302)	(0.302)	(0.302)
state_owned	-0.330	-0.330	-0.330	-0.330
	(0.361)	(0.361)	(0.361)	(0.361)
Years_since1st_entry	0.397*	0.181***	0.351***	0.390***
	(0.240)	(0.069)	(0.064)	(0.071)
first_group_entry_d	1.025	0.570	1.547***	2.056***
	(1.047)	(0.424)	(0.346)	(0.366)
first_country_entry_d	-0.633**	-0.633**	-0.633**	-0.633**
	(0.287)	(0.287)	(0.287)	(0.287)
MNO_sum_country	0.072	0.072	0.072	0.072
	(0.063)	(0.063)	(0.063)	(0.063)
Constant	1.610	-2.954	-5.963*	5.974
	(8.296)	(3.466)	(3.377)	(3.984)
Observations	248	248	248	248
ll	-298.3	-298.3	-298.3	-298.3
r2_p	0.147	0.147	0.147	0.147

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 3-11: Determinants of success, using a generalized ordered probit model, using model 2 from Table 3-10.

	Adoption_level			
	Generalized Ordered Probit (partial proportional odds)			
VARIABLES	0	1	2	3
log_Subs_MNO_Av	-0.186	-0.186	-0.186	-0.186
	(0.263)	(0.263)	(0.263)	(0.263)
log_Subscribers_ITU	-0.146	-0.457	0.239	-0.035
	(0.835)	(0.352)	(0.348)	(0.349)
Group_OECD_DAC	1.097***	1.097***	1.097***	1.097***
	(0.372)	(0.372)	(0.372)	(0.372)
state_owned	-0.571	-0.571	-0.571	-0.571
	(0.460)	(0.460)	(0.460)	(0.460)
Years_since1st_entry	-0.020	0.155*	0.341***	0.368***
	(0.255)	(0.087)	(0.085)	(0.091)
first_group_entry_d	-0.569	1.059*	1.194**	2.542***
	(1.470)	(0.568)	(0.474)	(0.498)
first_country_entry_d	5.211**	-0.963*	-0.931**	-1.509***
	(2.386)	(0.552)	(0.448)	(0.438)
MNO_sum_country	1.211	0.167	-0.207*	0.411**
	(0.985)	(0.116)	(0.120)	(0.165)
Act_formal_11	-0.005	-0.012	0.012**	-0.003
	(0.027)	(0.007)	(0.006)	(0.006)
Constant	-0.200	3.555	1.491	-1.570
	(4.804)	(4.136)	(4.116)	(4.115)
Observations	183	183	183	183
ll	-194.3	-194.3	-194.3	-194.3
r2_p	0.237	0.237	0.237	0.237

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 3-12: Determinants of success, using a generalized ordered probit model, using model 4 from Table 3-10.

In contrast to the positive significant effect of market share on entry, there is no evidence for a similar effect on adoption rates. However, firms that have been in the industry for more time see more adoption in a given market. Thus, industry-specific experience seems to improve the performance of mobile banking platforms. This effect also holds within firm —that is, the firm's first country-specific entry has more users than its subsequent entries. There is no clear effect of number of firms in the market. When assuming parallel odds (Table 3-10), we find no clear evidence of beneficial effects of being the first mover in a country. However, when separating the different levels of adoption, it appears that being a first mover has a negative effect on the uptake of the service (Table 3-11 and Table 3-12).

In terms of ownership, we find that state ownership has no significant effect; however, entries by firms that are from the North are more likely to see higher adoption rates.

3.6.2.2. Exceptional growth cases

The second measure of performance that we analyze is whether a mobile banking platform experienced exceptional growth. We use a metric provided by the GSMA, which classifies 14 Southern entries in the industry as 'sprinters' (Penicaud, 2013). Sprinters are measured by the ratio of transactions to the size of the addressable market. The advantage of measuring the number of functional transactions, rather than the number of customers, is that it allows for comparison between wallet-based services and those offered over-the counter. The addressable market is measured as the number of GSM subscribers (for MNOs) or the number of unique mobile subscriptions in the country (for non-MNOs). The GSMA's analysis shows that mobile network operators deployed the majority of fast-growing deployments, or 'sprinters'. The GSMA partially disclosed its list of sprinters, which was complemented by the authors.

We use the following estimation equation:

$$\begin{aligned}\text{Sprinter}_i^c = {} & \beta_0 + \beta_1 Market\_Share\_av_{it}^c + \delta_2 MSabovemean_{it}^c \\ & + \delta_3 \text{Previous\_group\_entry}_i + \delta_4 state\_owned_i \\ & + \delta_4 early\_entrant08_i + \delta_5 first\_group\_entry\_d_i^c \\ & + \beta_6 HHI\_Q1_t^c + \beta_7 MNO\_sum\_country_t^c + \beta_8 Subscribers\_ITU_t^c \\ & + \beta_9 firms\_entered_t^c + \delta_{10} \text{Previous\_country\_entry}_{it} \\ & + \beta_{11} Branches\_com\_bank\_100000 adults_t^c\end{aligned} \quad (4)$$

VARIABLES	(1)	(2)	(3)	(4)
			Sprinter	
			Probit	
log_Subs_MNO_Av	0.596***	0.561***	0.180	0.213
	(0.200)	(0.214)	(0.214)	(0.232)
log_Subscribers_ITU	-0.406**	-0.498**	0.020	-0.086
	(0.184)	(0.196)	(0.237)	(0.252)
Group_OECD_DAC	-0.200	-0.292	-0.027	-0.075
	(0.227)	(0.243)	(0.265)	(0.271)
state_owned	-0.042	-0.157	0.173	0.073
	(0.298)	(0.319)	(0.343)	(0.356)
Years_since1st_entry		0.202***		0.121**
		(0.045)		(0.056)
first_group_entry_d	0.906***	1.361***	0.473*	0.791***
	(0.213)	(0.261)	(0.256)	(0.307)
first_country_entry_d	0.394*	0.180	0.937***	0.675**
	(0.214)	(0.227)	(0.276)	(0.297)
MNO_sum_country	-0.007	0.012	-0.030	-0.016
	(0.038)	(0.030)	(0.073)	(0.065)
Act_formal_11			0.000	-0.001
			(0.004)	(0.004)
Constant	-10.990***	-11.497***	-4.900	-5.879*
	(3.032)	(3.230)	(3.248)	(3.521)
Observations	559	559	386	386
ll	-94.78	-83.58	-68.05	-65.72
r2_p	0.244	0.333	0.219	0.246

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 3-13: Determinants of being a sprinter.

A firm's market share of the mobile subscriber market positively affects its probability of becoming a sprinter, although this effect loses significance when we reduce the sample size by including a measure of financial access. However, it should be noted that the level of mobile penetration does not have a significant impact, as sprinters are present in markets with 28–103% penetration.

The advantage that Northern firms have for adoption levels does not hold for sprinters. Similarly, state ownership plays no role. However, experience increases the likelihood of high firm growth. Longer presence in the industry, a measure for industry-specific experience, has a positive effect on becoming a sprinter. There is also a first-mover advantage in terms of growth rates of the mobile banking platform.

3.6.2.3. Number of Services

Once a firm has entered a country, it may choose to expand its service offering by investing in adding new mobile financial services. Therefore, as a proxy for success after

entry, we look at the number of services a firm introduced per country in 2012, conditional on its entry.

$$
\begin{aligned}
Nr\_services^{c}_{i,2012} = {} & \beta_0 + \beta_1 Market\_Share\_av^{c}_{it} + \delta_2 MSabovemean^{c}_{it} \\
& + \delta_3 \text{Previous\_group\_entry}_i + \delta_4 state\_owned_i \\
& + \delta_4 early\_entrant08_i + \delta_5 first\_group\_entry\_d^{c}_{i} \\
& + \beta_6 HHI\_Q1^{c}_{t} + \beta_7 MNO\_sum\_country^{c}_{t} \\
& + \beta_8 Subscribers\_ITU^{c}_{t} + \beta_9 firms\_entered^{c}_{t} \\
& + \delta_{10} \text{Previous\_country\_entry}_{it} \\
& + \beta_{11} Branches\_com\_bank\_100000 adults^{c}_{t}
\end{aligned}
\qquad (5)
$$

We used two separate sources for the sum of services introduced by a firm in a given country up until 2012: the GSMA's mobile deployment tracker and ShiftThought's database. We combined these two data sources to minimize missing data; details can be found in Appendix F, which shows the results of the count-data model run separately for the GSMA and ShiftThought data. The service definitions employed by the two data sources were not identical, so instead of taking a simple average, we computed the 'fraction of all existing services' that were introduced according to each source. This fraction is computed by dividing the number of introduced services by the maximum number of services introduced. Our dependent variable is the average of the 'fraction of all existing services' of the two data sources. To run the model, we use the 2012 panel.

	(1)	(2)	(3)
		OLS	
VARIABLES	Fraction of all services adopted		
log_Subs_MNO_Av	0.004	0.014	0.002
	(0.020)	(0.018)	(0.015)
log_Subscribers_ITU	-0.020	-0.029	-0.027
	(0.023)	(0.021)	(0.017)
Group_OECD_DAC	0.009		
	(0.026)		
state_owned	0.022	0.015	0.003
	(0.032)	(0.028)	(0.023)
Years_since1st_entry	0.016***	0.015***	0.018***
	(0.005)	(0.005)	(0.004)
first_country_entry_d	-0.038	-0.041*	-0.045**
	(0.025)	(0.023)	(0.020)
first_group_entry_d	0.089***	0.081***	0.072***
	(0.029)	(0.027)	(0.023)
HHI_Q1	0.021	0.008	-0.074
	(0.096)	(0.086)	(0.074)
Firms_entered	0.005	0.006	0.013***
	(0.009)	(0.008)	(0.004)
total_firm_entries	0.004	0.004	0.003
	(0.003)	(0.003)	(0.002)
branches_com_bank_100000adults	-0.004**	-0.004***	
	(0.001)	(0.001)	
Constant	0.253	0.132	0.282
	(0.294)	(0.264)	(0.223)
Observations	188	220	307
R-squared	0.190	0.180	0.154
ll	95.17	117.4	163.1
r2_p	.	.	.

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 3-14: Fraction of all services adopted.

The model is first run with all independent variables, and then firm ownership (whether the firm originates in an OECD DAC country) and level of financial access (number of branches per 100,000 adults) are excluded because they limit the number of observations. We find that market share has no effect on the total number of services introduced by a firm and neither does origin from the North or state ownership. However, firm experience has a positive effect, as is shown by whether it is the firm's first entry, even when controlling for years in the industry. Controlling for the years in industry is important because presumably firms that have been in the market longer have also had more time to introduce more services since service entry tends to be gradual. The total number of entries by the firm does not appear to have any effect, although the number of

other firm entries in a country—a measure of competitive pressure—has a positive effect. Furthermore, our results show that first-movers introduce fewer services.

Firms introduce more services in countries where financial access (measured by the number of commercial bank branches per 100,000 people) is lower. The lends support to the notion that higher latent demand for financial services, particularly by the unbanked, prompts firms to offer a more diverse set of mobile financial services.

3.6.3. Impact of mobile financial services

Countries with firm entry into mobile banking can expect changes in the way mobile phones are used for financial transactions. We look at three dependent variables to examine this effect: mobile phone used to send money, to receive money, and to pay bills as a fraction of the total population above the age of 15. The variables are taken from the Findex Database. Data are available only for 2011; hence, we perform the estimation only on the 2011panel.

The estimation equation used for 'Mobile phone used to send money' is as follows:

$$\begin{aligned} MP\_sendmoney\_11^{c}_{2011} = {} & \beta_0 + \beta_1 first\_country\_entry^{c} + \beta_2 HHI\_Q1^{c}_{2011} \\ & + \beta_3 firms\_entered^{c}_{2011} + \beta_4 Subscribers\_ITU^{c}_{2011} \\ & + \beta_5 Act\_formal\_11^{c} + \delta_6 Group\_OECD\_DAC^{c}_{i} \\ & + \beta_7 MNO\_count^{c}_{2011} + \beta_8 ST\_Sum\_services^{c}_{i,2012} \\ & + \beta_9 Sum\_Panel^{c}_{i,2012} + \beta_{10} Adoption\_level^{c}_{i,2012} \\ & + \delta_{11}\text{Sprinter}^{c}_{i} \end{aligned} \quad (6)$$

VARIABLES	(1)	(2)
	MP_sendmoney_11	
	OLS	
Firms_entered	3.170***	3.413***
	(0.541)	(0.546)
Act_formal_11	-0.043	-0.023
	(0.043)	(0.044)
Mobile_Penetration	-0.776	-0.979
	(2.380)	(2.413)
MNO_count	-0.895***	-0.917***
	(0.176)	(0.176)
ST_sum_services	0.670**	0.743**
	(0.323)	(0.342)
adoption_level		-0.492
		(0.631)
Sprinter	10.669***	11.202***
	(2.115)	(2.203)
Constant	1.154	0.725
	(2.910)	(3.084)
Observations	303	294
R-squared	0.235	0.258

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 3-15: Mobile phone used to send money (% age 15+).

For ‘Mobile phone used to send money’, we use:

$$\begin{aligned} MP\_receivemoney\_11^{c}_{2011} = {} & \beta_0 + \beta_1 first\_country\_entry^{c} + \beta_2 HHI\_Q1^{c}_{2011} \\ & + \beta_3 firms\_entered^{c}_{2011} + \beta_4 Subscribers\_ITU^{c}_{2011} \\ & + \beta_5 Act\_formal\_11^{c} + \delta_6 Group\_OECD\_DAC^{c}_{i} \\ & + \beta_7 MNO\_count^{c}_{2011} + \beta_8 ST\_Sum\_services^{c}_{i,2012} \\ & + \beta_9 Sum\_Panel^{c}_{i,2012} + \beta_{10} Adoption\_level^{c}_{i,2012} \\ & + \delta_{11}\text{Sprinter}^{c}_{i} \end{aligned} \quad (7)$$

	(1)	(2)
VARIABLES	MP_receivemoney_11 OLS	
Firms_entered	3.699***	3.396***
	(0.564)	(0.567)
Act_formal_11	-0.051	-0.070
	(0.042)	(0.043)
log_Subscribers_ITU	-1.743***	-2.040***
	(0.644)	(0.653)
MNO_count	-0.590**	-0.500**
	(0.246)	(0.250)
ST_sum_services	0.795**	0.811**
	(0.364)	(0.352)
adoption_level	-0.120	
	(0.686)	
Sprinter	13.602***	13.518***
	(2.416)	(2.370)
Constant	-0.874	0.209
	(2.745)	(2.590)
Observations	298	307
R-squared	0.275	0.251

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 3-16: Mobile phone used to receive money (% age 15+).

For ‘Mobile phone used to pay bills’, we use:

$$\begin{aligned} MP\_sendmoney\_11^{c}_{2011} = {} & \beta_0 + \beta_1 first\_country\_entry^{c} + \beta_2 HHI\_Q1^{c}_{2011} \\ & + \beta_3 firms\_entered^{c}_{2011} + \beta_4 Subscribers\_ITU^{c}_{2011} \\ & + \beta_5 Act\_formal\_11^{c} + \delta_6 Group\_OECD\_DAC^{c}_{i} \\ & + \beta_7 MNO\_count^{c}_{2011} + \beta_8 ST\_Sum\_services^{c}_{i,2012} \\ & + \beta_9 Sum\_Panel^{c}_{i,2012} + \beta_{10} Adoption\_level^{c}_{i,2012} \\ & + \delta_{11}\text{Sprinter}^{c}_{i} \end{aligned} \quad (8)$$

VARIABLES	(1)	(2)	(3)
	MP_paybill_11		
	OLS		
Firms_entered	0.729***	0.983***	0.891***
	(0.176)	(0.164)	(0.154)
Act_formal_11	0.042***	0.037***	0.030**
	(0.014)	(0.012)	(0.012)
Mobile_Penetration	-3.524***		
	(0.779)		
log_Subscribers_ITU		-1.126***	-1.202***
		(0.188)	(0.177)
MNO_count	-0.206***	-0.009	0.054
	(0.057)	(0.071)	(0.068)
ST_sum_services	-0.150	-0.100	-0.035
	(0.110)	(0.106)	(0.095)
adoption_level	-0.077	0.314	
	(0.204)	(0.193)	
Sprinter	2.625***		3.389***
	(0.711)		(0.643)
Constant	4.057***	-0.678	-0.546
	(0.996)	(0.805)	(0.702)
Observations	294	298	307
R-squared	0.236	0.237	0.293

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 3-17: Mobile phone used to pay bills (% age 15+).

The three dependent variables used are similar measures of intensive adoption, and therefore the results for the three estimations are similar. The total number of firms that have entered into mobile financial services has a positive impact on the use of mobile phones to send money. This is not surprising because when more firms enter, it also means that more services are available on the market, and wireless subscribers are more likely to adopt and find a service that suits their needs. Network externalities also play an important role in terms of sending, receiving, and paying bills via mobile phone. The diversity of the firms' service offerings, measured by the number of services introduced by firms in the country, also has a positive effect on adoption.

We control for size of the market, number of bank accounts, and the total number of firms in the market.

3.7. Conclusions and Discussion

This chapter uses the mobile banking industry to illustrate how an industry in the South emerged and what the determinants of firm success were as well as impact on the financial services in the country. We find that the conditions in the mobile banking industry were conducive to new patterns of innovation and industry leadership in the South. Although there are several patterns that stand out convincingly in our study of the mobile financial service industry, the conclusions and implications on the general literature are stated hesitantly given the novel circumstances of our findings.

We explain how two conditions, namely the recent trend in increasingly rapid diffusion of technology in combination with increased access to knowledge, may cause this pattern of shifting geography to be repeated in the future.

Due to the different markets the firms were operating in and the disparate service portfolios they were commercializing, the performance of the mobile banking platforms showed stark differences. First of all, firms in Northern markets were adopted less and slower than firms in the South; this often attributed to lower demand for new payment methods and financial services in the North due a wide range of high-quality substitutes as well as a tougher regulatory environment.

In our study of mobile financial services, we find an exception to the fact presented by Comin et al. (2006), namely that leaders in technology adoption exist, which are not universal across technologies. We find that the intensive and extensive margins of technology adoption are higher in non-OECD countries, specifically in countries that have lower adoption rates in other technologies.

The findings could have important implications for management practices. First of all they imply that innovations may increasingly originate from emerging markets, which increases competition. On the other hand, they also imply that market opportunities are opening up in the South, in particular with respect to information and communication technologies that can be leveraged to solve a plethora of market needs.

For the research community, the observations seen in the mobile banking industry open up new areas of inquiry. The economic growth literature may need to revisit some of the important assumptions regarding the origin of technology. The innovation and technology diffusion literature may need to be extended to include a better understanding

of the role of geography, market need, and available technology and their role in technological advances.

Our observations are limited to a single industry, which is still developing at the time of writing and therefore further studies will be needed.

Chapter 4 Diffusion of Consumer Innovations: Evidence from Portugal and a Comparison with other Countries

Abstract

Diffusion of firm innovations has been studied extensively, yet the opposite is true for diffusion of user innovations. This chapter uses data from a large-scale innovation survey conducted by the Portuguese government to study two types of diffusion: commercial diffusion (market-based) and peer-to-peer (non-market-based) diffusion. The dataset is the largest national sample of user innovation collected to date and is used to shed light on how different components of the user innovation process, such as motivation, collaboration, and investment, affect diffusion of user innovations. Furthermore, we use the data to compare findings with large-scale surveys conducted in other countries. Our data shows that in Portugal, 12.2% of highly-educated people innovate to solve their own needs. We find that non-market-based diffusion is between 3–7 times more likely to occur than market-based diffusion, depending on whether the innovation was done at home or at work. Furthermore, we find that selling or making money was rarely a motivation for users to innovate, and if it was, and when innovations were intellectually protected, diffusion was more likely. Most of the user innovators in our sample collaborated with other people when innovating: professional-user innovators collaborated mostly with colleagues and end-user innovators with friends and/or relatives.

Diffusion and commercialization of innovations differs sharply depending on whether the source is the user or the firm. Surprisingly, collaboration has no significant effect on diffusion. Another main finding is that willingness to share and effort to inform others about the innovation were the most important determinants for diffusion. More than half of the innovations were never shared, despite users' willingness to do so for free, which helps explain why only 41% percent of the innovations in our sample diffused, of which 33% diffused through non-market mechanisms and 11% did so commercially. These results provide new evidence on the diffusion process of user innovation, which is especially relevant for innovation and entrepreneurship policy.

Furthermore, as the data collection effort was the first of its kind, lessons are offered for improving measurement and validation methods.

4.1. Overview: User Innovation and Implications for Innovation Policy

User innovation is of growing importance (Herstatt and von Hippel, 1992; Jeppesen, 2004; Shah, 2006) and has attracted interest from policy makers as well as from the academics who want to understand how user innovation contributes to social welfare and what role it plays in innovation policy (Gault, 2012). The majority of empirical research to date has focused on understanding the characteristics of user innovation and its role in the development of a single product- or service category, yet work that looks at the measurement of user innovation and innovation policy is scarce. To address some of the questions pertaining to these topics, large-scale national surveys in the UK, the Netherlands, Japan, and Denmark have recently been conducted. These surveys attempted to measure innovation by individuals on a national level and across product categories and industries and demonstrated that consumers spend significant resources on innovation. For example, in the UK, consumers' annual product development expenditures were found to be more than 1.4 times larger than the annual consumer product R&D expenditures of all firms in the UK combined (von Hippel et al., 2012). These findings have a profound impact on innovation policy and underscore the importance of gaining a more thorough understanding of the role of user innovation in the economy.

One of the conditions for innovation to have a broad economic significance is its diffusion (Rosenberg, 1972). Therefore, this study seeks to provide a better understanding of the mechanisms that governs the diffusion of user innovations. The research questions that we address are twofold: Which user innovations diffuse and what are the main drivers of their diffusion? To answer these questions, we use data from a study of more than 2,400 highly-educated people in Portugal. The unique set-up of the survey and the large sample size allows a deeper insight into the ways in which users share, how much they share, what resources are dedicated to diffusion, and how sharing relates to the innovator's motivations. The user innovation survey was administered by the Portuguese government and provided the largest sample of user innovation collected in any country to date. As a result, the data allow for a more thorough analysis, in particular of different

typologies of diffusion, such as peer-to-peer sharing and user entrepreneurship, than what has previously been possible.

We find that non-market-based diffusion is between 3–7 times more likely than market based diffusion, depending on whether the user innovation was done at home or at work. Furthermore, we find that selling or making money was hardly ever a motivation for innovation, and if it was, and when innovations were intellectually protected, diffusion was more likely. Most of the user innovators in our sample collaborated with other people when innovating: professional-user innovators with colleagues and end-user innovators with friends and/or relatives. Surprisingly, collaboration had no significant effect on diffusion. Another main finding is that willingness to share and effort to inform others about the innovation were the most important determinants for diffusion. More than half of the innovations were never shared, despite users' willingness to do so for free, which helps explain why only 41% percent of the innovations in our sample diffused, of which 33% diffused through non-market mechanisms and 11% did so commercially.

Additionally we compare the results from Portugal with previous large-scale user innovations conducted in other countries to draw lessons for future studies. Lessons are offered for improving measurement methods based on our data collection effort, which contained several novel components.

This chapter is divided into six sections. Section 4.2 looks at the existing literature on user innovation and on the diffusion of innovations. The next section discusses the methodology and details the survey used for data collection. The fourth section discusses the data, first focusing on only what we found in Portugal and subsequently contrasting this with other surveys that were recently conducted. Section 4.5 focuses on the analysis conducted to explain the findings, which is followed by a section on conclusions and implications.

4.2. Previous literature

In this section, we address the previous literature on the topics relevant to this chapter. First, we lay out the current state of knowledge on users as innovators, both at home and at work. We proceed by expounding existing theory on the diffusion of innovation and suggest how this ties into the user innovation literature.

4.2.1. Users as sources of innovation

Users have been known to be an important source of innovation, and there is ample literature showing this in a variety of contexts (von Hippel, 2005). Studies have looked at the incidence of user innovation in both goods (e.g., Franke et al., 2006; Luthje, 2004) and services (e.g., Oliveira and von Hippel, 2011; Repo et al., 2004; van der Boor et al., 2014) and have found that users play an important role in new product creation. Many studies have looked at incidences of user innovation in consumer good sectors, such as extreme sports (Franke and Shah, 2003), outdoor sports (Luthje, 2004), and rodeo kayaking (Baldwin et al., 2006). In some cases, this has led to entirely new sports, such as with mountain biking (Luthje et al., 2005) and kite surfing (Tietz et al., 2005). Other studies have begun exploring user innovations in services such as retail banking (Oliveira and von Hippel, 2011) and health care where patients solve their own needs (Oliveira et al., 2012).

The literature on user innovation has addressed a multitude of dimensions and implications of a changing paradigm where users are sources of innovation (see Bogers, 2010 for a survey of the literature). It has been shown, for example, that lead users often experience needs before the rest of the market and possess information about their needs, which is costly to transfer (von Hippel, 1986, 1994). Lead users expect to benefit significantly from new solutions and are often avid user innovators. In a study of innovation efficiency, Hienerth et al. (2014) found that lead users in whitewater kayaking communities spent more than four times as much money on their innovations and dedicate three times as much time compared to non-lead users.

Other work has shown that innovating users frequently work collaboratively as members of communities, as is often the case in open source software (Lakhani and von Hippel, 2003). Many of these communities facilitate the free sharing of ideas and solutions between other community members, regardless whether they are fellow innovators or free riders (Lerner and Tirole, 2002).

Much has also been written about the reasons that drive users to innovate, both on the cost and benefit side. ‘Sticky information’ (von Hippel, 1994) increases the costs for users to transfer information regarding specific needs. Furthermore, the benefit will be largest to the innovator who is able to largely appropriate the invested effort (von Hippel, 1988, 2005).

4.2.2. Measurement of user innovation

Most of the empirical evidence we have for user innovation is based on case studies of specific industries or product categories. Results of several selected studies are summarized in Table 3-1 below:

Innovation Area	Number and type of users sampled	% developing and building product for own use	Source
Industrial products			
Printed Circuit CAD Software	136 user firm attendees at a PC-CAD conference	24.3%	Urban and von Hippel (1988)
Pipe hanger hardware	Employees in 74 pipe hanger installation firms	36.0%	Herstatt and von Hippel (1992)
Library Information Systems	Employees in 102 Australian libraries using computerized OPAC library information systems	26.0%	Morrison et al. (2000)
Medical Surgery Equipment	261 surgeons working in university clinics in Germany	22.0%	Luthje (2003)
Apache OS server software security features	131 technically sophisticated Apache users (webmasters)	19.1%	Franke and von Hippel (2003)
Consumer products			
Outdoor consumer products	153 recipients of mail order catalogs for outdoor activity products for consumers	9.8%	Luthje (2004)
"Extreme" sporting equipment	197 members of 4 specialized sporting clubs in 4 "extreme" sports	37.8%	Franke and Shah (2003)
Kite surfing equipment		26.0%	Tietz et al. (2002)
Mounting biking equipment	291 mountain bikers in a geographic region known to be an "invention hot spot"	19.2%	Luthje et al. (2002)
Services			
Retail banking	14 experts were consulted to trace the sources of 36 corporate and retail banking services	44.0%	Oliveira and von Hippel (2011)
Mobile financial services in developing countries	Detailed innovation histories of all 20 mobile financial services available in the world were used to determine the source of innovation	50.0%	van der Boor et al., (2014)

Table 4-1: Frequency of user innovation. Table adapted from Luthje and Herstatt (2004) and von Hippel (2005).

Despite the evidence that user innovations are prevalent across industries, the standardized national innovation surveys such as the Community Innovation Survey (CIS) and technology use surveys have thus far excluded any measurement of user

innovation (Gault, 2010).[37] The exclusion of user innovation in these surveys can be attributed to various reasons. The primary reason is that the definition of innovation in the Oslo Manual precludes user innovation on the basis that it needs to 'be implemented in the market'. This is an artifact of the traditional innovation models, which assume that innovation is only carried out by manufacturers. Because users are often innovating to solve their own needs instead of for the purpose of selling their innovations, they often don't transfer their innovations to the market and are therefore ruled out. Second, innovation is most commonly measured by R&D expenditures, scientific publications, and patents granted. Users do not engage in R&D in the conventional way, and their efforts can therefore not be captured using this metric. Furthermore, as this chapter will show, the great majority of users don't protect their intellectual property through patents, which effectively excludes them from the two principle ways of measuring innovation.

As a result of the skewed measurement of innovation, policy makers were thus far left largely in the dark about any innovative activity that consumers were undertaking (Gault, 2011). This has made it more difficult for policy makers to maintain a national advantage (National Innovation Initiative Final Report, 2004).

4.2.3. Professional-user innovators and end-user innovators

The literature has made a distinction between two types of user innovators, those who innovate in their profession, so-called firm-based or professional-user innovators, and the 'weekend hobbyists' (Dahlin et al., 2004), also known as end-user innovators or consumer innovators. Shah and Tripsas (2007) define the difference as follows: professional-users innovate in industries that are generally different from those of their employers, and end-users create a product for their everyday lives. Although user firms have also been shown to be active user innovators (de Jong and von Hippel, 2009; Schaan and Uhrback, 2009), it should be noted that this is different than professional-user innovation. Firm-led user innovation looks at the firm as the unit of analysis, whereas individual-led user innovation looks at need and innovation at the level of the individual. See Figure 4-1 for a conceptual hierarchy.

Individuals can simultaneously innovate to solve needs at home and at work and may therefore be both end-user innovators as well as professional-user innovators;

[37] In 2013, for the first time, questions aimed at capturing user innovation were introduced to the CIS, but this was experimental. Because these surveys are distributed only among firms, individual-led user innovation is not included.

however, the innovation itself either addresses a need at work (professional-user innovation), or it addresses need that is not work-related (end-user innovation). Therefore, when the unit of analysis is the innovation carried out by an individual (as is the case in our data), we assign the innovation to one of the two individual-led innovation categories.

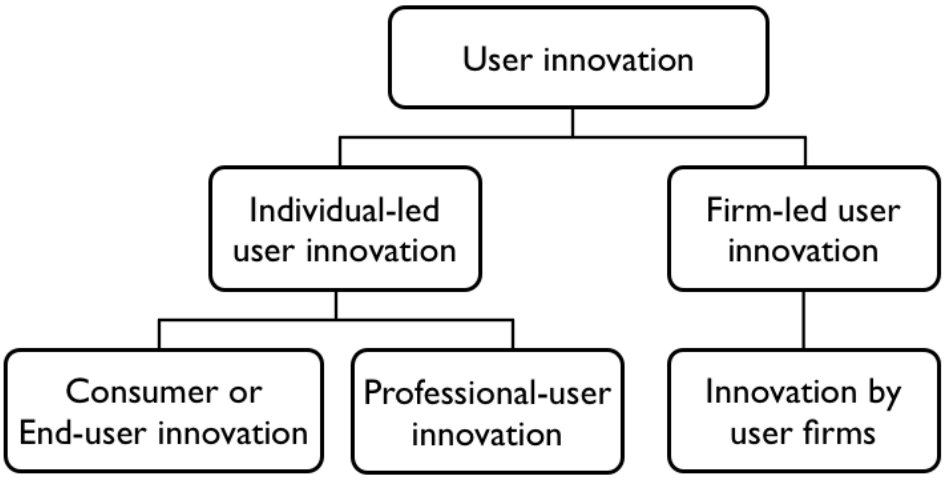

Figure 4-1: Conceptual hierarchy of user innovations.

The focus of our study is innovation by individuals, and hence we leave user firms aside. We proceed to highlight differences between consumer innovation and professional-user innovation.

Individuals at work often have unmet needs and will sometimes seek to solve those on their own. For example, Lettl (2007) details how surgeons were responsible for several radical innovations that were created in response to major needs they encountered in the work place. One neurosurgeon described a problem encountered during work, saying that a gap existed between the need to operate at sub-millimeter precision and the low-precision performance of available surgical equipment. Another neurosurgeon explained the inability to navigate surgical instruments in the depths of brain antrums and involved a medical device equipment manufacturer to commercialize his solution. The surgeons that innovated to solve their needs at work are professional-user innovators.

Given that most people spend a large fraction of their life at work, there is reason to believe that an important fraction of user innovation occurs at work. In fact, some of the early work in this field studied user innovators in a professional setting. For example, von Hippel (1976) found that 80% of scientific instruments were developed by professional users.

Table 4-1 highlights several other studies that documented professional-user innovation, such as pipe hanger hardware (Herstatt and von Hippel, 1992) and library systems (Morrison et al., 2000), where employees innovated to solve professional needs. These studies show that professional user innovators are embedded in their organizations and solve needs that they face during their work (Chatterji and Fabrizio, 2013; Jeppesen and Frederiksen, 2006; Riggs and von Hippel, 1994). Furthermore, many firms have claimed that the users of their products are the most important source of knowledge regarding feedback and development of innovations (Chatterji and Fabrizio, 2013). There is extensive academic research that supports this claim and that it holds for products and services across industries (Oliveira and von Hippel, 2011; Thomke and von Hippel, 2002; von Hippel 1986).

Individuals at home will seek to solve their needs differently, compared to individuals at work. We expect there to be differences in various dimensions, such as the motivation for innovation, collaboration, and investment of time and money—and particularly relevant to diffusion is whether sharing occurs and with whom. We will seek to identify these differences in this chapter.

4.2.4. Diffusion of Innovations

Stoneman and Battisti (2010) write that a successful new technology is a technology that has diffused. The OSLO manual defines diffusion as follows:

Diffusion is the way in which innovations spread, through market or non-market channels, from their very first implementation to different consumers, countries, regions, sectors, markets and firms. Without diffusion, an innovation has no economic impact. (OECD/Eurostat, 2005, p. 17)

This definition clearly highlights the importance of diffusion of an innovation in having an economic impact. Therefore, we proceed to briefly outline what is known about the diffusion of innovations. Potential adopters evaluate the benefits and costs of the new technology and will decide to adopt now or later. Some authors have emphasized the fact that, as the innovation spreads and learning occurs, the innovation is adapted and improved further, which makes adoption more attractive over time (Nelson and Nelson, 2002; Rosenberg 1976). On the other hand, costs of adoption, also known as switching

costs, can slow diffusion down when they are too high (e.g., Majumdar and Vankataraman, 1998). Network externalities also affect the value of an innovation to a potential adopter and therefore condition the speed of diffusion of an innovation (Katz and Shapiro, 1986).

Most of the literature has looked at this from a firm perspective, assessing the relative importance of different knowledge sources, internal and external (Arora and Gambardella, 1990; Cohen and Levinthal, 1990), to the firm's innovation process. This chapter, however, looks at this process from the user's perspective by comparing what different diffusion modes are most common to user innovations, and hence we also address existing knowledge on this aspect of diffusion.

4.2.4.1. Diffusion of producer innovations

There is a rich body of literature on the diffusion of innovations. In this section, we highlight the most important factors that dictate the diffusion of new technology by firms.

Ever since the first empirical studies of inter-firm diffusion found that adoption rates tend to follow an S-shaped curve (Griliches, 1957; Mansfield, 1968), theoretical work has proposed various models of diffusion such as the epidemic model and the probit model (see Geroski, 2000 for an overview) to explain these findings. The underlying assumptions driving the adoption pattern have been attributed to adopter heterogeneity and learning. Adopter heterogeneity means that adopters expect to have different benefits from a new technology, and because costs decline over time, they will switch at different points in time. Some models, such as the heterogeneity model (also known as the probit model), have made the assumption of perfect information, which implies that all firms and individuals know about all new available technologies at all times (see Karshenas and Stoneman, 1993). Instead, the epidemic model (also known as the learning model) is driven by the fact that not all potential adopters are aware of the new technology and that information about its existence dictates adoption rates. These models have been tested mostly in the area of inter-firm diffusion, and researchers have found several important stylized facts regarding this process. For example, larger firms and older firms are superior at making adoption decisions, perhaps because larger and older firms are more efficient or better able to appropriate the benefits of innovation (Hannan and McDowell, 1984; Karshenas and Stoneman, 1993; Noteboom, 1993; Romeo, 1975).

In practice, most firms try to actively protect their intellectual property because this deters competitors from imitating the innovation and increases an innovator's appropriable returns. Although intellectual property protection preserves economic incentives for firms to innovate, it can slow diffusion down as firms prevent other firms from imitating (and also improving upon) the innovation. In contrast to users (as will be discussed in the next section), firms do not usually freely reveal their innovation. Firms often engage various methods for protecting their intellectual property—such as secrecy, patents, etc. (Cohen et al., 2000; Cohen, 2010; Levin et al., 1989)—depending on the type of knowledge, the industry, and other factors.

The abovementioned models of diffusion assume that consumers are passive participants in the process of innovation. As we have seen in previous sections, this is not always the case, and we proceed to discuss related implications on the diffusion process.

4.2.4.2. Diffusion of user innovations

In the previous section, we detailed how firms predominantly rely on market mechanisms to diffuse their products. Users rely on market and non-market mechanisms of diffusion, and we will discuss these two modes separately. Contrary to the definition of innovation, which is limited to 'being available on the market', the definition of diffusion as given by the OSLO manual also encompasses non-market channels.

Market-based diffusion, also referred to as commercial diffusion, takes place when the innovation becomes available for sale in the market. Users can commercialize their innovation in three ways: first, they can bring it to market themselves. Shah and Tripsas (2007) coined the term 'user entrepreneurs' to describe users that commercialize innovations themselves. In a related study (Shah et al., 2012), user entrepreneurship is shown to be an important portion of new firm creation. When users don't want to venture into the market independently, they may share their innovation with their employer (Zejnilovic et al., 2012) and ask the organization they work for to commercialize it for them. Alternatively, they can share their innovation with another commercial entity (Allen, 1983; Morrison et al., 2000) and ask them for help with commercialization.

Often, innovations pioneered by users have large commercial value (Franke et al., 2006; Lilien et al., 2002; Hienerth et al., 2014). Luthje (2003) showed that 48% of surgical innovations developed by surgeons in university clinics in Germany had been or would be produced as commercial products. Similarly, manufacturers of library IT

systems indicated that many of the IT innovations developed by libraries had potential value as commercial products (Morrison et al., 2000). Other studies have found that firms attach high value to ideas coming from their customers. For example, Cohen et al. (2000) find that many firms identify customers as the most important source of information for suggestions for new projects. Furthermore, Baldwin et al. (2006) found that 60% of the important hardware innovations in whitewater kayaking developed in the household sector were commercialized.

Users frequently also rely on non-market channels for diffusion, which are distinct from market-channels in that non-market-based sharing is done for free. Because users are often willing to share their innovations for free (de Jong and von Hippel, 2009; Gault and von Hippel 2009; Harhoff et al., 2003), the channels of diffusion are different. For example, users engage in peer-to-peer sharing (Franke and Shah, 2003) and sharing through communities (Baldwin and von Hippel, 2011). Sharing within communities is especially common when users create innovations related to communities to which they belong, as was found to be the case with sports enthusiasts or open source software programmers (Henkel, 2006). That peer-to-peer diffusion can be a very successful method of diffusing innovations has been proven, in particular in the case of software, such as the diffusion of user-generated games (Jeppesen and Molin, 2003). Shah and Tripsas (2007) show that community interactions can be a key part in the collective creation of a new idea and that the collective process of improving on the original idea can sometimes lead to a commercially viable product.

Because users frequently rely on non-market mechanisms of diffusion, they do not need to take into account strategic effects detailed in the diffusion literature (Fudenberg and Tirole, 1985; Quirmbach, 1986; Reinganum, 1981). Yet, there are complementaries between market and non-market channels for diffusion (Raasch and von Hippel, 2012).

Diffusion of innovation is a *sine qua non* of its ability to have an impact on social welfare. Yet, the prolific literature on user innovation has thus far said little about the way user innovations diffuse. Many questions remain unanswered in this area. Do users have any incentive to share their solutions with others once they have solved their need? If a user innovator is part of a community that could benefit from the innovation, does active promotion happen to encourage the adoption of one's innovation? Will a user commercialize a solution if it is likely that the innovation will be profitable? A user's

willingness to share for free is not the same as actively investing in promoting an innovation. A previous large-scale UK survey found that only a fourth of user innovations products had been taken up by other users or adopted and manufactured by producers (von Hippel et al., 2012). Not much is known about the effect of willingness to share on diffusion itself or what efforts users put into actively sharing their diffusion. We attempt to answer some of these questions in the following sections.

4.3. Data & Methodology

In this section, we discuss the methodology of large-scale surveys as well as the survey design. We then elaborate on the validation mechanism used to eliminate false positives before describing the sample and sample descriptive statistics.

4.3.1. Large-scale surveys on user innovation by consumers

Traditionally, the methods for measuring innovation have either been by account of patents or R&D expenditures (see the Frascati Manual, OECD, 2005). Neither of these methods can fully capture individual innovation, and as a consequence, consumer innovation has been largely ignored in country- and industry innovation statistics. In recent decades, innovation surveys, such as the Community Innovation Survey (CIS), have been conducted in many countries. Mairesse and Mohen (2010) provide an overview of how these surveys have evolved over time and have become a useful tool for benchmarking innovation activity across countries. The majority of these surveys is conducted with firms and allows collection of qualitative and quantitative data. However, given that we know users innovate, some governments have begun conducting similar surveys among individuals to measure their innovativeness.

In recent years, several large-scale studies have addressed the topic of user innovation and diffusion; there was a study of high-tech firms in The Netherlands (de Jong and von Hippel, 2009) and a representative household study in the UK (von Hippel et al., 2012) as well as in Japan and the USA (Ogawa and Pongtanalert, 2010 and 2011), and Finland (Niemi and Kuusisto, 2013). These studies showed that a large part of the population innovated (6.1% in the UK, 5.2% in the US, and 3.7% in Japan) and confirmed that user innovations are shared and get adopted but don't distinguish between the different forms of sharing. Furthermore it was found that consumers, in aggregate, spend a comparable amount on developing their innovations in the UK as firms spend on

R&D; in the UK, consumers spent 144% of firm expenditures, in the US 36%, and in Japan 13%.

Because user innovators constitute a relatively small proportion of the total population, uncovering the characteristics of user innovation on a national level requires large amounts of data (and is therefore costly), which makes these studies rare.

4.3.2. Survey and Sample

A national survey was conducted in Portugal to shed light on questions of motivation and diffusion of user innovation. The survey was distributed to people in a registry owned by the Portuguese Ministry of Science and Education, which includes all individuals with a PhD, all researchers in the medical sciences (including sociologists, nurses, biologists, and others as long as they were developing research in the medical sciences and had a higher education degree) as well as those in the medical profession. The reason for focusing on people with higher education is because we expect a higher incidence of user innovation, as was shown in the past (von Hippel, 2005). The reason for this is that individuals use knowledge that is already in their possession when carrying out creative cognitive tasks (Marsh et al., 1999).

The survey was divided into five comprehensive sections: demographics, consumer innovation, innovation process, innovation diffusion, and individual traits. Respondents were asked if they had ever innovated, and if so, to indicate whether their most significant innovation was done for their job/business or for themselves/other purposes and to describe their innovation.

The survey allowed people to report innovations at work because, as was discussed in previous sections, a significant amount of users innovate at work and, at any given time, 45% of the Portuguese population is employed. Therefore a large fraction of the population spends a large amount of time at work.

The first survey question probing for innovation was: “In the past three years, did you ever use your leisure and/or work time to create any of your own?” The survey then asked respondents to identify the purpose, whether it was ‘for my job/business’, ‘for myself/other purposes’, and ‘don’t know/will not say’. If the respondent indicated that the primary purpose of the innovation was to sell the innovation or indicated that the innovation was already available on the market, then the responses were not considered user innovations. The survey was sent to 9,235 people, and 2,423 responded (response

rate = 26.2%), of which 1,479 claimed to have innovated, and 589 were considered potential user innovations.

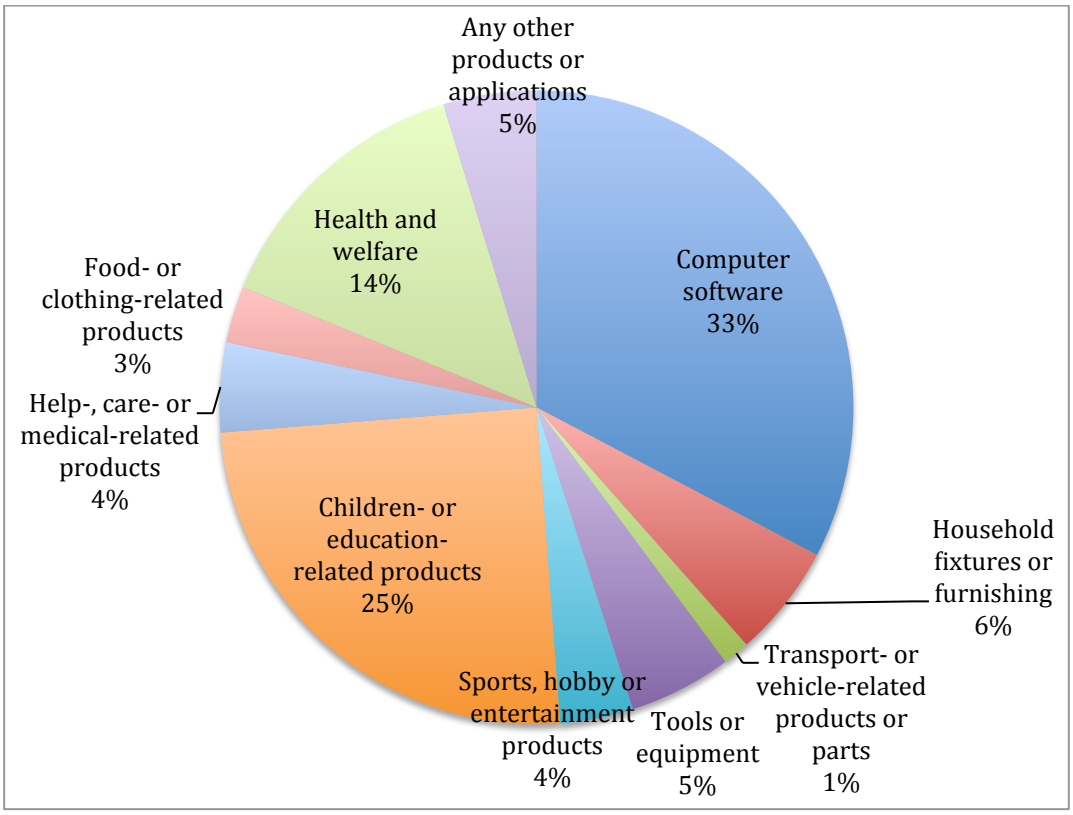

Figure 4-2: Categories in which the 589 innovators identified their most important innovations.

The 589 respondents were asked multiple follow-up questions about the innovation process, which included a description of the innovation, its novelty and importance, the motivation for innovating, whether there were any collaborators, time and money invested, and finally questions pertaining to intellectual property protection. The diffusion section centered around the attitude the respondent has towards sharing, if any investment was made towards sharing information about the innovation, and whether anybody adopted the innovation. The last section contained questions about personality traits. The full survey, translated into English from Portuguese, can be found in Appendix H.

4.3.3. Validation and Categorization

Given the richness of the data collected through the survey, we were able to validate the self-reported user innovations and eliminate false-positives. False-positives, also known as 'Type I errors', occur when users report activities as innovations that should not be considered as user innovations according the definition (Flowers et al.,

2010; OECD/Eurostat, 2005). We used two different ways to validate the innovations. The first was to have independent coders validate the innovations based on the descriptions provided by the respondents. The rules used for the independent coding process are detailed below. The second method was to have an expert evaluate the innovations based on the descriptions and combining these with answers to other questions by the same respondent. This expert was involved in coding user innovations in the previous large-scale user innovation surveys in the UK, The Netherlands, and Finland.

Independent validation was carried out with the help of five independent coders. These coders were given the descriptions and answers of the 598 self-identified innovations provided by the respondents. Their task was to check those descriptions for false-positives, which were identified by five criteria. After having been given instructions, independent raters were asked to eliminate activities or ideas that:

1. **Would normally fall under copyright, such as music, books, publications, etc.** — These are not considered innovations and should therefore not be counted as such in the sample.

Example: "Published a book and held exposition of a stained glass collection which was previously unknown to the public."

2. **Are organized activities such as workshops or events that are clearly not services.**

Example: "I created public events in the area of sports, physical training, and entertainment."

3. **Are clearly not done to solve the respondent's own need and fall under their regular job description** — Typically this would be someone who innovates at work, as part of their job description and obviously doesn't do it for him- or herself, or to make his or her work easier.

Example: "I created a vaccine against a certain pathogenic agent, against which currently no cure exists."

4. **Use existing software in a way for which it was intended, but don't introduce any new functions or applications**

Example: "I used Microsoft Excel to log the temperature outside."

5. **Clearly do not solve his /her own problem using a new combination of tools or resources.**

Example: "I implemented volunteering programs."

These rules were provided to the independent coders together with the diagram shown in Figure 4-3.

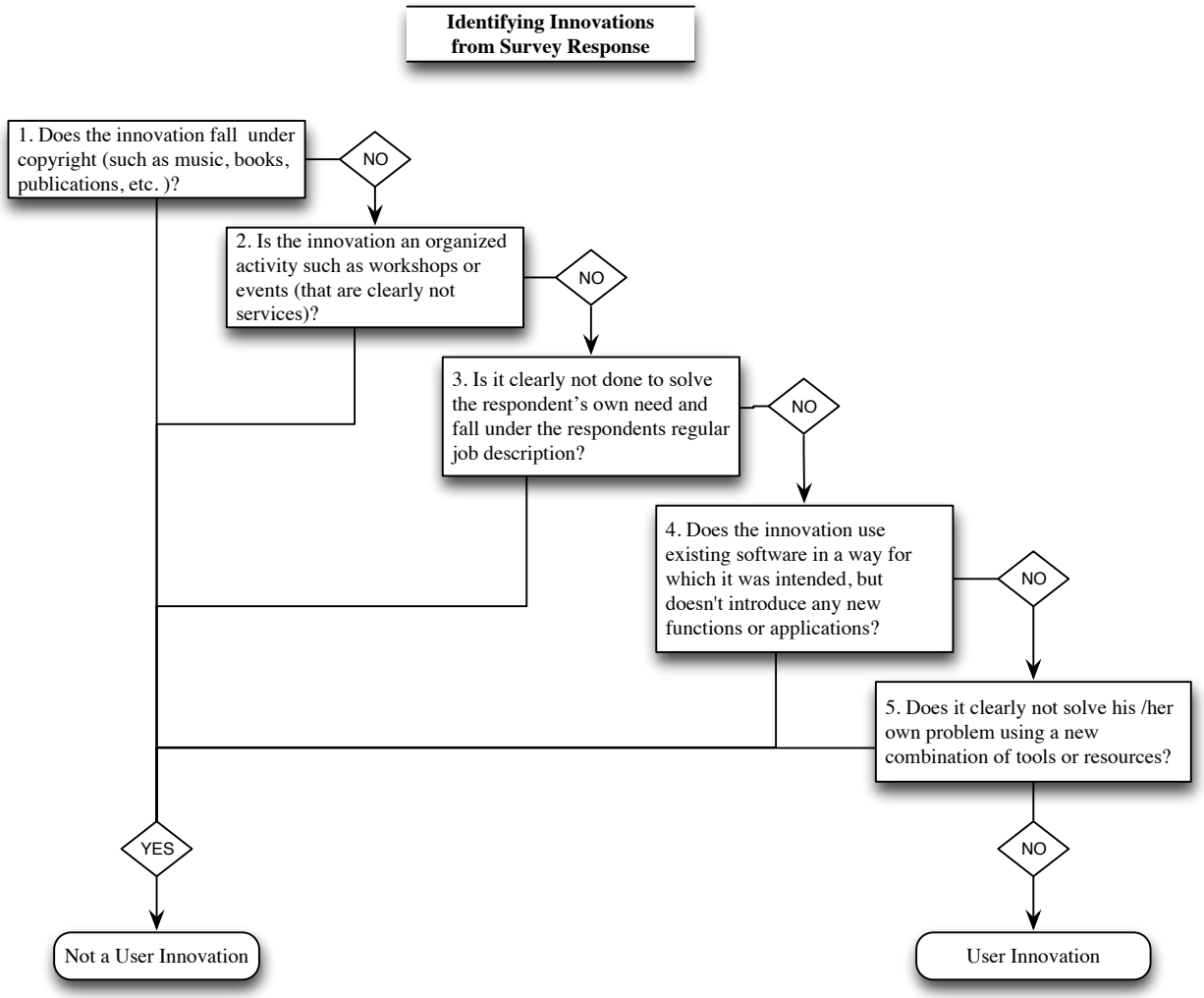

Figure 4-3: Diagram of the validation process.

Some of these criteria could be perceived as ambiguous to the raters; therefore, to mitigate this issue, they were given examples from the OSLO Manual (OECD/Eurostat 2005) and NESTA's "Measuring User Innovation in the UK" as guidelines (Flowers et al., 2010), which include examples of what constitutes (user) innovation. The five independent coders used the above criteria to classify the innovation description in three ways: "is disqualified based on these criteria," "is not disqualified based on these criteria," and "not enough information to decide." An innovation that was disqualified based on any of the criteria was excluded from the sample. If there wasn't enough information, it was classified as such, and finally those that didn't get eliminated were included in the sample as user innovations. Clear rules were used to consolidate the inter-rater differences. To be conservative, these rules strongly favor false negatives over false positives: if ≥ 80% of the coders agreed, then the majority's coding was used; if ≥ 50%

disqualified a response, then it was disqualified; for all other situations, the majority category was used. When the final category was that "not enough information was provided to disqualify the description," it was included in the sample of user innovations. The main reason for this is that the survey was structured in a comprehensive way, such that the majority of non-user innovators were excluded from the sample due to the preceding questions (see Section 4.3.2) and we believe that redundancy in the survey provides sufficient filtering before users fill in the descriptions of their self-reported innovations and that we can therefore trust the user's response.

	Independent Coders			
Expert Coding	**Not User Innovation**	**Unsure**	**User Innovation**	**TOTAL**
Not User Innovation	150	105	36	291
User Innovation	10	113	173	296
TOTAL	160	218	209	587

Table 4-2: Comparison of two validation methods: independent coders and expert coding.

Because of the high overlap between the two validation procedures, we use the results coded by the experts. This also allows a more consistent comparison with the surveys done in the UK, The Netherlands, and Finland because the same expert using the same methodology also coded the data from those surveys.

The adjusted sample of user innovation contained approximately 296 user innovations, which means that 12% of all respondents are user innovators; this is comparable to the samples of higher-education individuals in previous large-scale surveys. Much elimination occurred because of the third criterion; most probably this was because the respondents were mostly highly-educated professionals or medical researchers who were involved in innovation as part of their professional activities.

Next, a distinction had to be made between professional-user innovations and consumer innovations. End-user innovators are those who innovate at home and professional-user innovators are those who innovate in their main occupation (Riggs and von Hippel, 1994). Professional user entrepreneurs are embedded in an organization and employ a product in their professional life. They experience a need for improvement and leave their firm in order to develop and commercialize a solution. Consumer innovators, in contrast, are individuals who use a product in their day-to-day lives. We used two

methods to identify in which category an innovation belonged. First, we looked at how respondents answered the survey question: "Did you do this for your job/business or for yourself/other purposes?" Then we asked the same expert that coded the innovations to also classify them into end-user/professional-user categories based on the descriptions and answers provided for other questions by the innovator.

	Response to the question: "Did you do this for your job/business or for yourself/other purposes?"*			
Expert Coding	**for my job/ business**	**for myself/other purposes**	**for my job/business and for myself/ other purposes**	**TOTAL**
Professional-user	156	14	58	228
End-user	4	47	8	59
TOTAL	160	61	66	287
*excludes the category "Don't know/will not say," which was only chosen by one respondent.				

Table 4-3: Comparison of responses in the survey with classification by experts.

We provide various examples of excluded and included innovations from both categories in Table 4-4.

End-user innovations
Included in Sample:
"Excel/VBA of domestic accounting. The software imports the internet homebanking statement, updates it and determines the real balance available to spend until the end of the month, deducting all unpaid predicted expenses and deducting the annual, biannual, triannual and bimonthly expenses in the future. When it detects a new salary, the software updates the new monthly expenses list (private school, fees, taxes, triannual alarm, etc.), whose funds are saved up and removes future monthly savings from the balance. It manages expenses and income by items: car, fun, extraordinary."
"An in-vase watering system, for temporary absence from home."
"Utensils and kitchen equipment: A system for collecting used cooking oil that allows integration in any type of sink, enabling washing, separation and collection of waste cooking oils directly into household dishwasher."
Excluded from Sample:
"Cake design"
"Educational material to supply to my students"
"Bicycle repair"
Professional-user innovations
Included in Sample:
"Creation of a simulator for low-cost endoscopic surgery, for self training as well as training in workshops."
"The purpose of the software is to count elements in microscopic images. The available software either did not serve our counting purpose (which involved the association between various elements), or were too costly. With this software, we were able to reduce counting times and improve counting precision. This task, previously carried out on the microscope, is now done by the computer and much less tiresome for the user. [. . .] "
Excluded from Sample:
"The nourishment and subsidization of children living in orphanages in East Timor."
"Creation of a vaccine against a relevant pathogenic agent and against which there is no effective solution."

Table 4-4: Examples of user innovations in our sample (descriptions translated from Portuguese).

4.4. Data

In this section we first look at descriptive statistics from the results obtained in Portugal and then proceed to compare only the consumer innovations in our sample to those results obtained in other large-scale user innovation surveys conducted in the UK, Canada, and The Netherlands.

4.4.1. Final Sample and Summary Statistics from Portugal

The final sample shows a rate of user innovation of 12.2%, or 296 individual user innovations. This was categorized into 59 (2.4%) end-user innovations and 228 (9.4%) professional user innovations, with 9 (0.4%) falling under the 'unknown' category. These results imply that 12.2% of the population of highly-educated Portuguese is user innovators. We are not able to determine the total independent incidence for each of the two categories of user innovators because respondents were able to choose between innovations they carried out at home or at work. The two categories are not mutually exclusive—that is, an end-user innovator could at the same time also be a professional-

user innovator. There is good reason to believe that someone that puts effort into innovation at home does the same at work. In total, 1,479 people indicated that they innovated at least once and on average selected 3.83 categories in which they innovated. In our survey, the users were asked to select their most significant innovation. Therefore, on average, they were choosing between 3.83 innovations when selecting 'the most significant' innovation and whether these were home- or work related. Hence, we say that at least 2.4% of the people in our sample are end-user innovators, and at least 9.4% are professional-user innovators.

4.4.1.1. Demographics: Who innovates?

Here, we begin by looking at who innovates and the representativeness of our sample.

Age	**Portuguese population***	**Average response of all innovators**	**Professional-user innovators**	**End-user innovators**
18–30	15.3%	10.1 %	10.1 %	10.2 %
31–40	15.3 %	44.3 %	45.6 %	39.0 %
41–50	14.5 %	32.4 %	31.1 %	37.3 %
51–60	13.0 %	10.8%	10.1 %	13.6 %
61–70	10.9 %	2.4 %	3.1%	0.0 %
Level of Education				
Bachelor degree	1.3 %	0 %	0 %	0 %
Licenciatura – 5 years degree	7.6 %	11.9 %	10.5 %	17.0 %
Master's degree	0.9 %	13.2 %	11.0 %	22.0 %
PhD	0.25 %	74.9 %	78.5 %	61.0 %
Gender				
Female	52.2 %	41.8 %	36.8 %	61.0 %
Male	47.8 %	58.2 %	63.2 %	39.0 %
Field of Education				
Exact sciences	5.3 %	13.9 %	13.6 %	15.3 %
Natural sciences	0.9 %	10.5 %	9.2 %	15.3 %
Engineering and technology	16.8 %	22.0 %	25.0 %	10.2 %
Medical sciences	14.8 %	39.0 %	38.2 %	42.4 %
Agricultural science	2.2 %	0.7 %	0.4 %	1.7 %
Social Sciences	43.4 %	11. 5%	10.5 %	15.3 %
Humanities	16.6 %	2.4 %	3.1%	0.0 %

* From 2011 census in Portugal (see: http://www.ine.pt/)

Table 4-5: Demographics.

The survey was distributed to a subset of the population with higher education degrees and those conducting research in the medical field; consequently, the sample is not meant to be representative of the Portuguese population. Table 4-5 shows the

differences between our sample of respondents and the general population of Portugal. There are important differences in most of the categories above, such as age distribution and education, which underscore that our conclusions will be relevant to a specific subset of people. An interesting finding is that women are about 50% (p-value = 0.001) more likely to engage in end-user innovation than in professional-user innovation compared to men.

4.4.1.2. Motivation: Why do users innovate?

Respondents were asked to assign 100 points between different reasons that possibly motivated them to innovate. The first thing that stands out is that a very small fraction innovates to sell or to make money. The most important reasons chosen by respondents were "personal use," "to learn or develop skills," "to help other people," and "for the pleasure of doing it." This reflects previous findings, such as those by von Hippel and Hienerth (2011), who studied whitewater kayaking, where the most important reason to innovate was for personal use. It also resonates with the findings in open source software communities, which show that users contribute for free because they enjoy the process, because they may benefit from the solution, or because they earn reputation in the community they work in (Hertel et al. 2003). When comparing between professional-user and end-user innovators, the major difference is that those who innovate at work allocated more points to "learning and developing skills," compared to those who innovate at home, who allocate more points to "personal use" and "for the pleasure of doing it."

"Indicate what is the distribution of reasons that lead you to develop this innovation."	**Average response of all innovators**	**Professional-user innovators**	**End-user innovators**
Personal Use	28.7	26.2	38.3
Sell / Make money	1.9	2.2	0.4
To learn or develop skills	26.2	28.5	17.3
to help other people	19.9	20.7	16.5
for the pleasure of doing it	17.0	15.3	23.5
Other reason	6.4	7.0	3.9
TOTAL	100	100	100

Table 4-6: Respondents' indicated motivation for developing the innovations.

4.4.1.3. Innovation process: how do users innovate?

Next, we examine *how* users innovate, starting with collaboration. Our results show that the majority of innovators collaborated and that professional-user innovators collaborate more than end-user innovators (*p*-value = 0.0025).

Did any other people work with you or contribute to developing this innovation?	**Average response of all innovators**	**Professional-user innovators**	**End-user innovators**
Yes	62.4 %	66.7 %	45.8 %
No	37.6 %	33.3 %	54.2 %
Who contributed or worked with you when developing this innovation?	N = 179	N = 152	N = 27
None	37.6 %	33.3 %	54.2 %
Relatives and/or personal friends	20.1 %	9.9 %	77.8 %
Members of a club or web community	5.0 %	2.6 %	18.5 %
Colleagues at work	69.8 %	79.6 %	14.8%
External business contacts	16.8 %	17.8 %	11.1 %
Other	19.6 %	22.4 %	3.7 %
TOTAL	296	228	59

Table 4-7: Collaboration.

Professional-user innovators and end-user innovators exhibit large differences in who they collaborate with; those who solve needs at work collaborate predominantly with colleagues at work, whereas those who innovate at home collaborate with relatives and/or personal friends.

Did you invest any money in the innovation?	**Average response of all innovators**	**Professional-user innovators**	**End-user innovators**
Yes	30.7%	24.6 %	54.2 %
No	69.3 %	75.44 %	45.8 %
If yes, can you estimate how much money you invested in this innovation?	N=88	N=56	N=32
>€0 and <€100	18.2 %	10.7 %	31.3 %
>€100 and <€1000	52.4 %	50.0 %	59.4 %
>€1,000	28.4 %	39.3 %	9.4 %
Average	€ 2,621	€ 3,639	€ 1,046

Table 4-8: Money invested in innovation.

Table 4-8 shows that professional-user innovators are less likely to spend money on their innovations, but when they do, they spend more than consumer innovators—an average of €3,639 and €1,046, respectively (*p*-value = 0.04). While the data are not conclusive about this, we assume professional-user innovators predominantly spend their employers' money and speculate that this is often harder to get access to; authorization may be required, it may not be considered part of their job description, etc. However, in

those cases in which they are able to get access to company resources, the amount is larger than what end-user innovators have available through their personal budgets.

We cannot distinguish what part of the money spent by professional-user innovators is personal money versus their employers' money. Nonetheless, we can estimate the total amount of money spent by end-users on innovation. Given that 2.4% of the people in our sample spent an average of €1,046 on consumer innovation and that 15.4 % of the Portuguese population has a higher education degree (see Table 4-5), we deduce that at least €40.9 million was spent on end-user innovation in Portugal (by highly-educated innovators). For professional user-innovation, we find that total expenditure is €558 million. These amounts are assumed to be over a period of three years since the survey asked for innovations that occurred in the previous three years from the date the survey was answered. In contrast, it is estimated that annually €1.3 billion is spent annually on R&D by Portuguese firms.[38]

The abovementioned calculations don't take into account user innovation by the segment of the population that is not highly educated. Furthermore, actual expenditure on innovation by consumers is likely to be much higher since users were to choose only their most significant innovation. It is also difficult to draw conclusions about innovative output based on the amount of financial investment because there may be large differences in the costs users incur versus those of a firm. For example, independent inventors have been found to market their products at costs that are about 8% of those of established firms with gross profit margins that are comparable in the pharmaceutical industry (Astebro, 1998).

Did you use any methods to protect the intellectual property related to this innovation?	**Average response of all innovators**	**Professional-user innovators**	**End-user innovators**
Yes	14.6 %	17.5 %	3.4 %
No	85.4 %	82.5 %	96.61 %
What kind of intellectual property did you use?	N = 42	N = 40	N = 2
Patent	33.3 %	32.5 %	50.0 %
Trademark	14.3 %	12.5 %	50.0 %
Copyright	14.3 %	15.0 %	0.0 %
Confidentiality agreement	23.8 %	25.0 %	0.0 %
Technical protection (e.g., password, code encryption)	31.0 %	32.5 %	0.0 %

Table 4-9: Intellectual property.

[38] Values for national R&D statistics were obtained from Instituto Nacional de Estadisticas (Statistics Portugal) via their website http://www.ine.pt/ (accessed October, 2013).

We found that 14.6% used some form of intellectual property protection, where the most popular method of protection was patenting. The vast majority of those user innovators in our sample that protected their innovations were professional-user innovators; all except two end-user innovators responded that they do not protect their innovations. This corroborates previous findings that it is rare for user innovators to restrict access to innovations or seek intellectual property protection (Prügl and Schreier, 2006; Shah, 2000).

4.4.2. Diffusion of Innovations

We proceed to look at the diffusion patterns of innovation. First of all we look at whether innovators did anything to inform others about their innovation, and we find that over half of professional-user innovators—and only a fifth of end-user innovators—did so. The majority of innovations, 51.2%, was never shared with others and are therefore ex-ante excluded from adoption by others because they were unaware they existed.

Did you do anything to inform other people about your innovation?	**Average response of all innovators**	**Professional-user innovators**	**End-user innovators**
Yes	48.8 %	56.1 %	20.3 %
No	51.2 %	43.9 %	79.7 %
What did you do to inform others about your innovation?	N =140	N = 128	N = 12
I showed it to other individuals	68.6 %	65.6 %	100.0 %
I posted information on a website	37.9 %	39.1 %	25.0 %
I showed it to commercial businesses	15.0 %	15.6 %	8.3 %
I spent time and/or money to help others (individuals, businesses) in adopting it	18.6 %	20.3 %	0.0 %
I developed a manual or other documentation that would make it easier to adopt	32.1 %	34.4 %	8.3 %
Other	29.3 %	32.0 %	0.0 %

Table 4-10: How innovators informed others.

The answers on time and money invested in informing others are based on small sub-samples and are more difficult to interpret. For example, Table 4-11 suggests that professional-user innovators were not only more likely to share, but those who did share also spent more time on sharing, although the difference is not statistically significant.

How much time did you spend on informing others about this innovation?	**Average response of all innovators**	**Professional-user innovators**	**End-user innovators**
< 1 day	30.0 %	26.6 %	66.7 %
>1 day and < 30 days	40.7 %	43.0 %	16.7 %
> 30 days	29.3 %	30.5 %	16.7 %
Average	2944 hrs	2989 hrs	2461 hrs

Table 4-11: Time spent on informing others.

Did you spend any money to inform others about this innovation?	Average response of all innovators	Professional-user innovators	End-user innovators
Yes	9.8 %	12.3 %	0%
No	90. 2%	87.7 %	100 %
If yes, can you estimate how much?	N = 28	N = 28	N = 0
>€0 and < €100	10.7 %	10.7 %	-
>€100 and < €1000	57.1 %	57.1 %	-
> €1000	32.1 %	32.1 %	-
Average	€1729	€1729	-

Table 4-12: Money invested in informing others.

Respondents provided information on whether the innovation diffused, and, if so, how it did so. Peer-to-peer diffusion is used to describe the process by which other people start adopting the innovation. Commercial diffusion occurs when a commercial enterprise adopts the innovation; this can be the employer of the respondent, a different organization, or even a firm started by the respondent. Table 4-13 shows that the majority of user innovations did not diffuse: More than half of professional-user innovations and almost three-quarters of end-user innovations did not diffuse at all. When innovations did diffuse, non-market-based diffusion is 3–7 times more likely than market-based diffusion, depending on whether the innovation took place at home or at work.

Diffusion	Average response of all innovators	Professional-user innovators	End-user innovators
No Diffusion	175 (59%)	132 (57.9%)	43 (72.9%)
P2P	97 (33%)	83 (36.4%)	14 (23.7%)
Commercial adoption by employer	13 (4%)	12 (5.3%)	1 (1.7%)
Commercial adoption by other organization	12 (4%)	11 (4.8%)	1 (1.7%)
User entrepreneurship	1 (0.3%)	1 (0.4%)	0 (0.0%)
TOTAL	296	228	59

Table 4-13: Type of diffusion.

4.4.3. Comparison to Other National Large-scale User Innovation Surveys

We briefly compare the results from our survey in Portugal to the results found in previous studies.

Country	Year	Sample	Frequency of user innovation
United Kingdom	2009	1,173 consumers	6.1 %
The Netherlands	2010	553 consumers	6.2 %
United States of America	2010	1,992 consumers	5.2 %
Japan	2011	2,000 consumers	3.7 %
Finland	2012	993 consumers	5.4 %
Portugal	2012	2,423 consumers and professionals	12.1 % (combined)

Table 4-14: Overall diffusion rates compared by country.

At first it seems that Portugal has a much higher rate of user innovation, although this is likely to be the result of two main differences between the Portuguese survey and

surveys conducted in other countries. First, the Portuguese sample was aimed at higher educated individuals, and second, respondents could also include innovations they produced at work, whereas previous surveys were focused on consumer (end-user) innovation only.

4.5. Analysis

This section explores the main drivers of diffusion for different subsets of innovators as well as different diffusion types. First we explore drivers for diffusion of professional-user and end-user innovations together. Then, we analyze commercial diffusion and peer-to-peer diffusion separately before looking at consumer innovators only.

We broadly categorize diffusion in two ways, as discussed in the literature review: market and non-market diffusion. Peer-to-peer falls under non-market because no monetary transaction takes place, whereas commercial adoption and entrepreneurship are both market-based mechanisms.

4.5.1. General Determinants of Diffusion

There are a multitude of reasons that could affect whether or not diffusion of user innovations occurs. First of all, the motivation for innovation plays an important role: If a user innovates for personal use or for the fun of doing it, then satisfaction can be obtained without anybody else adopting the innovation. On the other hand, if an innovator was principally motivated to make money, or to help others, then his or her satisfaction depends on the extent of the diffusion of the innovation. Therefore, one would expect the innovator to spend time and effort making sure the information relevant to his or her solution is shared as widely as possible, and the extent to which the subsequent diffusion is successful will depend on the amount invested by the innovator as well as other factors explored below. Since we have information about these different drivers, we are able to include them in our regression analysis.

As a dependent variable, we use a binary variable to indicate whether or not diffusion happened and run several logit models with the following independent variables: level of education (A3_Education), novelty of the innovation (C3_Novelty), a dummy variable for professional-user innovations (Professional-user innovation), reasons for which the innovation was carried out (C5a_Motivation_personaluse,

C5b_Motivation_tosell, C5c_Motivation_tolearn, C5d_Motivation_tohelpothers, C5e_Motivation_process), collaboration (C6_collaboration), who the innovator collaborated with (C61a_collaboration_relatives, C61b_collaboration_community, C61c_collaboration_colleagues, C61d_collaboration_externalbusiness, C61e_collaboration_other), intellectual property protection (C10_IP_protection), willingness to share (D3_Willingness to share), whether other people were informed (D6_inform other people), and investment of money (C9_invested_money). The results are shown in Table 4-15.

VARIABLES	Diffusion (1 = any type of diffusion, 0 = none) (1)	(2)	(3)	(4)
A3_Education (0=Bachelor's, 4=PhD)	0.0782	0.1696		0.0938
	(0.202)	(0.190)		(0.200)
C3_Novelty (1=new only to myself, 4=did not exist before)	0.0866	0.2897**		0.0757
	(0.170)	(0.147)		(0.166)
Professional-user innovation (1=yes, 0=no)	0.1680	0.4086	1.0688	0.2559
	(0.369)	(0.341)	(0.657)	(0.366)
C5a_Motivation_personaluse	0.0047			
	(0.009)			
C5b_Motivation_tosell	0.0118			
	(0.028)			
C5c_Motivation_tolearn	0.0099			
	(0.009)			
C5d_Motivation_tohelpothers	-0.0002			
	(0.009)			
C5e_Motivation_process	-0.0016			
	(0.012)			
C6_collaboration (1=yes, 0=no))	-0.1540			-0.1601
	(0.297)			(0.288)
C10_IP_protection (1=yes, 0=no)	0.3749			0.4090
	(0.394)			(0.365)
D3_Willingness to share	1.6964**			1.6593**
	(0.771)			(0.765)
D6_inform other people	0.7093**			0.7320**
	(0.292)			(0.290)
C61a_collaboration_relatives			0.4831	
			(0.606)	
C61b_collaboration_community			-0.5784	
			(0.881)	
C61c_collaboration_colleagues			0.6684	
			(0.538)	
C61d_collaboration_externalbusiness			0.3940	
			(0.412)	
C61e_collaboration_other			0.2734	
			(0.478)	
C9_invested_money (1=yes)				0.0514
				(0.289)
Constant	-3.4207**	-2.1304***	-1.9516***	-3.1239***
	(1.349)	(0.754)	(0.749)	(1.049)
Observations	287	287	179	287
ll	-176.5	-186.7	-116.3	-177.8

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 4-15: Factors that affect diffusion.

The two factors that significantly affect the diffusion of user innovations (professional-user and end-user categories aggregated) is the innovator's willingness to share the innovation and whether he/she did anything to inform other people about the

innovation. Intuitively this makes sense because if people do not know about the innovation, they cannot choose to adopt it. Another interesting finding is that collaboration does seem to affect diffusion at all at the aggregate level. Even when specific types of collaboration are included in the regression, they don't appear to affect diffusion. One would expect that when helping others is an important driver that the innovator may be more eager to diffuse his or her solution. Yet, the motivation "to help other people" has no effect on diffusion in our model. Because the survey also asks what people did to share the innovation, we looked at specific effects but were not able to find any significant results; this is something we look at in more detail when we disaggregate the different types of diffusion in the next section. We also include the amount of money invested, but no significant effects are found.

4.5.2. Commercial Diffusion

The processes that determine commercial- and peer-to-peer diffusion are very different; hence, we proceed to analyze them separately. It should be noted that user entrepreneurship is not included in this part of the analysis because there were too few cases. We include additional independent variables on who the innovator informed: "I showed it to other individuals" (D61a_inform_showed other people), "I posted information on a website" (D61b_inform_posted on website), "I showed it to commercial businesses" (D61c_inform_showed to businesses), "I spend time and/or money to help others (individuals, businesses) adopting it" (D61d__inform_help other people adopt), and "I developed a manual or other documentation that would make it easier to adopt" (D61e_inform_created documentation).

VARIABLES	Commercial_diffusion (1 = diffused commercially, 0 = no commercial diffusion) (1)	(2)	(3)	(4)	(5)
A3_Education (0=Bachelor, 4=PhD)	0.468			1.375*	-0.605
	(0.437)			(0.769)	(0.571)
C3_Novelty (1=new only to myself, 4=did not exist before)	-0.643*		-0.287	-0.651	-0.262
	(0.329)		(0.275)	(0.397)	(0.422)
Professional-user innovation (1=yes, 0=no)	0.672	0.648	1.029	0.442	
	(0.865)	(1.226)	(0.785)	(1.460)	
C5a_Motivation_personaluse	-0.019				
	(0.014)				
C5b_Motivation_tosell	0.111**				
	*				
	(0.035)				
C5c_Motivation_tolearn	0.002				
	(0.013)				
C5d_Motivation_tohelpothers	-0.036*				
	(0.018)				
C5e_Motivation_process	-0.004				
	(0.019)				
C6_collaboration (1=yes, 0=no))	0.090				-1.347*
	(0.555)				(0.765)
C10_IP_protection (1=yes, 0=no)	1.044*			1.719**	1.847**
	(0.585)			(0.671)	(0.720)
D3_Willingness to share	0.566		0.581	-0.478	-1.162
	(1.149)		(1.075)	(1.267)	(1.588)
D6_inform other people	0.509		0.826*	-0.442	
	(0.570)		(0.490)	(0.674)	
C61a_collaboration_relatives		0.128		-0.025	
		(1.103)		(1.310)	
C61b_collaboration_community		0.697		0.818	
		(0.930)		(1.078)	
C61c_collaboration_colleagues		1.329**		1.186*	
		(0.542)		(0.614)	
C61d_collaboration_externalbusiness		0.040		0.172	
		(0.755)		(0.779)	
C61e_collaboration_other				-0.045	0.178
				(0.740)	(0.698)
D61a_inform_showed other people					-0.527
					(0.660)
D61b_inform_posted on website					-0.149
					(0.702)
D61c_inform_showed to businesses					1.633**
					(0.671)
D61d__inform_help other people adopt					-0.158
					(0.861)
D61e_inform_created documentation					0.216
					(0.742)
Constant	-3.541	-3.625**	-3.547**	-6.834**	2.400
	(2.256)	(1.458)	(1.257)	(3.358)	(2.505)
Observations	287	170	287	170	128
ll	-66.33	-53.69	-81.34	-47.77	-38.63

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 4-16: Logit regressions for commercial diffusion.

We find that intellectual property and motivation to sell are strong predictors of commercial diffusion, and that this effect is stronger for commercial diffusion by one's

own employer. When people showed their solutions to other businesses, commercial diffusion was more likely as well. When collaboration occurred with colleagues, this had a positive effect on commercial diffusion.

4.5.3. P2P Diffusion

Next we analyze peer-to-peer diffusion—the non-market mechanism of diffusion. We find that, in particular, willingness to share and effort to diffuse information are important predictors of P2P diffusion, as was the case when looking at all diffusion types combined. Collaboration has no significant effect on P2P diffusion. The different types of motivation don't show a significant effect, either.

VARIABLES	Diffusion_P2P (1 = adoption by other people, 0 = no adoption by other people) (1)	(2)	(3)	(4)
A3_Education (0=Bachelor's, 4=PhD)	-0.074	-0.060	0.201	0.404
	(0.207)	(0.206)	(0.296)	(0.361)
C3_Novelty (1=new only to myself, 4=did not exist before)	0.251	0.217	0.129	0.022
	(0.174)	(0.170)	(0.210)	(0.246)
Professional-user innovation (1=yes, 0=no)	0.197	0.189	1.162	0.332
	(0.384)	(0.383)	(0.743)	(0.690)
C5a_Motivation_personaluse	0.014			
	(0.010)			
C5b_Motivation_tosell	-0.008			
	(0.029)			
C5c_Motivation_tolearn	0.010			
	(0.010)			
C5d_Motivation_tohelpothers	0.010			
	(0.010)			
C5e_Motivation_process	0.003			
	(0.013)			
C6_collaboration (1=yes, 0=no))	-0.338	-0.347		-0.623
	(0.309)	(0.300)		(0.475)
C10_IP_protection (1=yes, 0=no)	0.196	0.022	0.330	0.110
	(0.402)	(0.370)	(0.419)	(0.459)
D3_Willingness to share	2.254**	2.176**	1.555	
	(1.048)	(1.043)	(1.129)	
D6_inform other people	0.865***	0.867***	0.599	
	(0.305)	(0.302)	(0.398)	
C9_invested_money (1=yes)		-0.022	-0.014	-0.174
		(0.299)	(0.392)	(0.401)
C61a_collaboration_relatives			1.059	
			(0.695)	
C61b_collaboration_community			-0.427	
			(0.899)	
C61c_collaboration_colleagues			0.468	
			(0.596)	
C61d_collaboration_externalbusiness			-0.241	
			(0.459)	
C61e_collaboration_other			0.126	
			(0.508)	
D61a_inform_showed other people				0.657
				(0.415)
D61b_inform_posted on website				0.613
				(0.398)
D61c_inform_showed to businesses				-0.352
				(0.520)
D61d_inform_help other people adopt				0.455
				(0.520)
D61e_inform_created documentation				-0.046
				(0.430)
Constant	-4.517***	-3.475***	-5.177***	-2.220
	(1.584)	(1.268)	(1.817)	(1.688)
Observations	287	287	179	137
ll	-167.4	-168.9	-107.4	-89.99

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 4-17: Logit regressions for peer-to-peer diffusion.

Another surprising effect is that 'Being member of a club or community' (C7) does not have an effect on P2P adoption.

4.6. Conclusions

This study finds that in Portugal, 12.2% of highly-educated people are innovating to solve their own needs. At least 2.4% of the people in our sample are end-user innovators, and at least 9.4% are professional-user innovators. We find that non-market-based diffusion is between 3–7 times more likely to occur than market-based diffusion, depending on whether the innovation was done at home or at work. User innovators, both professional- and end users, do not indicate 'selling or making money' as a motivation for innovation. And while the majority of innovators in our sample collaborated, this had no effect on the likelihood to diffuse. Collaboration differs between professional-user innovators and end-users; the former are more than five times as likely to collaborate with colleagues than the latter, who are almost eight times more likely to collaborate with friends and relatives.

As drivers for diffusion, we find that mainly the willingness to share with others and whether effort was invested in informing others about the innovations were the primary determinants for diffusion. The majority of all user innovations in our sample never diffused, and this was likely because more than half never shared their innovation with anybody. Commercial diffusion is strongly related to intellectual property protection and the motivation of the innovator to make money from the innovation.

These results provide new evidence on the diffusion process of user innovation, which is especially relevant for innovation and entrepreneurship policy. Furthermore, as the data collection effort was the first of its kind, lessons are offered for improving measurement and validation methods.

4.6.1. Limitations

There are several important limitations to this study. First of all, our method does intensive measures of diffusion, for example, in terms of the number of adopters. Furthermore, the answers are self-reported, and hence there is no independent validation of the answers to most questions. Unfortunately, this shortcoming is not unique to this survey and is inherent to the methods; other innovation surveys such as the CIS have the same problem. Like previous surveys, this survey's responses are subject to self-reporting bias. The advantage of our dataset is that respondents also included descriptions of their innovations, which were rid of false positives and validated by experts.

When comparing likelihood of diffusion between the two categories of professional- and end-user innovation, it must be noted that there are confounding effects, particularly for innovations carried out at work. Employers may have policies in place that promote (idea management systems, etc.) or discourage (secrecy, confidentiality, etc.) the sharing of ideas, both internal and external to the firm. Although these effects are constant across firms, we do not know which employees worked for which firms and can therefore not control for these effects.

4.6.2. Implications

As this chapter shows, the willingness to share information and having invested effort in actually doing so is an important determinant of diffusion. However, the limited availability of information about the existence of the innovation prevents user innovations from diffusing more. Therefore, the assumption of many theoretical models that perfect information is available (Fudenberg and Tirole, 1985; Reinganum, 1981) seriously limits these models' ability to explain the user innovation diffusion process. The findings in this chapter have important implications on innovation policy as well as for intellectual property rights due to the fact that users are willing to share their innovations for free. And in era where communication costs are near-zero, policy makers as well as managers should consider creating platforms that facilitate the sharing of information about innovations.

From a policy standpoint, one may argue that it is inefficient to have hundreds or even thousands of innovators work on the same or similar problem in parallel. Hienerth and von Hippel (2011) point out that this is not necessarily the case—for example, there is much value in the massive parallel testing of software code. Having concurrent processes is more likely to yield multiple valuable solutions, none of which needs to be 'the best', given that the market needs are heterogeneous (Franke and von Hippel, 2003).

Additionally, we add that firms frequently innovate in parallel as well. However, the difference with user innovation is that the firm innovation process operates more like winner-takes-all race, with the first firm that is able to innovate and patent the solution appropriating the rewards, while other firms get nothing or only partial rewards for taking more time or having developed inferior solutions.

Summary and Conclusions

This dissertation looked at innovation and diffusion in developing countries and the role that users play in innovation. The first chapter concluded that users play an important role in financial service innovation in developing countries: Half of all mobile financial service innovations were pioneered by users. When an increasing number of firms subsequently imitated and commercialized mobile financial service innovations, those that were developed by users diffused more than twice as widely and more than three times as quickly compared to producer innovations. While it has been argued that user innovations are more commercially attractive because they better meet market needs, this is the first study that demonstrates this at an industry level.

We argue that users in developing countries are increasingly able to contribute globally valuable innovations because of the following reasons. First, the lack of formal financial services and the high fraction of unbanked population result in a great need for faster, cheaper, and more reliable financial services. Additionally, increased technological diffusion leads to greater access to general purpose technologies, such as the mobile phone, in developing countries. Users leveraged these technologies by engaging in behavioral innovations that resulted in radical new financial services.

We used a multi-method longitudinal analysis and created a novel approach to systematically categorize service innovations. Inter-rater coding was used to validate the sources of the innovations; coders were found through Amazon MTurk. There is no standard method used in the literature to establish the sources of service innovations, and, as far as we are aware, this is the first study that does this systematically. The methods proposed in this dissertation can be used for further user innovation studies, particularly those in services.

In the second chapter, we explored what factors enable firms to be successful innovators and entrants in the South. We used an extensive hand-collected dataset to show that indeed Southern firms in the mobile banking industry were able to enter early and become global market leaders. We argue that three types of resources are required to be successful in the South: industry-specific knowledge, country-specific knowledge, and knowledge about the global frontier. Industry-specific knowledge is gained through experience in the industry—for example, through previous entry. Country-specific

knowledge is related to the country in which a firm enters or considers entering; the main determinant of having this knowledge is whether a firm is local or foreign and has experience in the country. Global frontier knowledge contains all knowledge regarding the latest technology and often comes from global market-leading firms or educational institutions in the North. These three types of knowledge are obtained differently depending on the origin and experience of the firm. *De-novo* entrants can gain country-specific and industry-specific knowledge through entry; firms that have entered previously may share this through intra-firm knowledge diffusion or, alternatively, knowledge can be acquired externally through mergers or acquisitions. Previous entrants are more likely to be successful in subsequent entry in new markets because industry-specific knowledge accumulates over time. Furthermore, founders' professional heredity is important because founders tend to bring different types of knowledge with them when they start new firms or pioneer new ideas. Often founders in the South bring global frontier knowledge with them when they move from Northern firms to the South, or often they were educated at world-class universities in the North that they leveraged when entering in the South.

Furthermore, we found that MNOs are more likely to be successful mobile financial service providers than banks or third-party providers. MNOs often have more international links that precipitate intra-firm knowledge diffusion than other entrants into the mobile banking industry. The early pioneers, such as Smart in the Philippines, Safaricom in Kenya, and Celpay in Zambia, all had important ties to the North. Mobile network operators also have the advantage of having a large market base through their voice and data subscribers to which they can market new mobile financial services.

We also analyzed the origin of the technology that powers mobile banking platforms and found that a substantial proportion of technology vendors, which are providers of the technology for mobile banking, are founded in the South. Similar patterns were observed for those firms as for the entrants in mobile banking. Southern technology vendors that have links to Northern firms are more likely to enter and be successful. The most successful technology vendors had founders that had been educated in the North and had partnered with Northern firms.

The fourth chapter used data from a Portuguese national survey on user innovation to study various patterns of market and non-market diffusion. The survey was distributed

among highly-educated individuals and those employed in medical research facilities. We devised a systematic process for validating the user innovations and removing false positives in our sample. After validation of the responses, it was established that 12.1% of the respondents were user innovators, which included 298 individual innovations. This fraction is higher than the results of previous large-scale surveys of consumer innovators, which fell in the range of 3.7% (Japan) and 6.2% (The Netherlands). The difference can be attributed to two reasons: first, the fact that the survey in Portugal targeted highly-educated individuals, which are known to engage more in innovation and second, because respondents were also allowed to select innovations they had carried out at work (this was not the case in previous surveys). The 298 user innovations were categorized into end-user innovations (2.4%) and professional-user innovations (9.4%).

Analysis of the diffusion of these innovations shows that the majority of innovations did not diffuse at all. We argue that the reason for this is that the innovators did not actively inform others, who therefore were not aware of and thus could not adopt the innovations.

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Appendix A Service Innovation History

List of Definitions

Airtime - prepaid cell-phone credit to be used for text and voice.

Load - prepaid cell-phone credit to be used for text and voice.

M-Commerce - Electronic commerce conducted on cellular phones

MFI - Microfinance Institution

Microfinance - Lending small sums of money to the poor so they can work their way out of poverty.

MNO - mobile network operator (MNO), also known as mobile phone operator

Mobile Wallet - An electronic account that is associated to a specific mobile phone number. It can be accessed through the phone and can be used to store, and transfer value.

Mobile Money - money that is stored on the mobile wallet.

P2P - Person to Person

POS - Point of Sale

ROSCA - Rotating Savings and Credit Association

RBAP-MABS = Rural Bankers Association of the Philippines Microenterprise Access to Banking Services

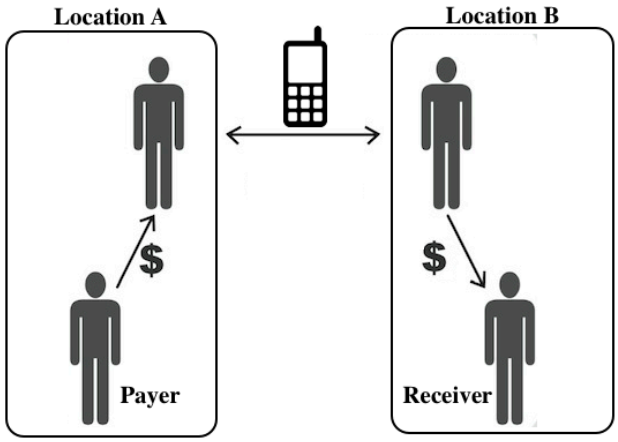
SMS - Short message (or messaging) service, a system that enables cellular phone users to send and receive text messages.

Top-up - to reload one's airtime credit level

Service	Description	User Innovation and Commercialization Histories of Mobile Financial Services
Mobile Banking	***Performing banking services through the mobile phone***	
1. Bank Account Balance Alert	Receive account balance updates and alerts on a mobile phone (initially via SMS)	***User innovation history:*** Users couldn't self-provide this service using a mobile phone. ***Producer commercialization history:*** **"**The first commercial or 'business' use of SMS was in Business-to-Consumer use, when Merita Bank of Finland offered banking balance alerts via SMS in 1995." http://neurojava.net/2010/03/25/sms-that-good-old-messaging-service/ ***Classification:*** This is a producer innovation

Service	Description	User Innovation and Commercialization Histories of Mobile Financial Services
2. Bank Account Deposit	Deposit money to bank account using mobile wallet	***Joint innovation history:*** John Owens, Chief of Party of the RBAP-MABS* in the Philippines, was approached by his nanny who said that she was happy that her salary was paid in G-Cash, but commented that she couldn't send the money to her family members. They lived in the rural areas of the country and did not own cell-phone. She asked if he could send the G-Cash to her brother's bank account so he could withdraw the money. While Owens was not a regular user, his goal was to improve the system for the use of it, not the profit. He approached the bank and the telecom operator and proposed a solution. Globe Telecom developed the menu so that it includes an optional message field. Once they had this optional message field, rural banks had the flexibility to develop their own mobile banking products. John Owens, the bank and the nanny tested the service together. In the testing phase, the first transaction was sent from Owens' nanny's phone to the bank account owned by the brother of the nanny that worked for Mr. Owens. Hence in September 2006, services were expanded to include G-Cash deposits on the bank through Text-a-Deposit, their new mobile banking product. With text a deposit, clients can make a deposit into their existing savings account with a rural bank using their mobile phone. Once the e- Money is in the mobile phone account, the client can make a deposit by keying in the amount and the account number. The bank will then verify account name, number, date and time of transaction and it is then immediately credited to the deposit account. Deposit instructions are encrypted and password protected. *Sources: Interview with John Owens, Chief of Party of the RBAP-MABS program; Mendes et al. (2007)* [*RBAP-MABS: Rural Bankers Association of the Philippines - Microenterprise Access to Banking Services] ***Classification:*** This is a joint innovation because the user and the producer participated in the pilot phase, prior to commercialization.

Service	Description	User Innovation and Commercialization Histories of Mobile Financial Services
3. Bank Account Withdrawal	Virtually withdraw money from a bank account and receive this on a mobile wallet	***User innovation history:*** Before bank account withdrawal was possible through the mobile phone was launched, users would have to travel to the bank branch to withdraw money. An example of how one user would solve the problem: *"*Before Text-A-Withdrawal [by Globe in Philippines], Merlita would travel to Bangko Kabayan's Calaca branch, a town fifteen minutes away from her home in Balayan, and wait for another half-hour to complete her transaction." *Source:* *http://www.portalmicrofinanzas.org/p/site/s/template.rc/1.26.9139/* ***Producer innovation history:*** SMART MONEY was launched in December 2000 in the Philippines and was initially linked to a customer's bank account with Banco de Oro; a feature that from the start enabled customers to load or cash out their SMART MONEY account. *Source: Proenza, 2007* ***Classification:*** This is a producer innovation because users were not able to withdraw the cash using the mobile phone.

Service	Description	User Innovation and Commercialization Histories of Mobile Financial Services
4. Bank Transfer	Users can make a bank transfer between two accounts using their mobile phone.	***User innovation histories:*** Hawala, the Arabic word for "transfer," refers to an informal global network of individuals (hawaladars) who transact cash for their clients, similar to a wiring service. In a hawala, no physical money transfers are made between traders. In the early days of this thousand-year old system, transactions were based on trust and more recently a phone call or fax is sent from one hawaladar to another hawaladar, instructing the latter to dispense cash to the intended recipient. Before mobile communication, settling accounts would take months, but when the mobile phone revolution hit hawaladars switched from HF radios to satellite phones and then to the robust local mobile phone network. This means that they could do communicate instantaneously, and often settle accounts that way. There is significant evidence that Bin Laden and his associates used satellite mobile phones to communicate with hawaladars to execute money transfers, starting as early as 1996 in Afghanistan. They often needed money to be sent rapidly, were making transactions from remote areas and couldn't afford to wait for letters of trust to be sent between hawaladars. *Sources: http://whiteafrican.com/2010/10/03/hawala-tech-and-banks-in-somalia/, Gunaratna (2002). Basile (2004); Al Qaeda's phone records revealed (http://www.rense.com/general21/noc.htm)*  ***Producer commercialization history:*** In 1997 Merita bank in Helsinki launched the first mobile phone SMS based banking service. *Source: http://www.upvery.com/67879-aarkstore-enterprise-mobile-wallet-location-based-commerce-and-peer-to-peer-payments.html* ***Classification:*** This is a user innovation because Bin Laden and his associates would use mobile phones to do bank transfers and thereby increasing the speed of the process.

Service	Description	User Innovation and Commercialization Histories of Mobile Financial Services
5. Storage of Savings	Using the mobile wallet to safeguard savings (an alternative could be in a sock under the mattress).	***User innovation history:*** Users started saving money when the mobile wallet was introduced by M-Pesa in March 2007. Vodafone made this observation: **"**21% of people were already using their mobile wallet as a savings account before the introduction of M-Kesho." *Greg Reeve, head of Vodafone Innovation Global, at Global Mobile Money Transfer Conference in Dubai, October 2010. Vodafone was the partner of Safaricom (the producer) of this service.* CGAP also concluded something similar: "A fifth of the unbanked interviewees in Kibera [a slum in Kenya] use M-PESA as a substitute for informal methods of savings, especially keeping money at home." *Source: Morawczynski and Pickens (2009)* A survey conducted by the Kenyan government found that 75% of M-Pesa users used the service to store money. *Source: FSD Kenya (2008)* ***Producer innovation history:*** M-Kesho was launched in March of 2010 by Safaricom in Kenya. M-Kesho is a bank account introduced by both Equity and Safaricom where customers can earn interest. M-Kesho is geared towards micro-savings. Customers can withdraw cash from their Equity Bank Account to their M-PESA accounts and customers can also deposit through their M-PESA accounts to their M-KESHO Bank account. For one to open this account, the person must be an M-PESA subscriber. *Source: http://www.gsma.com/mobilefordevelopment/programmes/mobile-money-for-the-unbanked/mmu-examples/m-kesho* ***Classification:*** This is classified as a user innovation because many users were already using the mobile wallet to save money.

Service	Description	User Innovation and Commercialization Histories of Mobile Financial Services
Mobile Commerce	***Buying goods with mobile phone.***	
6. Automated Service Payment	Automated payment using the mobile phone for services such as vending machines, public transport or parking	***User innovation history:*** none found. ***Producer innovation history:*** "The first SMS-enabled vending machines were installed in Finland in 1997 [by Sonera]. Today most of Finland's vending machines accept mobile payments, the total count of such vending machines is past 1,000. Globally vending machine vendors are falling in love with the idea from Poland to Hong Kong." http://neurojava.net/2010/03/25/sms-that-good-old-messaging-service/ "Mobile-payment services began in 1997, when Nokia enabled users to pay for soft drinks in Finnish vending machines via short-message-service transmissions from cellular phones." http://www.leavcom.com/ieee_dec10.php "First appeared in 1997 in Finland with 2 mobile phone enabled Coca Cola machines that accepted payment by SMS (text messages)." http://www.getelastic.com/multichannel-webinar-recap/ "By dialing a certain telephone number posted on vending machines, a customer can purchase products, like soft drinks or golf-balls and the price is added to the bill for his or her mobile phone." *Source: Böhle et al. (1999)* ***Classification:*** This is a producer innovation.

Service	Description	User Innovation and Commercialization Histories of Mobile Financial Services
7. Merchant Payment	Consumer to business payments for retail purchases	***User innovation history:*** This was written about the Philippines after the introduction of the prepaid phone credit in 1998: ***"***Since its introduction [in 1998], the prepaid cell-phone credit—popularly known as 'load'—is becoming a new form of currency. Services are already being performed in exchange for 'load'." *Sources: Lallana (2004), Celdran (2002)* ***"***The use of SMS as a means of conducting m-Commerce originated in the Philippines, starting with the innovation of passing top off credits among subscribers in exchange for services." *Source: Lallana (2004)* ***Producer innovation history:*** "SKT pioneered mobile payments in Korea with a mobile cash (m-cash) product, NeMo (Network + Money), which was launched alongside nine major Korean banks in 2001 and was subsequently rebranded Moneta Cash. Customers subscribing to Moneta Cash got a virtual money account, with their phone number acting as their account number. Once the Moneta Cash account was loaded, customers were able to use their mobile phones to transfer money to other Moneta Cash accounts, including at points-of-sale to effect payments for goods." *Source: Rotman (2008)* ***Classification:*** This is a user innovation since the service was introduced commercially much later.

Service	Description	User Innovation and Commercialization Histories of Mobile Financial Services
8. Mobile Insurance	Issue insurance payments through the mobile phone	***User innovation history:*** Rotating savings and credit association (ROSCAs) often serve as an insurance mechanism (Calomiris and Rajaraman, 1998), especially those that are called bidding ROSCA's. Users are often in more than one ROSCA's at the same time to be able to bid and withdraw the money when necessary. In 2008 Morawczynski tracked the financial diaries of M-Pesa users and found that some of them used M-Pesa to make their scheduled contributions to ROSCA's. *Source: Ndiwalana et al. (2010)* Interviews by Stuart Rutherford in 2010 revealed that the practice of using M-Pesa to make ROSCA payments has become widespread. "Ruth is a landlady in a small way, owning three small shacks in Kusumu market, one of which is rented out to an M-PESA agent. Her ROSCA (like almost everyone here she calls it a 'merry-go-round') is typical. She and her nine fellow members, all women, each deposit $1.30 (100 Kenya shillings) each day with their treasurer, and every tenth day one of the members receives the full $130 collected in the ten-day period. Ruth explained to me that since nearly all the members are small traders or craftswomen, they often have to move around to other markets, and may not be able to keep up with the daily deposits. But M-PESA has helped: a member away for a few days can send her payments by phone to the treasurer, and the frequency of perfect full-value payouts has climbed steeply. Kate, a clothes-and-shoes stall holder nearby told me she is now in no fewer than five ROSCAs of the sort described by Ruth: in several of them, the pay-out is made via M-PESA, leaving a convenient audit trail in the form of the text-messages that confirm the sending and receipt of all M-PESA payments. Out in the small market at Holo, I found the same kinds of story. Belinda, turning a sewing machine on the veranda of her small market stall, told me that she is in two ROSCAs, each of $1.30 a day, and her friend Isabel, who sells fruit and vegetables from the stall next door, said that 'almost everyone' she knows has a phone and an M-PESA account' and that 'yes, of course we use it to make merry-go-round payments – why wouldn't we?'" *Source: http://financialaccess.org/node/2988* ***Producer innovation history:*** Since 2009, farmers in Nanyuki have been able to insure their crops against the effects of drought. The Syngenta Foundation's Agriculture Insurance Initiative called Kilimo Salama, which in Kiswahili means "safe farming", uses a combination of mobile phones and solar-powered weather stations to provide crop insurance to over 5,000 farmers in western and central Kenya. After insuring their crops, and following a period of inclement weather, a panel of experts uses an index system to assess whether a crop is no longer viable, and remits payments back to the farmers via M-Pesa." *Source: http://microfinanceafrica.net/tag/m-kesho/* In 2010 M-Pesa launched M-Kesho, a new product that allows users to buy personal accident insurance. *Source: http://blogs.cgdev.org/open_book/2010/05/glimpsing-the-future-in-kenya.php* ***Classification:*** We code this a user innovation since mobile money was used to make insurance payments since the launch of M-Pesa in April 2007, and therefore earlier than the commercial insurance payment mechanisms.

Service	Description	User Innovation and Commercialization Histories of Mobile Financial Services
Mobile Money	***Using money through the mobile phone.***	
9. Authorized Cash Collection	An authorized agent collects cash and sends the equivalent in mobile money via his mobile phone to the receiver	***User innovation history:*** The Village Phone was an early form of authorized cash collection. This was observed during a study done in 2006: "In Uganda, when it became too expensive and insecure to send money using the bus system, people started to transfer airtime through the Village Phone (launched in 2003 in Uganda, and in 1997 in Bangladesh) operator instead. A person living in the city would simply buy airtime, call the Village Phone operator and give the operator the airtime details. The operator then load the phone with the given airtime, charge a commission, and give the rest of the money in cash to the recipient. *Source: Hellström (2010), Chipchase (2009)* ***Producer innovation history:*** In Zambia Celpay launched a cash collection service in late 2003. South African Brewers was especially keen on adopting this because their truck drivers used to carry a lot of cash with them as retailers as the would do their delivery rounds. They forced their customers to deposit the cash payment to their Celpay account which would then go instantly to their head office, greatly simplifying account reconciliation and speeding the time that it takes to bank their money. *Source: Interview with Kamiel Koot, CFO Celpay;* *http://allafrica.com/stories/200304090601.html* ***Classification:*** The evidence we have for users engaging in this practice is from 2006. However, The Village Phone was launched in 1997 in Bangladesh and in 2003 in Uganda and so it is highly likely that Village Phone operators were already doing this earlier than the producer, in Bangladesh. Nonetheless, as there is no evidence of this we code it a producer innovation.
10. Bill Payment	Pay bills through the mobile phone	***User innovation history:*** Users were using the person-to-person transfer of 'load' (airtime) services to make bill payments (not only for one's bills but also for another person). Smart and Globe, two of Philippines' largest telecom operators, had launched the person-to-person solutions in 2003. Smart e-Load (May 2003) and Pasa-Load (December 2003) are both mobile person-to-person solutions that enable person-to-person transfer of 'load' (airtime). *Source: Proenza (2007)* ***Producer innovation history:*** This is from Finnish Sonera's annual report: "Sonera's wireless telebanking allows subscribers to use their mobile handsets as an automated teller machine, through which subscribers can access account information and pay bills using SMS messaging or voice response technology." *Source: Sonera Annual Report, 1999* ***Classification:*** This is a producer innovation.

Service	Description	User Innovation and Commercialization Histories of Mobile Financial Services
11. Domestic Money Transfer (P2P)	Sending money between two domestic mobile wallets	***User innovation histories:*** In 1999, users were already sending airtime to each other via SMS (see Domestic Airtime Transfer). Some users were sending airtime and converting it into cash at the receiving end. The recipient can sell the received airtime to a local broker in return for cash, thus effecting a transfer of purchasing power from the initial sender to the recipient. This was already common practice in 1999, in the Philippines. *Sources: Interview with RBAP-MABS employee in Philippines in January 2011; Camner and Sjöblom (2009); Jack and Suri (2011)* Later, in Uganda, where no producer offered this service yet, the user re-invented this practice which became widespread and even got its own name "Sente" which means money in Luganda and can be seen as a forerunner to m-transactions in Uganda." *Hellström (2010)* ***Producer innovation history:*** Smart Money was introduced in December 2000 in the Philippines (Proenza, 2007). "Smart Money is a debit card (pre-paid card), which can be accessed using an automatic teller machine, a credit card terminal or a mobile phone. The Smart Money card allows users to withdraw credit or to charge purchases through any MasterCard terminal. It also allows users to conduct transactions using mobile phones such as sending cash credit from a Smart Money account to another person's Smart Money account." (Mendes et. al., 2007) However, Smart Money was much more limited than the user's method because it was limited to Smart Money user's only, which required a bank account, whereas 'Sente' was available to anyone, including the poorest without mobile phones or bank accounts. ***Classification:*** This was a user innovation because users found a way to send airtime, and turn this transferred airtime into cash at the receiving end.
12. Emergency Credit	Requesting, sending or receiving airtime or mobile money in the form of an emergency loan	***User innovation history:*** In September 2008 Jack & Suri undertook a survey of 3,000 randomly selected households across Kenya, and found that 12% used M-Pesa for emergencies. *Source: Jack and Suri (2011)* Another example observed in 2008 by Morawczynski and Pickens (2009): "Rural users also made transfers to their urban relatives. Sometimes this occurred because there was an "emergency" in the city. For example, one elderly farmer explained that his son had recently been injured in an accident at work. He used M-PESA to send money for hospital fees. He also sent him small amounts for his "up keep" until he recovered." ***Producer innovation history:*** M-KESHO, launched by M-Pesa on March 18th 2010 in Kenya offers emergency credit and insurance facilities. *http://mmublog.org/blog/m-kesho-in-kenya/* ***Classification:*** This is a user innovation because users did this before producers.

Service	Description	User Innovation and Commercialization Histories of Mobile Financial Services
13. G2P (Government to Person)	Government payments are paid to the mobile wallet (includes social transfers as well as wage and pension payments)	***User innovation history:*** none found. ***Producer innovation history:*** Launched in 2006, in Democratic Republic of Congo: Direct deposit to mobile wallet accessible at agents and payment locations. Over the course of 12 months during 2006–07, approximately 100,000 demobilized soldiers were paid an initial amount equivalent to US$110 followed by 12 monthly stipends of US$25. The payment system was managed by Celpay, the only mobile phone financial services provider present in the DRC, although headquartered in South Africa. *Source: Bankable Frontier Associates LLC (2008)* ***Classification:*** Producer innovation.
14. International Money Transfer	Sending money between two international mobile wallets	***User innovation history:*** A survey done in March 2000 in Bangladesh regarding the Village Phone Program showed that "among phone users, 42% indicated that their main use of the phone was to discuss financial matters or remittances with family members." Using the phone to arrange for safe passage of funds and verification of the amount of funds being transferred were common comments among phone users interviewed. The Village Phone is a key tool used to ask for remittances and to reduce the risks associated with remittance transfers. *Source: Richardson et al. (2000)* ***Producer innovation history:*** In the Philippines Smart Padala was launched on August 2004, facilitating national and international transfers of money using the Smart Money mobile platform. Smart Padala is an international remittance service which accepts over-the-counter payments in remittance shops abroad and informs the recipient of the remittance through the recipient's mobile phone. The remittances are then cashed through Smart Padala partner establishments in the Philippines using Smart Money technology. *Source: Proenza (2007)* ***Classification:*** Although users were using the phone to request and check on remittances, the actual remittance was still executed through a different channels, such as postal orders, hence we code it as a producer innovation.

Service	Description	User Innovation and Commercialization Histories of Mobile Financial Services
15. Microfinance Loan Disbursement	Giving out microfinance loans through the mobile phone, depositing the value onto the mobile wallet	***User innovation history:*** Users in the Philippines were using the functionality of over-the-air purchase of credit to send airtime between one another, which was then converted into cash on the receiving end. Users realized they could ask for, and receive credit from friends or family by transferring airtime. Users would request via SMS a particular amount of credit from another subscriber. Usually the debt was then settled at a later time. This functionality was launched May of 2003 by Smart Telecom under the name of Smart e-Load and was originally intended to share airtime. In this regard, the exchange of mobile credits, or 'loads,' has become a de facto form of micro-finance in the Philippines. *Source: Mendes et al. (2007)* ***Producer innovation history:*** On October 11, 2005, Safaricom in Kenya launched a pilot with a small microfinance institution Faulu Kenya. The goal of the pilot was to test the disbursement and repayment of microfinance loans using mobile money. It was the first to include disbursement of microfinance loans to the mobile wallets of recipients. *Source: Hughes and Lonie (2007)* ***Classification:*** Users were already requesting money from one another and fulfilling those request with airtime transfers. These were then settled at a later stage. Hence we code this a user innovation.
16. Microfinance Loan Repayment	Repaying microfinance loans using mobile money, using credit in the mobile wallet	***User innovation history:*** Users in the Philippines were sometimes settling debts using airtime transfers. When this was happening is unclear and we found no convincing evidence that this was settled with any of the large microfinance providers. ***Producer innovation history:*** RBAP-MABS (Rural Bankers Association of the Philippines - Microentreprise Access to Banking Services) recognized the power of innovation of Globe G-Cash for its mission of making financial services available in rural areas in the Philippines. In November of 2004, it decided to pilot Text-a-Payment which became the first commercial micro-loan collection service through the mobile phone. Source (for both): *Interviews with John Owens, Chief of Party of MBAP-RABS in the Philippines.* ***Classification:*** Although users were performing this service between themselves before the producer did, we did not find evidence of money being sent to the bank. Hence we code this a producer innovation.

Service	Description	User Innovation and Commercialization Histories of Mobile Financial Services
17. Salary Disbursement	Paying salary into an employee's mobile wallet	***User innovation history:*** In 2006 in the Philippines, Robert P. Alingog of PR Bank paid his own 250 employees in G-Cash. He instructed one of his administrative assistants at the PR Bank to send the 250 salaries of PR Bank employees per phone at the end of the month. He was doing this because he did not want to keep a large sum of cash in the bank every end of the month. *Sources: Customer Success Story: RBAP-MABS, Mobile Enabled Microfinance Ecosystem (2009); Interview with John Owens, Chief of Party of MBAP-RABS in the Philippines.* ***Producer innovation history:*** Globe Telecom (the provider of G-Cash) noticed the high increase in transaction volumes when PR Bank began doing this so they decided to make this an official part of their service. They contacted PR Bank to inquire the best ways to make a spreadsheet to automate the process. Eventually the full service was commercialized by the middle of 2007: 'Text-a-Sweldo.' This was developed by RBAP-MABS and Globe, using an additional text field in Globe's service to upload payroll files and directly transmit employee salaries to their mobile wallets. Eventually rural banks in the Philippines spearheaded this movement by paying their employees with G-Cash. ***Classification:*** This is a user innovation since PR bank was already doing this, albeit manually, before Globe had launched the commercial version under the name 'Text-a-Sweldo'.
Telecom	***Financial & Telecommunication services through the mobile phone***	
18. Ask a Load	Allows users to send out a free request to any other user for airtime reload.	***User innovation history:*** In the Philippines in 1999, we know there were users who received requests for transfers of airtime via SMS. At this time SMS was still a free service. [In response, the person who received the request would buy a scratch card for 'load', scratch the card to reveal the unique activation code, and send the code via SMS. The receiver could then punch in the code and thereby top-up his or her airtime.] *Sources: Celdran (2002); Interview with RBAP-MABS employee in the Philippines.* ***Producer commercialization history:*** On 8 October 2004, Globe launched its Ask-A-Load service. This allows a subscriber to literally request via SMS a particular amount of credit from another subscriber, which the latter could then choose to approve or disapprove. The request was free for the requester but would cost 1Peso for the requested. *Sources: Globe Annual Report 2004, Mendes et. al (2007). Wishart (2006)* ***Classification:*** We code this as a user innovation because people were asking each other for airtime 'load' via SMS before the producer officially introduced the Ask-a-Load product.

Service	Description	User Innovation and Commercialization Histories of Mobile Financial Services
19. Domestic Airtime Transfer (P2P)	Enables subscribers to buy and send load credits (airtime) between two domestic phone numbers	***User innovation history:*** In 1999, we know there were users who were registered as resellers to send airtime to each other when requested and did so by sending the unique activation code via SMS. The receiver could punch in the code and thereby top-up his or her airtime. Usually the actual payment was settled at a later time, when the two would meet. This sort of dealing in airtime was often only between trusted friends and family. Sometimes, but not always, this was done to earn some money, and mostly on an informal basis. Some went as far as registering as official top-up resellers, such as the wife of Anthony Petalcorin, an employee we interviewed that currently works for RBAP-MABS, was doing this. *Source: Interview in Manila with RBAP-MABS employees.* ***Producer innovation history:*** In December 2000, Smart, the second telecom company in the Philippines launched Smart Money. Once registered, customers may use their mobile phone without having to visit an agency to transfer credit to a prepaid account and then transfer airtime credit from one user to another. It was also "the world's first electronic cash card linked to a mobile phone". This service was restricted to people with a bank account. *Source: Connect (2004)* ***Classification:*** This is a user innovation because user's were doing this before the producer introduced it. Furthermore, the producer innovation was much more limited than the user innovation, because it only allowed this transfer between Smart Money customers. The user solution was possible between any mobile phone subscriber and was not limited to any telecom provider.
20. International Airtime Transfer (P2P)	Sending airtime between two international SIM cards	***User innovation history:*** None found. ***Producer innovation history:*** Globe Telecom introduced International Share-a-Load in July 2004 between the Philippines, Hong-Kong, Japan and Singapore. *Source: www.cwhonors.org/case_studies/GlobeTelecomAutoLoadMax.pdf* ***Classification:*** Producer innovation

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Appendix B Example of mobile banking transaction

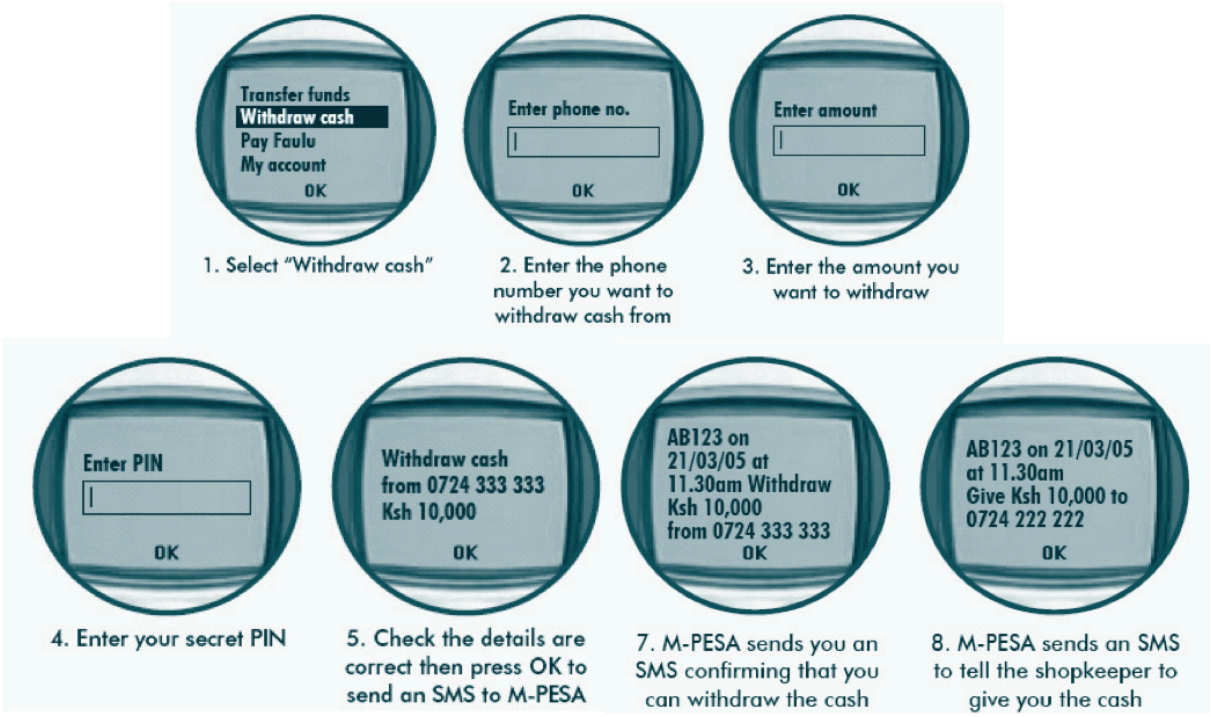


Figure 0-1: Example of what a customer sees on his/her phone in a cash withdrawal: the case of M-Pesa in Kenya.

Source: Mas, I. and Kumar, K., 2010. Banking on mobiles: why, how, for whom? Focus Note 48. CGAP, Washington, D.C. (downloaded on 19 December 2013 from http://www.cgap.org/sites/default/files/CGAP-Focus-Note-Banking-on-Mobiles-Why-How-for-Whom-Jul-2008.pdf).

Appendix C Origin of Mobile Financial Services

7. Merchant Payment	Consumer-to-business payments for retail purchases	***User innovation history:*** *"*Since its introduction [in 1998], the prepaid cell-phone credit—popularly known as 'load'—is becoming a new form of currency. Services are already being performed in exchange for 'load'." *Sources: (Lallana, 2004), Celdran (2002)* "The use of SMS as a means of conducting m-Commerce originated in the Philippines, starting with the innovation of passing top off credits among subscribers, in exchange for services." *Source: (Lallana, 2004)* ***Producer innovation history:*** "SKT pioneered mobile payments in Korea with a mobile cash (m-cash) product, NeMo (Network + Money), which was launched alongside 9 major Korean banks in 2001, and was subsequently rebranded *Moneta Cash*. Customers subscribing to *Moneta* Cash got a virtual money account, with their phone number acting as their account number. Once the *Moneta Cash* account was loaded, customers were able to use their mobile phones to transfer money to other *Moneta* Cash accounts, including at points-of-sale to effect payments for goods." *Source: CGAP, Going Cashless at the Point of Sale: Hits and Misses in Developed Countries*. ***Classification:*** This is a user innovation, since users in the Philippines had pioneered the service before it was commercially available in Korea.

Table C.1: Example of data used to code the Merchant Payment service

		User		Producer		
	Service	**Introduction by User**	**Country**	**Introduction by Producer**	**Country**	**Final Coding**
Category: Mobile Banking						
1	Bank Account Balance Alert	-	-	1995	Finland	**Producer**
2	Bank Account Deposit	Jul-06	Philippines	Sep-06	Philippines	**Joint**
3	Bank Account Withdrawal	-	-	Dec-00	Philippines	**Producer**
4	Bank Transfer	1996	Afghanistan	1997	Finland	**User**
5	Storage of Savings	Mar-07	Kenya	Mar-10	Kenya	**User**
Category: Mobile Commerce						
6	Automated Service Payment	-	-	1997	Finland	**Producer**
7	Merchant Payment	1998	Philippines	Sep-01	South Korea	**User**
8	Mobile Insurance	Apr-07	Kenya	2009	Kenya	**User**
Category: Mobile Money						
9	Authorized Cash Collection	2006	Zambia	2003	Zambia	**Producer**
10	Bill Payment	May-03	Philippines	1999	Finland	**Producer**
11	Domestic Money Transfer (P2P)	1999	Philippines	Dec-00	Philippines	**User**
12	Emergency Credit	Sep-08	Kenya	Mar-10	Kenya	**User**
13	G2P (Government to Person)	-	-	2006	DCR	**Producer**
14	International Money Transfer	-	-	Aug-04	Philippines	**Producer**
15	Microfinance Loan Disbursement	May-03	Philippines	Oct-05	Kenya	**User**
16	Microfinance Loan Repayment	-	-	Nov-04	Philippines	**Producer**
17	Salary Disbursement	Dec-06	Philippines	Jul-07	Philippines	**User**
Category: Telecom						
18	Ask a Load	1999	Philippines	8-Oct-04	Philippines	**User**
19	Domestic Airtime Transfer (P2P)	1999	Philippines	Dec-00	Philippines	**User**
20	International Airtime Transfer (P2P)	-	-	Jul-04	Philippines	**Producer**

Table C.2: Service listing and coding for user/producer/joint

	Service	Description
	Mobile Banking	**Performing banking services through the mobile phone**
1	Bank Account Balance Alert	Receive account balance updates and alerts on a mobile phone (initially via SMS)
2	Bank Account Deposit	Deposit money to bank account using mobile wallet
3	Bank Account Withdrawal	Virtually withdraw money from a bank account and receive this on a mobile wallet
4	Bank Transfer	Users can make a bank transfer between two accounts using their mobile phone.
5	Storage of Savings	Using the mobile wallet to safeguard savings (an alternative could be in a sock under the mattress).
	Mobile Commerce	**Buying goods with mobile phone.**
6	Automated Service Payment	Automated payment using the mobile phone for services such as vending machines, public transport or parking
7	Merchant Payment	Consumer to business payments for retail purchases
8	Mobile Insurance	Issue insurance payments through the mobile phone
	Mobile Money	**Using money through the mobile phone.**
9	Authorized Cash Collection	An authorized agent collects cash and sends the equivalent in mobile money via his mobile phone to the receiver
10	Bill Payment	Pay bills through the mobile phone
11	Domestic Money Transfer (P2P)	Sending money between two domestic mobile wallets
12	Emergency Credit	Requesting, sending or receiving airtime or mobile money in the form of an emergency loan
13	G2P (Government to Person)	Government payments are paid to the mobile wallet (includes social transfers as well as wage and pension payments)
14	International Money Transfer	Sending money between two international mobile wallets
15	Microfinance Loan Disbursement	Giving out microfinance loans through the mobile phone, depositing the value onto the mobile wallet
16	Microfinance Loan Repayment	Repaying microfinance loans using mobile money, using credit in the mobile wallet
17	Salary Disbursement	Paying salary into an employee's mobile wallet
	Telecom	**Financial & Telecommunication services through the mobile phone**
18	Ask a Load	Allows users to send out a free request to any other user for airtime reload.
29	Domestic Airtime Transfer (P2P)	Enables subscribers to buy and send load credits (airtime) between two domestic phone numbers
20	International Airtime Transfer (P2P)	Sending airtime between two international SIM cards

Table C.3: Description of Services

Appendix D Mobile Cellular Subscriptions In the Developing World

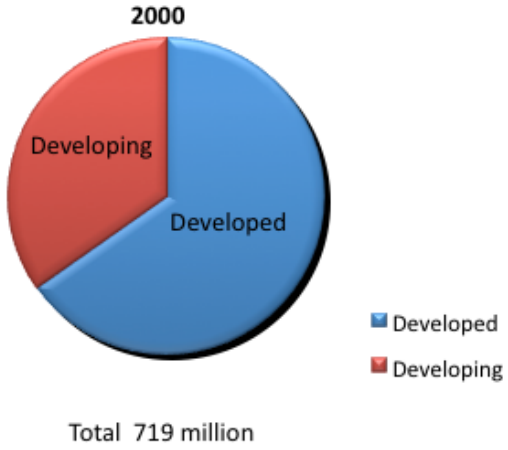


Figure D.1: Total number of mobile cellular subscriptions in 2000

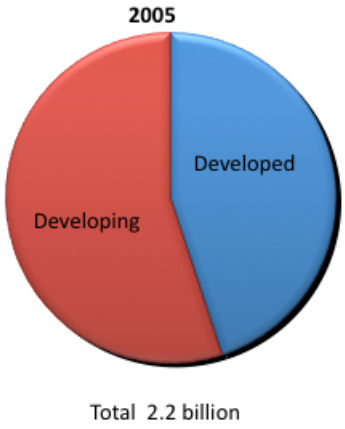


Figure D.2: Total number of mobile cellular subscriptions in 2005

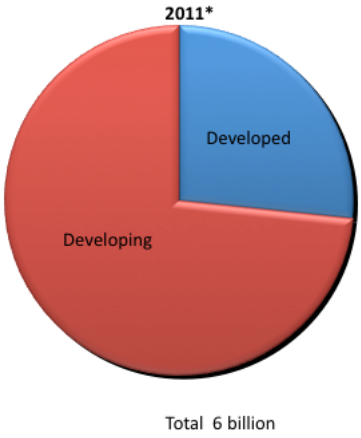


Figure D.3: Total number of mobile cellular subscriptions in 2011

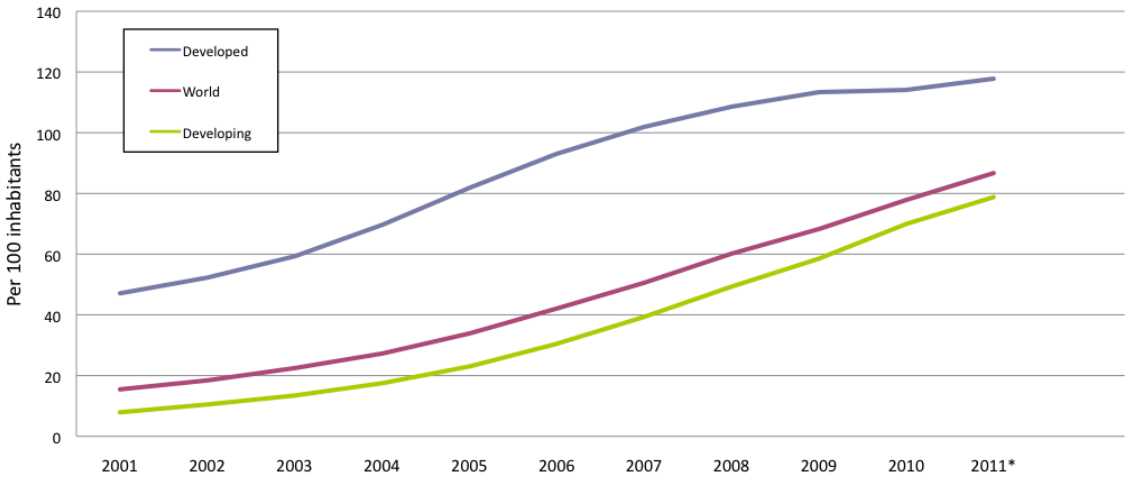


Figure D.4: Mobile cellular subscriptions per 100 inhabitants, 2001-2011

Source: ITU Statistics (http://www.itu.int/ict/statistics)

Appendix E Technical Appendix Chapter 2

Renaming and adding services to the GSMA's list:

Part of the data collection and cleaning process was validating GSMA's list of services, in terms of its completeness, and its accuracy. We added four additional services that we found, from other sources, were also present in the market, but which were not included in the GSMA list: Emergency Credit (sources: Morawczynski and Pickens, 2009; Jack and Suri, 2011; M-Kesho, M-Pesa's product); Ask-A-Load (sources: Celdran, 2002; Globe Annual Report, 2004; Mendes et al., 2007; Wishart, 2006); Storage of Savings (sources: Morawczynski and Pickens, 2009; Vodafone, 2010); and Bank Account Balance Alert (source: Merita Bank, 1995). The reason for adding them was to make sure we had the compete sample of mobile financial services available in the market. Seven services in the GSMA sample were merged due to excessive similarity: Microfinance Institution (MFI) Loan Repayment, Loan Payment, and MFI Payment; Salary Disbursement and Salary Payment; and Bill Payment and Electricity Purchase.

The services that were renamed for clarity included: Airtime Top Up became Domestic Airtime Transfer (P2P); Corporate Cash Collection became Authorized Cash Collection; Text-a-Deposit became Bank Account Deposit; and Text-a-Withdrawal became Bank Account Withdrawal.

Selecting which services should be included in the sample:

The first criterion was that, to define the sample clearly, mobile phones needed to be used as part of the service. Second, if producers eventually commercialized the service, we viewed this as evidence that the service was relevant to the producer and the market, and was not a minor modification made by a small group of users. This condition also conforms to the Oslo Manual's conditions for measurement of innovation, which stipulate that an innovation needs to have been implemented to be included in the data (OECD, 2005). By requiring that the producer commercialize the service, we are being conservative with our sample, because user innovations that have not (yet) been commercialized by a producer are excluded.

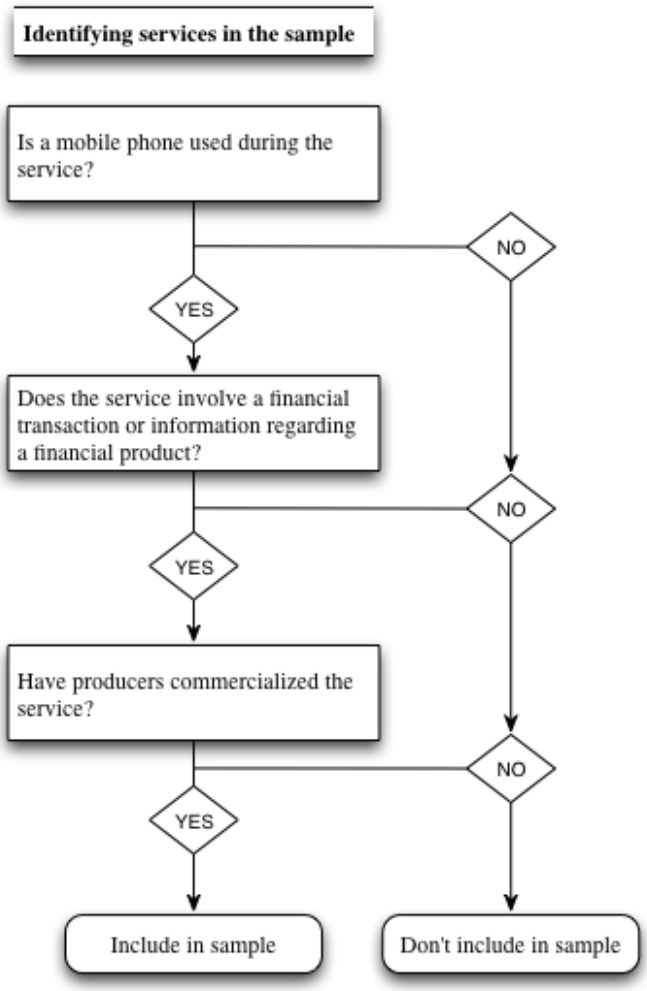


Figure 0-2: Identification process for the sample.

Following this procedure, four services were excluded from the sample: Bank Account Management (10 deployments), Linked MFI, SACCO, Bank Account (nine deployments), Manage Bank Account (four deployments), and Prepaid Service Payment (two deployments). Together, these comprised 7% of the base sample.

Amazon Mechanical Turk:

We mainly used Amazon Mechanical Turk (Mturk for short) to categorize the services into one of three innovation groups: user, producer, or joint innovation. Mturk has two types of profiles: "requesters" are those who need work to be done (like ourselves), and "workers" are those who have time and want to earn some money solving micro-tasks. The Mechanical Turk Workers were provided with information by us, the Mechanical Turk Requesters. The information included instructions, user and producer service innovation histories, and the decision tree, which the workers had to use to

provide justification for their decisions in order to ensure the validity and reliability of their answers.

We created Human Intelligence Tasks (HITs) on Mturk that consisted of creating a set of instructions that looked like this:

Carefully read below user and producer innovation histories. Then go to the decision tree (image), start at the top and answer the questions using the histories to code the innovation as a USER, PRODUCER or JOINT. Select your category from the list below.

Name of the innovation to be categorized: Authorized Cash Collection (An authorized agent collects cash and sends the equivalent in mobile money via his mobile phone to the receiver)

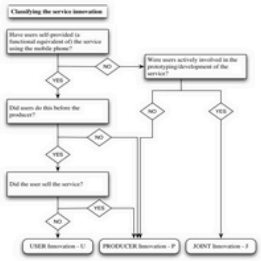
User Innovation History:

The Village Phone was an early form of authorized cash collection: "In Uganda, when it became too expensive and insecure to send money using the bus system, people started to transfer airtime through the Village Phone (launched in 2003 in Uganda, and in 1997 in Bangladesh) operator instead. A person living in the city would simply buy airtime, call the Village Phone operator and give the operator the airtime details. The operator then load the phone with the given airtime, charge a commission, and give the rest of the money in cash to the recipient. Jan Chipchase observed this practice in 2006 in Uganda.

Producer Innovation History:

In Zambia Celpay launched a cash collection service in late 2003. South African Brewers was especially keen on adopting this because their truck drivers used to carry a lot of cash with them as retailers as the would do their delivery rounds. They forced their customers to deposit the cash payment to their Celpay account which would then go instantly to their head office, greatly simplifying account reconciliation and speeding the time that it takes to bank their money.

Use this decision tree to help categorize the innovation:



Go to this link for a larger version of the image: http://i40.tinypic.com/e3tax.jpg

- ○ USER Innovation
- ○ PRODUCER Innovation
- ○ JOINT Innovation
- ○ Not Sure

Please provide justification for your choice, this will determine your approval. You can use the decision tree (image above) to justify your choice. If you are not sure which category, please state why. Thank you.

Submit

Figure 0-3: Example of instructions shown to Amazon Mechanical Turker.

The decision tree is Figure 2-1in the chapter. The price for completion of one HIT was set at $2.00. When they were uncertain about the stories or the category to which the service-innovation belonged, they could select a fourth option: "not sure." Workers were also asked to provide justification for their choices; in particular if they were unsure. This was useful as it indicated that information was missing and not that the innovation could

not be categorized without more information on its history. In a few cases in which the justification was clear and based on the decision tree, their choices were accepted; otherwise, their answers were rejected and the task would re-open for a new coder to answer. Some of these features were included after doing a trial run.

Once the instructions were finalized, we created 14 different HITs, one for each service for which we had multiple innovation sources. Each HIT was completed seven different times. Mechanical Turk made it possible to set required qualifications for the coders to be able to perform our HITs. For our assignments, we selected the qualifications "Categorization Masters," "HIT approval rate greater than 90%," and "Number of HITs approved greater than 1000." Coders were limited to coding each service only once, and could choose to stop anytime and after as many services as they wanted, up to 14. In our sample, 17 unique coders, also known as "Turkers," participated in categorizing our sample of services.

N.B.: We realized after the fact of the experiment that there seemed to be some mistakes in the text that is listed in the captured image above. We had a look at all other descriptions and found that the mistakes were mainly spelling mistakes. While undoubtedly confusing, they were minimal and we do not believe that they affected the results of the coding.

Inter-rater Agreement Comments:

For two services, Microfinance Loan Repayment and Authorized Cash Collection, there was no clear consensus, manifested by 45% agreement between coders. In the absence of convincing evidence that suggested otherwise, these services were coded as producer innovations. For some services, there was little time between the dates of introduction of user and producer innovations. In those cases, we attempted to determine the exact month in which the introduction took place, to ensure that there was a clear "first" innovator.

Appendix F Technical Appendix Chapter 3

Firm (group) level data creation

We collected data from various sources on the links and connections between MNO across countries. The four sources that contained information on how the firm that was linked to groups and other MNOs in the industry, and any entry in mobile financial services are:

1. Owners (MNO Directory)
2. MNO Group in 2007 (MNO Directory)
3. ST.group (ShiftThought)
4. mfs.group (handcollected for MFS entries)

Several checks were done to eliminate duplicates. This was mainly done on the basis of their names. For example Bharti Airtel group with unique ID '77' first showed up disaggregated because it was given more than 10 different names across the different data sources, a few examples below:

- *Bharti Airtel Limited*
- *Bharti Airtel Ltd*
- *Bharti Enterprises*
- *Bharti Enterprises via Bharti Airtel*
- *Bharti Group*
- *Bharti Tele-Ventures Limited*
- *Bharti Telecom Limited*
- *Mittal*

After this check was done the list was reduced from originally 1917 different unique firms to 1070 unique firm firms. Each firm was assigned a country of origin, which was then assigned dummy variables for membership of OECD and OECD (DAC).

In those cases where the different sources of data overlapped, then the same firm could be associated multiple times with the same MNO or the same MFS entry. Therefore, duplicates were eliminated as follows: when firm ID, year, country and mfs_id were the same, the duplicate entry is eliminated. The different sources of data show up with the following frequency in the final dataset:

	Variable Name	Source	Freq (including duplicates)	Freq (after eliminating duplicates)
1	Owner.ID.dup.1	MNO Directory (all years)	5115	4613
2	Owner.ID.dup.2		938	881
3	Owner.ID.dup.3		339	326
4	Owner.ID.dup.4		157	153
5	Owner.ID.dup.5		82	81
6	Owner.ID.dup.6		37	37
7	Owner.ID.dup.7		25	21
8	Owner.ID.dup.8		14	11
9	Group.07.MNO.id	MNO Directory (only 2007 panel)	355	197
10	mfs.group.id	Hand-collected	744	576
11	strat.partner.id	Hand-collected	180	162
12	ST.main.group.id	ShiftThought	106	40

Table 0-1: Summary of variables

Current limitations of the data

- We don't have firm level data on non-MNO firms that are not mentioned in the MNO Directory, outside the country they entered. For example if Ecobank was an owner or firm member of a mobile banking platform in Sierra Leone, then we don't know in which countries Ecobank also had operations but did not launch any mobile banking, unless it is included in the MNO Directory. However, we don't think this influenced the results because most mobile banking platforms were somehow affiliated with an MNO, and because we have the complete MNO landscape, most firms with MNO-links are included.
- There may be undocumented duplicates in the list of unique firm id's. Current check only done on name similarity, not for actual ownership (e.g.: Cellular one may be linked to Monaco Tel, but this is not registered at the moment).

Variable name	n	Mean	S.D.	Min	Max
EntryMFS	6095.00	0.13	0.34	0	1
early_entrant09	16042.00	0.15	0.35	0	1
early_entrant08	16042.00	0.08	0.26	0	1
first_country_entry	6556.0	2008.9	2.5	2000	2013
first_country_entry_d	16042.00	0.07	0.25	0	1
traction_level	1956.00	2.47	1.18	0	4
Sprinter	207.00	0.03	0.17	0	1
entry_hazard	16042.00	0.02	0.15	0	1
HHI_Q1	9235	0.29	0.18	0.00	1.00
MNO_sum_country	10447	9.40	17.02	1	69
Market_Share_Av	8870	0.29	0.23	0.00	1.21
MSmax	16042	0.32	0.46	0	1
MSabovemean	8870	0.23	0.42	0	1
MStopquart	8870	0.63	0.48	0	1
state_owned	16042	0.12	0.32	0	1
Group_OECD_DAC	5841	0.37	0.48	0	1
Firms_entered	16042	0.45	1.26	0	14
Previous_group_entry	16042	0.14	0.35	0	1
Previous_country_entry	16042	0.15	0.36	0	1
branches_com_bank_100000adults	7263	22.73	38.87	0	
Subscribers_ITU	13910	6.15	12.76	0	110

Table 0-2: Variables summary table

Technology Vendor Name	Total Number of Mobile Money Platforms Supported	Country	OECD	Year Founded
Comviva	29	India	0	1999
Fundamo	29	South Africa	0	2000
Gemalto	22	Netherlands	1	2006
Utiba	17	Singapore	0	2001
Oberthur	14	France	1	1984
Telepin	8	Canada	1	2005
Obopay	6	United States	1	2005
Sybase 365	6	United states	1	1984
Vodafone Money Transfer	6	United Kingdom	1	2005
Taggattitude	5	France	1	2005
eServGlobal	3	France	1	1983
inhouse	3	NA	NA	NA
MobiCash	3	Mauritius	0	2007
Creova	2	France	1	2008
Datanets	2	Papua New Guinea	0	1993
E-Fulusi	2	Tanzania	0	2004
Finaccess	2	Nepal	0	2009
Genweb2	2	Bangladesh	0	2009
Afric Xpress Services	1	United States	1	2007
Cellulant	1	Kenya	0	2004
Cointel	1	South Africa	0	1996
Cyphermint	1	United States	1	0
Eko SimpliBank	1	India	0	2007
Equity Bank Transactional Platform	1	Kenya	0	0
etranzact	1	Nigeria	0	2003
Horus Noomadic	1	France	1	1990
inov8	1	Pakistan	0	2004
Inovasoft	1	Burkina Faso	0	2007
Kabira	1	United States	1	1998
Leapfrog Technology	1	United States	1	0
M4U	1	Brazil	0	2000
MAP	1	United States	1	2007
mChek	1	India	0	2006
mobile pay ltd	1	Kenya	0	2010
Mobile Payment Solutions	1	Zambia	0	2008
Mode	1	Bahrain	0	2007
More Magic	1	United States	1	2001
OpenRev	1	United States	1	2008
Osprey Zenith	1	Nigeria	0	2009
Oxigen	1	India	0	2004
Paybox	1	Germany	1	1999
Sagentia	1	United kingdom	1	1986
SMARTTrust	1	Finland	1	1991
Visa	1	United States	1	1958
YellowPepper	1	United States	1	2007
ZipCash	1	India	0	2007
TOTAL	200	-	22	-

Table 0-3: Overview of vendors

State-Owned	Freq.	Percent
No	14,111	88.03
Yes	1,919	11.97

Table 0-4: Overview of state ownership

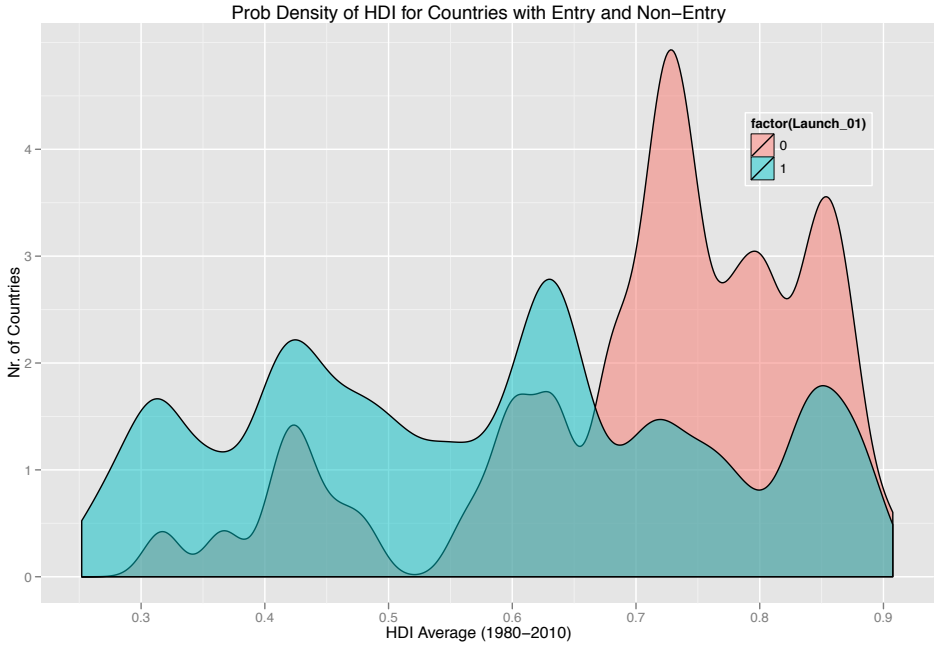


Figure 0-4: Distribution of Human development index for all countries, separating between countries where at least 1 entry occurred, and countries with no entry.

Figure 0-5: Distribution of GDP groth for all countries, separating between countries where at least 1 entry occurred, and countries with no entry.

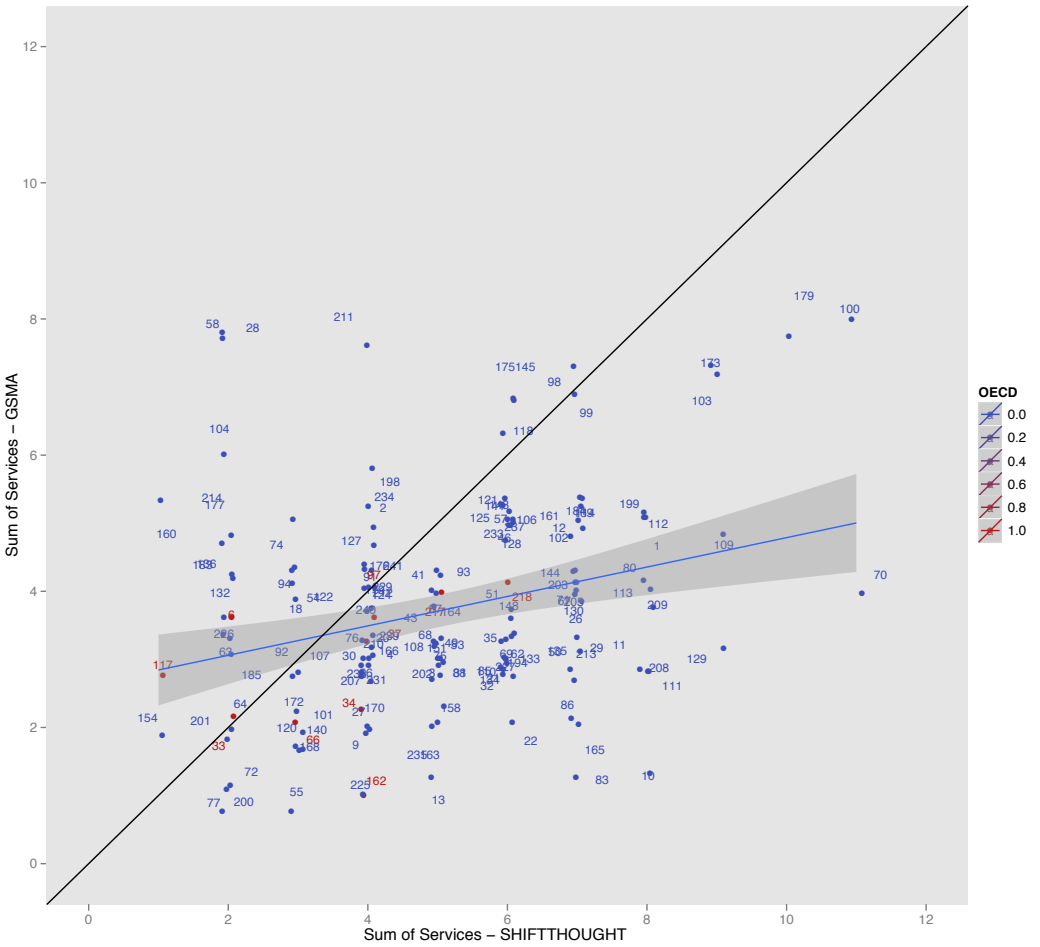


Figure 0-6: Comparison between the total number of services as counted by GSMA and ShiftThought, an independent consulting firm,

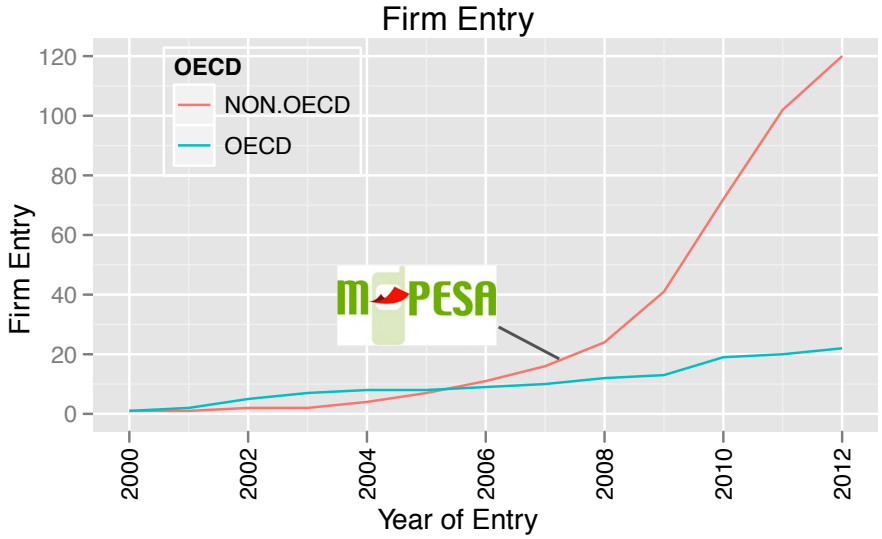


Figure 0-7: Entry of firms into mobile banking, separated by OECD and non-OECD countries.

Appendix G Major Initiatives in the North

Recently, new large-scale mobile banking initiatives in the North are being conceptualized and tried in the market, such as Google Wallet, Square, and Isis (a joint-venture between AT&T, T-Mobile, and Verizon in partnership with Visa, MasterCard, and American Express). The dust has not yet begun to settle as these large-scale initiatives try to conquer the market. There is a renewed interest by firms in the North to enter the mobile banking and mobile payments space, and these firms are doing this using a new generation of smart phones. Many of these efforts emulate the mobile wallet model pioneered in the South.

Appendix H Portuguese User Innovation Survey

A.Demography, education and family characterization

A1. Birth date:

☐☐/☐☐/☐☐☐☐
[DD/MM/YYYY]

A2. Gender:

☐ Female

☐ Male

A3. Formal Education path:

Degree:

☐ Bachelor degree
☐ Graduation
☐ Master degree
☐ PhD

If you answer "PhD", please fill in additionally the question A5

Starting year:
☐☐☐☐

Graduation year:
☐☐☐☐

Disciplinary area: *[Field of Science and Technology (FOS) Classification]*

☐ Exact sciences
☐ Natural sciences
☐ Engineering and technology
☐ Medical sciences
☐ Agricultural science
☐ Social sciences
☐ Humanities

Institution:

_____
__

A4. Did you spend any period abroad during your education?

☐ Yes
A4.1. How long? (in months)_____

☐ No

A5. During your PhD, did you complemented training with some soft skills courses?

☐ Yes

- ☐ Project Management
- ☐ Presentation and communication
- ☐ Negotiation
- ☐ Time management
- ☐ Team management
- ☐ Leadership
- ☐ Entrepreneurship
- ☐ Other. Specify:_____

☐ No

A6. Parents level of education: (optional)

Mother _____

Father _____

B.Consumer innovator

Innovation activities:
The next questions relate to any creative activities you have engaged during your leisure and/or work time. You may have created any products or applications for personal use, to help other people, to learn, or just for fun.

B1. In the past three years, did you ever use your leisure and/or work time to create any of your own?
[Please consider the following examples]

	Yes	No	Don't know/will not say
Computer software [by programming original code]	☐	☐	☐
Household fixtures or furnishing [e.g., kitchen- and cookware, cleaning devices, lighting, furniture]	☐	☐	☐
Transport or vehicle-related products or parts [e.g., cars, bicycles, scooters]	☐	☐	☐
Tools or equipment [e.g., utensils, molds, gardening tools, mechanical or electrical devices]	☐	☐	☐
Sports, hobby or entertainment products [e.g., sports devices, games]	☐	☐	☐
Children or education related products [e.g., toys, tutorials]	☐	☐	☐
Help, care or medical related products	☐	☐	☐
Food or cloth related products	☐	☐	☐
Health and welfare	☐	☐	☐
Any other products or applications. Specify: _____	☐	☐	☐

If you answer all "No" or "Don't know/Will not say" go to Section E

B2. Did you do this for your job/business, or for yourself/other purposes?
[Please consider the following item(s) that you select in B1]

	for my job/ business	for myself/ other purposes	Don't know/wil l not say
Computer software [by programming original code]	☐	☐	☐
Household fixtures or furnishing [e.g., kitchen- and cookware, cleaning devices, lighting, furniture]	☐	☐	☐
Transport or vehicle-related products or parts [e.g., cars, bicycles, scooters]	☐	☐	☐
Tools or equipment [e.g., utensils, molds, gardening tools, mechanical or electrical devices]	☐	☐	☐
Sports, hobby or entertainment products [e.g., sports devices, games]	☐	☐	☐
Children or education related products [e.g., toys, tutorials]	☐	☐	☐
Help, care or medical related products	☐	☐	☐
Food or cloth related products	☐	☐	☐
Health and welfare	☐	☐	☐
Any other products or applications. Specify: _____	☐	☐	☐

If you answer all items "Don't know/Will not say" go to Section E

B3. At the time of development, was a similar product, device or application already available as a commercial product on the market?

[Please consider the following item(s) that you select in B1]

	Yes	No	Don't know/will not say
Computer software [by programming original code]	☐	☐	☐
Household fixtures or furnishing [e.g., kitchen- and cookware, cleaning devices, lighting, furniture]	☐	☐	☐
Transport or vehicle-related products or parts [e.g., cars, bicycles, scooters]	☐	☐	☐
Tools or equipment [e.g., utensils, molds, gardening tools, mechanical or electrical devices]	☐	☐	☐
Sports, hobby or entertainment products [e.g., sports devices, games]	☐	☐	☐
Children or education related products [e.g., toys, tutorials]	☐	☐	☐
Help, care or medical related products	☐	☐	☐
Food or cloth related products	☐	☐	☐
Health and welfare	☐	☐	☐
Any other products or applications. Specify: _____	☐	☐	☐

If you answer all items "Yes" or "Don't know/Will not say" go to Section E

B4. Did you primarily create it to use yourself or in your business, to sell it, or for some other reason (e.g., helping others, learning, developing skills)?

[Please consider the following item(s) that you select in B1]

	personal / internal use	selling	Other	Don't know/ will not say
Computer software [by programming original code]	☐	☐	☐	☐
Household fixtures or furnishing [e.g., kitchen- and cookware, cleaning devices, lighting, furniture]	☐	☐	☐	☐
Transport or vehicle-related products or parts [e.g., cars, bicycles, scooters]	☐	☐	☐	☐
Tools or equipment [e.g., utensils, molds, gardening tools, mechanical or electrical devices]	☐	☐	☐	☐
Sports, hobby or entertainment products [e.g., sports devices, games]	☐	☐	☐	☐
Children or education related products [e.g., toys, tutorials]	☐	☐	☐	☐
Help, care or medical related products	☐	☐	☐	☐
Food or cloth related products	☐	☐	☐	☐
Health and welfare	☐	☐	☐	☐
Any other products or applications. Specify: _____	☐	☐	☐	☐

If you answer all items "selling" or "Don't know/Will not say" go to Section E;
If you answer all items "personal/internal use" or "other" go to Section C;
If you answer in one item "personal/internal use" or "other" go to Section C, question C2.

C. Innovation process

Innovation:
Innovation is defined as the introduction of a product or service in order to satisfy a need. For example, to time management you may have created a new alarm clock to remind you of your appointments, or a service to solve the same problem as automated telephone calls to remind you of scheduled appointments. This questionnaire focuses on innovations in products or services that have been developed to meet your or others needs and interests, and not the needs of the organization where you work.

C1. For the various activities/products that you selected in the previous question, which one do you consider your most significant creation:

☐	Computer software [by programming original code]
☐	Household fixtures or furnishing [e.g., kitchen- and cookware, cleaning devices, lighting, furniture]
☐	Transport or vehicle-related products or parts [e.g., cars, bicycles, scooters]
☐	Tools or equipment [e.g., utensils, molds, gardening tools, mechanical or electrical devices]
☐	Sports, hobby or entertainment products [e.g., sports devices, games]
☐	Children or education related products [e.g., toys, tutorials]
☐	Help, care or medical related products
☐	Food or cloth related products
☐	Health and welfare
☐	Any other products or applications. Specify: _____

C2. Can you tell us what kind of activitie/product you created and what was new about it or what problem did you solve?

The next questions are concerned with this specific item that you created. We will refer to it as 'the innovation'

C3. Do you think this innovation was new to:

- ☐ basically everyone, it did not exist before
- ☐ to many but not to all
- ☐ to some
- ☐ only to yourself

C4. How important was it to you to develop this innovation:

- ☐ Not important
- ☐ Less important
- ☐ Some importance
- ☐ Very important

C5. Why did you develop this innovation?
[You here find a list of reasons. Please indicate their relevance by distributing 100 points]

For personal or internal use	____
To sell/make money	____
To learn, or develop skills	____
To help other people	____
For the fun of doing it	____
Any other reason	____
Total of points	***100***

C6. Did any other people work with you or contribute to developing this innovation.

- ☐ Yes
- ☐ No, I did it on my own

If you answer "No, I did it on my own" go to C7

C6.1. Who contributed or worked with you when developing this innovation?
[multiple answers possible]

- ☐ Relatives and/or personal friends
- ☐ Members of a club or web community
- ☐ Colleagues at work
- ☐ External business contacts (e.g., suppliers, customers)
- ☐ Other.
  Specify:_____

C6.2. How many other people contributed or worked with you when developing this innovation
_____ persons

C7. Are you a member of a club or web community where people share information related to this innovation?

- ☐ Yes
- ☐ No

If you answer "No" go to C8

C7.1. How much time do you spend on average per year to this club/community?

_____ **Time**

Measuring unit

- ☐ Hours
- ☐ Days
- ☐ Weeks
- ☐ Months

C7.2. How many members does this club or web community have?

_____ members

C7.3. How many members of this club or web community share an interest in the innovation that you developed?

- ☐ (basically) none
- ☐ few
- ☐ many
- ☐ (nearly) all

C7.4. How many members of this club or web community create innovations related to the one you created?

- ☐ (basically) none
- ☐ few
- ☐ many
- ☐ (nearly) all

C8. How much time did you spend to develop this innovation?

_____ **Time**

Measuring unit

- ☐ Hours
- ☐ Days
- ☐ Weeks
- ☐ Months
- ☐ Years

C9. Did you spend any money to develop this innovation?

- ☐ Yes
- ☐ No

If you answer "No" go to C10

C9.1. Can you estimate how much?

_____€

C10. Did you use any methods to protect the intellectual property related to this innovation?

[e.g., patents, trade marks, copyrights, confidentiality agreements, technical protections like passwords or code encryptions]

- ☐ Yes

☐ No

If you answer "No" go to Section D

C10.1. What kind of intellectual property did you use?
[multiple answers possible]

☐ patent
☐ trade mark
☐ copyright
☐ confidentiality agreement
☐ technical protection (e.g., password, code encryption)

D.Innovation diffusion

D1. To what extent was the innovation successful? Was it…

- ☐ a complete success (i.e. it did what it was supposed to do)
- ☐ a partial success
- ☐ not successful (i.e. it did not work at all)

D2. For each of the following statements, choose the answer that best fits
[Choose one option for each statement]

	nothing valuable	little valuable	somewhat valuable	highly valuable
To me, this innovation was:	☐	☐	☐	☐

	no one	few others	many others	nearly anyone
In addition to myself, this innovation is valuable to:	☐	☐	☐	☐

	no one	very small market	reasonable market	substantial market
I consider this innovation a valuable commercial product to:	☐	☐	☐	☐

	negative	neutral	positive
My attitude towards the adoption of innovation by others is:	☐	☐	☐

	negative	neutral	positive
My attitude towards the commercialization of innovation by others is:	☐	☐	☐

D3. Are you willing to share what you know about your innovation?

- ☐ yes, with everyone for free
- ☐ yes, but only with individuals or firms I select
- ☐ no, I would like to keep it for myself

D4. How important is it to you that other users or firms adopt this innovation?

- ☐ Not important
- ☐ Less important
- ☐ Some importance
- ☐ Very important

D5. Please mark to what extent you agree with the following statements:

	strongly disagree	somewhat disagree	I agree partially	I totally agree
Free revealing motives				
People who freely obtain this innovation would be willing to help me at some future time.	☐	☐	☐	☐
The more people obtain this innovation, the more generally useful it becomes - also to me.	☐	☐	☐	☐
If others obtain my innovation it would advance my reputation.	☐	☐	☐	☐
If others obtain my innovation, this is not at my expense.	☐	☐	☐	☐
I don't mind others obtaining my innovation, as I would like to help other people.	☐	☐	☐	☐
Selective revealing motives				
I want to reveal my innovation only to people that I work with and/or whom I like.	☐	☐	☐	☐
I want to reveal my innovation only to those who will pay me.	☐	☐	☐	☐
I want to reveal my innovation only to someone who will improve and/or produce it for me .	☐	☐	☐	☐
Helping others to obtain my innovation takes effort – I only can do that selectively	☐	☐	☐	☐
Motives not to reveal				
I want my innovation to be unique to me.	☐	☐	☐	☐
I am competing with others and/or prefer keeping the advantage of this innovation for myself.	☐	☐	☐	☐
I intend to commercialize this innovation myself.	☐	☐	☐	☐
Legal issues keep me form sharing this innovation with others.	☐	☐	☐	☐

D6. Did you do anything to inform other people about your innovation?
[e.g., showing it off, communicating about it, posting its design on the Web]

☐ Yes
☐ No

If you answer "No" go to D7

D6.1. What did you do to inform others about your innovation?
[multiple answers possible]

☐ I showed it to other individuals
☐ I posted information on a website
☐ I showed it to commercial businesses
☐ I spend time and/or money to help others (individuals, businesses) adopting it
☐ I developed a manual or other documentation which would make it easier to adopt
☐ Other. Specify:_____

D6.2. How much time did you spend to inform others about this innovation?
_____ **Time**

Measuring unit
☐ Hours
☐ Days
☐ Weeks
☐ Months

☐ Years

D7. Did you spend any money to inform others about this innovation?

☐ Yes
☐ No

If you answer "No" go to D9

D7.1. Can you estimate how much?

_____ €

D8. To the best of your knowledge, did any commercial business adopt this innovation for general sale?
[e.g., your own employer or any other organization]

☐ Yes, my employer
☐ Yes, another organization
☐ No

D9. To the best of your knowledge, have any other people adopted this innovation?
[e.g., not commercial businesses, but relatives/friends or any other users – think for example of building a copy for themselves]

☐ Yes
☐ No

If you answer "No" go to D11

D10. Did some of these people involve members of a club or web community where people share information related to innovations like yours?

☐ Yes
☐ No

D11. Do you, alone or with others, currently own a business you help manage, or are you self-employed?

☐ Yes
☐ No

D12. Are you currently, alone or with others, trying to start a new business, including any self-employment?

☐ Yes
☐ No

If you answer both in D11 and D12 "No" go to Section E

D13. Did you commercialize your innovation via your business? Or do you intend to do so via your start-up?

☐ Yes, I already commercialize via my business
☐ I did not yet commercialize but intend to do this
☐ No, and I have no intention to do this

E.Traits

E1. Please indicate your level of agreement with the following statements:

	strongly disagree	somewhat disagree	I agree partially	I totally agree
I feel terribly restricted being tied down to tightly organized business activities, even when I am in control.	☐	☐	☐	☐
I seldom follow instructions unless the task I am working on is too complex.	☐	☐	☐	☐
I feel best about my work when I know I have followed accepted procedures.	☐	☐	☐	☐
Most of my time is spent working on several business ideas at the same time.	☐	☐	☐	☐
I usually take control in unstructured situations.	☐	☐	☐	☐
I often approach business tasks in unique ways.	☐	☐	☐	☐
I enjoy finding good solutions for problems that nobody has looked at yet.	☐	☐	☐	☐
I get a thrill out of doing new, unusual things in my business affairs.	☐	☐	☐	☐
I usually seek out colleagues who are excited about exploring new ways of doing things	☐	☐	☐	☐
I have a strong preference for risky projects.	☐	☐	☐	☐
I strongly believe that readiness to assume a risk is essential to reach my objectives.	☐	☐	☐	☐
If I'm in risky situations I prefer to wait to see what happens to avoid and minimize risk and the costs of wrong decisions.	☐	☐	☐	☐

E2. The following list gives an overview of causes you may find important in life. How important is this to you?

	Not important	Less important	Some importance	Very important
To be a very wealthy person.	☐	☐	☐	☐
To grow and learn new things.	☐	☐	☐	☐
To have my name known by many people.	☐	☐	☐	☐
To have good friends that I can count on.	☐	☐	☐	☐
To work for the betterment of society.	☐	☐	☐	☐
To have many expensive possessions.	☐	☐	☐	☐
At the end of my life, to be able to look back on my life as meaningful and complete.	☐	☐	☐	☐
To be admired by many people.	☐	☐	☐	☐
To share my life with someone I love.	☐	☐	☐	☐
To assist people who need it, asking nothing in return.	☐	☐	☐	☐

E3. Please indicate your level of agreement with the following statements:

	strongly disagree	somewhat disagree	I agree partially	I totally agree
Often, I do not feel very competent.	☐	☐	☐	☐
People I know tell me I am good at what I do.	☐	☐	☐	☐
I have been able to learn interesting new skills recently.	☐	☐	☐	☐
I feel like I am free to decide for myself how to live my life.	☐	☐	☐	☐
I get along with people I come into contact with.	☐	☐	☐	☐
I generally feel free to express my ideas and opinions.	☐	☐	☐	☐
People in my life care about me.	☐	☐	☐	☐
There are not many people that I am close to.	☐	☐	☐	☐
There is not much opportunity for me to decide for myself how to do things in my daily life.	☐	☐	☐	☐

End of the questionnaire

Thank you very much for your contribution!