Social networks and mobile money adoption
a quantitative case study in Uganda

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Social Networks and Mobile Money Adoption: A quantitative case study in Uganda.

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Dedicated to my families; the one I was given, and the one I chose along my travels. You are the most important part of my life.

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Abstract

In recent years, mobile money services for the unbanked have been recognized as one of the best opportunities for economic growth, poverty alleviation, and establishing financial security in the African continent and beyond. These services can become a platform that transforms the entirety of a society's economy, as they are adopted across commerce, health care, agriculture, and any other sector. Furthermore, while mobile phones have become ubiquitous all around the world, banking has not.

Although some studies have examined adoption of mobile money services, the main focus has been on individual characteristics associated with the Technology Acceptance Model (TAM) and related theories. In these models, social influences are defined as an individual's perception of social norms and expectations. Focusing only on perceptions dismisses group dynamics that are inherent to the adoption process. This creates a gap of research on how the adoption and use of mobile money services are affected by the social context in which users are embedded.

Additionally, there's a need to understand mobile money use beyond adoption. Current research on mobile money adoption has focused mostly in intention to adopt and very few studies have explored actual use of the system.

This study analyzes the effects of social networks, specifically peer adoption, in the adoption and variety of use of mobile money services. A survey based research is carried out in urban Uganda, exploring the ego-network structures of mobile money adopters and non-adopters, controlling for several variables from literature, including the two main antecedents of TAM models, perceived ease of use and perceived usefulness.

The results showed an effect of peer adoption in both mobile money adoption and variety of use. People with more peers using mobile money not only have a higher chance of adopting the service themselves, but those who have adopted have a higher variety of use of the system. When

compared to variables found in previous literature and used here as controls, the effect of peer adoption is large, being the third largest determinant of mobile money adoption, and the first largest for variety of use.

After relationships between peer adoption and mobile money adoption and variety of use were found, peer adoption was split by the type of ties with the participant. This resulted in different effects from different type of relationships. For adoption, it was family and friends that explain the influence of peer adoption; for variety of use, on the other hand, it was friends and other relationships instead. These results suggest social contagion by cohesion in the decision to adopt mobile money, and the importance of weak ties in the variety of use.

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Chapter One

Introduction

Information and Communication Technologies for Development (ICT4D) is a growing field that considers how technologies can contribute to global socio-economic development of impoverished communities (Toyama, 2010). Mobile phones have been link directly to improvements in economic development indicators: according Waverman, Meschi, and Fuss (2005) a country's year-on-year GPD growth increases by an additional 0.6% for every 10% penetration of mobile phones. Additionally, the rate of adoption of mobile phones has been extremely fast: according to the International Telecommunication Union, it will move from 7.19 million in 2000 to over 7.09 billion[1] active subscriptions estimated by the end of 2015 (that is, 96.8 subscriptions per 100 inhabitants around the world), of which 78.5% will be in developing countries (Statistics I.T.U., 2015).

Mobile phones have had a profound effect in the daily lives of their users, and they have been recognized as a potential tool for poverty alleviation and overcoming inequality. As pointed out in a 2012 report on mobile technologies commissioned by the World Bank, "mobile applications not only empower individual users, but they also enrich lifestyles and livelihoods" (Kelly & Minges, 2012, p. 3). Indeed, the so called "mobile revolution" has led many institutions, practitioners, and researchers to understand mobile phones as means to improve systems and services, especially in underserved contexts in different areas: education and information access, health, agriculture, etc. (Banks, McDonald, & Scialom, 2011).

[1] Following American numerical notation, a short scale is used through this document: a billion represents *a thousand millions* instead of *a million million*.

In recent years, mobile financial services for the unbanked have been recognized by organizations like the World Bank, the Bill & Melinda Gates foundation, and others, as one of the best opportunities for economic growth, poverty alleviation, and establishing financial security in the African continent and beyond. As stated by Donovan (2012), mobile financial services can become a platform that transforms the entirety of a society's economy, as they are adopted across commerce, health care, agriculture, and any other sector. Furthermore, while mobile phones have become ubiquitous all around the world, banking has not: only 54% of adults in the developing world have an open bank account (in contrast to 94% in developed countries), with the situation being especially dramatic for Sub-Saharan Africa, where it is estimated that only one in four adults have a bank account at a financial institution (Demirguc-Kunt, Klapper, Singer, & Van Oudheusden, 2015).

The first mobile banking services date back to the end of 1990 in Germany, developed by the company Paybox in collaboration with Deutsche Bank (Shaikh & Karjaluoto, 2015). These systems are, however, fundamentally different from the ones that have emerged in developing countries. Porteous (2006) differentiates between additive and transformative models of mobile banking, being additive mobile banking just another channel to an existing banking account, and transformative mobile banking those targeting the unbanked, who are largely low income people. This research focuses on the latter type of services.

Mobile financial services are mentioned by many names in scientific literature (Shaik & Karjaluoto, 2015). The term "mobile money services" is used from now on in this study due to its popularity in Eastern Africa and its increasing usage in the literature (Donovan, 2011). Mobile money can be defined as "the convergence of mobile telephony and financial services" (Donovan, 2011, p. 6). In other words, mobile money is the provision of multiple services traditionally given by financial institutions using the mobile phone network and nonbank retail agents, or, even simpler, "the ability to access and utilize [...] digital cash using the mobile phone" (Gencer, 2011, p. 4).

An important aspect of mobile money is the agent network that is providing access to the services. In order for users –and, in some cases and for an increased fee, non-users– to deposit or withdraw funds to or from their mobile money accounts, they must visit an authorized mobile money agent

that will receive the money and register it to the client's account. In practice, these intermediaries not only provide access to mobile money, they tend to provide several other mobile related services (selling airtime, troubleshooting, selling mobile phones and accessories, etc.). Additionally, established businesses (e.g. supermarkets, petrol stations, banks, etc.) can choose to register as mobile money agents as well.

Gencer (2011) organizes the services provided by mobile money in three main categories: mobile payments, mobile finance, and mobile banking. Mobile payments are monetary transfers that occur between people (domestically or internationally), clients, and businesses (for example, store payments or online shopping), between businesses during the supply chain, or between institutions and employees (salaries, pensions, etc.). Mobile finances represent traditional banking services like credits, insurances or saving accounts. Finally, mobile banking is the connection between a mobile money account and a formal bank account in order to access information (e.g. account balance, receive alerts) and/or do transactions on-the-go (e.g. pay bills).

From a scientific perspective, Donner and Tellez (2008) classify the study of mobile money services in three categories: those who explain adoption, those who assess the impact of the system on people's lives, and those who try to understand the use of such system in context.

The present research follows the first category of studies, that is, the adoption of mobile money, but brings forth elements from the other two traditions by understanding adoption beyond the binary of adoption/rejection, looking at how the system is used; and also by ingraining it in the social context of the users.

By including social context and addressing use beyond adoption, this study aims to bridge two gaps in the scientific study of mobile money adoption: the lack of studies on actual mobile money use, and the poor representation of social influences in the adoption process.

The importance of use beyond adoption in mobile money research was put forth by Donner and Tellez (2008), who after a review of available literature on mobile money services argued that adoption studies on this topic can benefit from a stronger articulation of what is being adopted (e.g. transfers, virtual wallets, etc.). Current research on mobile money adoption has focused mostly on

intention to adopt and very few studies have explored actual use of the system (Shaikh & Karjaluoto, 2015). As noted by Rogers (2003), adoption is a continuous process that starts with the research and planning that lead up to the decision of adopting (initiation), and ends up in a process in which the innovation is used and adapted to meet the individual needs, finally becoming a routine (implementation). The fact that most research on mobile money focuses on the intention and/or decision to adopt is problematic because the factors that support adoption may not be the same as those who support sustained use (Wells & Lemak, 1996).

Another critical aspect on mobile money adoption research is the constrained definition of social influences in the adoption process. Current literature of mobile money adoption has been heavily based on attitudinal models like the Technology Acceptance Model (TAM) or the Unified Theory of Acceptance and Use of Technology (UTAUT). In these models, social influences are defined as an individual's perception of social norms and expectations (Venkatesh, Morris, Davis, & Davis, 2003). The problem is, however, that focusing only on a person's perception dismisses group dynamics that are inherent to the adoption process (Tornatzky & Fleischer, 1990).

In order to determine the role of social influences in mobile money adoption, this study frames the problem from the analysis of interpersonal networks, that is, the relationships between users and non-users with the people surrounding them. Following Granovetter's argumentation: "the analysis of processes in interpersonal networks provides the most fruitful micro-macro bridge [...] it is through these networks that small-scale interactions become translated into large-scale patterns" (1973, p. 1360).

An individual's interpersonal connections are an important predictor of said individual's adoption of an innovation (Rogers, 2003). This idea provides the foundation for the research question of this study: *what is the influence of peer adoption of mobile money services within a person's social network in his or her adoption and use of mobile money?* In other words, does the decision to adopt or reject mobile money of people within my personal network affects my own decision of using mobile money? Furthermore, does it affect how I use it?

This thesis puts forth that both the decision to use mobile money and the way it is used are dependent on the adoption or rejection of peers within a person's interpersonal network. In order

to this, it explores the idea both theoretically and empirically. Chapter 2 presents a summary of existing literature of adoption theory, mobile money adoption, and social influences in the process of adoption, including a gap analysis of existing research on mobile money, and two hypotheses that can be tested empirically. Chapter 3 introduces the methodological characteristics of a survey based study carried out in Uganda to test said hypotheses. Chapter 4 shows the results of the analysis of the proposed study, providing evidence for the acceptance of the hypotheses. In Chapter 5 the analysis of social networks is further developed by exploring the structural characteristics of the network, characterizing the social influence given by different ties in the process of mobile money adoption and use. Finally, Chapter 6 presents a comprehensive discussion of the results, implications for both scientific research of adoption of mobile money services and practical implications for practitioners and people looking to improve the provision of said services, and limitations of the study.

Chapter Two

Literature Review

Technology adoption is a core concept in both innovation sciences and human-technology interaction. The main objective of this field of research is, simply put, to understand how and why individuals adopt new technology. Straub (2009) distinguishes between adoption and diffusion theories, arguing that adoption theories tend to focus on the micro-perspective, that is, in explaining the *adoption determinants*, parameters that influence technology acceptance; while diffusion theories, in contrast, focus on how an innovation spreads through a population, considering time and social context much more holistically. Most researchers, however, use these concepts somewhat interchangeably. And it makes sense: both approaches nourish each other, and more often than not, elements of diffusion are incorporated in adoption theory and vice-versa.

In a literature analysis of trends and issues in adoption and diffusion research, Williams, Dwivedi, Lal, and Schwarz (2009) describe the complexities of both processes, highlighting the importance of social context and that both adoption and diffusion changes are relatively slow and orderly; there are stages that represent a progression in both knowledge and understanding of the technology. These authors also highlight the importance of personal factors that influence adoption and diffusion: personality traits, previous experiences, etc. In other words, theories that try to explain technology adoption must consider cognitive, affective and contextual factors within them.

In order to understand better the diffusion and adoption processes, two main theories are presented in more detail: the theory of diffusion of innovations, and the technology acceptance model.

Diffusion of Innovations

One of the most influential works in the study of adoption comes from Everett Rogers in 1962 with his book *Diffusion of Innovations*. According to Rogers, diffusion is "the process in which an innovation is communicated through certain channels over time among the members of a social system" (2003, p. 5). In his perspective, the diffusion process has four main elements that interact to define the how and why of a technology is adopted or not: (a) characteristics of the innovation itself, (b) communication channels, (c) time, and (d) social system.

In Rogers' perspective an *innovation* can be an idea, behavior, object or technology that is perceived as new by an individual. A key concept in Roger's theory is that the "objective" characteristics of the innovation are not as important as the subjective assessment given by the individual, for example, the "objective" newness of the innovation is not as important as the perceived newness of it. In this sense, an innovation's perceived attributes can make it more or less likely for an individual to adopt it.

Diffusion for Rogers is a specific type of communication in which the messages are concerned with new ideas. A *communication channel* is the means by which messages get from one person to the other. According to Straub (2009), this can be direct communication, vicarious observation of peers, or even mass media.

The third element in this theory is *time*. The process of diffusion is framed through the concept of time in two ways: in the individual decision-making process, and in the innovativeness and adopter categories. The innovation-decision process is characterized by five stages in which the individual moves from understanding the innovation, creating an opinion about it, then accepting it or rejecting it, implementing the innovation if it is accepted, and finally confirming his or her perspective. Innovativeness, on the other hand, is the degree to which an individual is relatively earlier in the adoption of new ideas when compared to other members of his or her social system. The degree of innovativeness of an individual allows it to be classified in different categories of adopter, ranging from innovators and early adopters to late majority and laggards.

The final element in Rogers' theory comes from the idea that any diffusion process occurs embedded in a *social system,* "a set of interrelated units that are engaged in joint problem solving to accomplish a common goal" (Rogers, 2003, p. 23). Depending on the unit of analysis, a social system can be an organization, a village, or an entire country. Rogers highlights three main elements of a social system that influence adoption: social structure, social norms, and the role of opinion leaders and change agents. The influence of social systems in the adoption of mobile money services will be discussed in more depth later on in this chapter.

Technology Acceptance Model

Introduced by Davis (1986) as part of his doctoral dissertation, TAM was specifically created to model user acceptance of information systems. The main goal of this model is to provide with an analysis tool that is general, capable of explaining user behaviors across the broad range of computing technologies and populations, while at the same time being both parsimonious and theoretically justified (Davis, Bagozzi, & Warshaw, 1989).

Because TAM builds upon the theory of reasoned action (TRA) proposed by Azjen and Fishbein (1980), it becomes necessary to understand the latter first before dwelling any deep in the former. TRA is a general model to explain conscious intended behavior in specific situations (Davis et al. 1989), and it has been described as one of the most influential and fundamental ones in social psychology (Venkatesh et al., 2003). According to TRA, behavior is determined by the behavioral intention to perform it, and, in turn, behavioral intention is jointly determined by the person's *attitude* (evaluative affect, i.e., positive or negative feelings towards said behavior) and *subjective norm* (perceived expectations of individuals/groups of reference for the person). In other words, an individual's behavior is the result of their attitudes about the expectation of a behavior and the social norms about a particular behavior (Straub, 2009).

TAM takes this basic idea of attitudes influencing behavior and proposes two perceived characteristics ("beliefs") about a technological innovation as being of uttermost importance in the decision-making process of adoption or rejection: perceived usefulness (PU) and perceived ease of use (PEOU).

Perceived usefulness is defined as "the degree to which a person believes that using a particular system would enhance his or her job performance" (Davis, 1989, p. 320) and it has been linked to innovativeness, as it may influence how salient a particular technology is for the individual in his or her context (Straub, 2009).

Perceived ease of use, in contrast, refers to "the degree to which a person believes that using a particular system would be free of effort" (Davis, 1989, p. 320). Davis et al. (1989) argue that PEOU influences attitudes and behavior via two mechanisms: self-efficacy and instrumentality. An increased perception of a system's easiness increases the sense of self-efficacy and personal control in operating said technology, increasing the intrinsic motivation to use the system. Likewise, if the system is perceived as effortless, it becomes more instrumental for the individual, allowing him or her to accomplish more work with less effort.

Expanding on this basic structure, multiple modifications have been made to TAM, both ad-hoc (i.e. including variables specifics to the topic of interest), and as extensions or alternative models. Regarding the first category of expansions, King and He (2006) recognize four types of modifications: prior factors (e.g. prior usage or experience), factors suggested from other theories, contextual factors, and consequent factors (e.g. actual usage beyond intention).

One of the main efforts to extend TAM comes from Venkatesh et al. (2003) who examined eight different theoretical frameworks and models used in adoption and technology use research, and integrate the variables with higher explanatory power in UTAUT. The model is highly complex, resulting in multiple mediations and moderations to predict behavioral intention and use behavior.

TAM and its extensions have been deeply influential in the study of technology adoption: in their literature review on trends and issues in IT adoption and diffusion, Williams et al. (2009) found out that the most popular theory was TAM, being used in 29% of the reviewed articles, almost twice as much as the second most popular theory in their sample, diffusion of innovations (16.3%).

Despite the far reach of TAM and derived theories in the literature of technology adoption, multiple criticisms have been posed against them. Bagozzi (2007) argues that when social influences have been introduced into TAM, they have been done in the limited sense of either a

constraint on the decision-making or as an attempt to enhance one's status, which in turn neglects group, social, and cultural aspects of the decision-making. UTAUT, the author continues, despite using 41 independent variables and including up to four moderating variables to predict behavioral intention, it still may not include all variables that influence adoption of a specific technology. And with mobile technologies, this has been the case, Wang and Wang (2010) for example, extend UTAUT including three new variables to analyze behavioral intention (no actual use) of mobile internet.

Mobile Money Services

The story of mobile money services in Africa is rooted in social innovation and corporate social responsibility. Its inception occurred at the World Summit on Sustainable Development in 2002, in a discussion on how telecommunication companies (specifically Vodafone) could support the achievement of the Millennium Development Goals (Morawczynski, 2011). After many proposals and enlisting several other partnerships, the first mobile money service of the continent was launched in March 2007 in Kenya via Safaricom (a subsidiary of Vodafone), M-PESA, and with huge success: in eight months it reached over a million active users, and by 2013, over 17 million, a 38% of the country's total population (Safaricom Limited, 2014).

Adoption of mobile telephony in Uganda has been fast. Mobile networks begin to operate in the country in 1996 (Nyeko, Moya, Kabbale, & Odongo, 2014), and by the second quarter of 2014, more than 19 million subscriptions were active, representing a tele-density of 53%. When it comes to mobile money in the country, according to a speech given on December 2014 by the Finance Minister Maria Kiwanuka, there were more than 18 million mobile money accounts registered, from just about 10,000 in March 2009 (Oketch, 2015). These numbers are especially relevant when considering the economical context: Uganda has been recognized as a *success story in Africa* due to its macroeconomic stabilization and growth during the 1990s (Mwesige, 2003), but the country is still classified as a low-income country, having a low human development index and high levels of inequality (Farrar, 2012). In a study of financial inclusion carried out by InterMedia Uganda (2014), 38% of Ugandans were classified as financially included, that is, with access to some kind of

financial services. However, most of this inclusion is through mobile money accounts (33%) while formal banking remains much lower (14%).

Mobile money services in Uganda are provided by five telecommunication companies in the country: Airtel's Airtel Money, MTN's Mobile Money, Uganda Telecom's M-Sente, Orange's Orange Money, and Smart's Mobile Money. Additionally, although not officially working with any telecommunication company of Uganda, M-PESA agents can be found in several central spots of Kampala, the capital of the country.

Specific services available through mobile money are dependent on the network the user is registered to, but they all include the following: deposit funds, transfer funds, withdraw funds, buy airtime/mobile internet data, pay bills and taxes (e.g. parking), and connect the mobile money account with a bank account.

Adoption of Mobile Money

Mobile money services have attracted the attention of researchers from multiple areas of scientific development, and according to Donner and Tellez (2008), "[mobile money services] have all the markers of an innovation waiting to be 'diffused' or adopted by a subset of mobile users in the developing world" (p. 320). However, literature remains fragmented (Ducombe & Boateng, 2009; Shaikh & Karjaluoto, 2015) and lacks of a clear roadmap (Dahlberg, Mallat, Ondrus, & Zmijewska, 2008), which makes it difficult to approach it sensibly.

Dahlberg et al. (2008) review and summarize 73 publications on mobile payment (a sub-service of mobile money), 20 focused on users' perspectives, of which 15 addressed the issue of consumer adoption/acceptance. Most of the research was, indeed, based on TAM or diffusion of innovations theories, either testing the models' predictability or proposing additional factors. In their results, they suggest that ease of use, trust and security, usefulness, cost, and compatibility are among the most important factors driving adoption. Among their final conclusions, they define social and cultural factors impacting mobile payments as "the uncharted black areas of past [mobile money] research" (p. 178).

Donner and Tellez (2008), on the other hand, focus their literature review on mobile banking / mobile payment services in the developing world, looking not only at adoption, but also use. They organize their study around two main arguments. First, that there is a need for research focusing on the context in which mobile money is being use, and researchers should start to consider the issues of users' comfort with electronic money, the availability of alternatives, and the social context of transactions. Secondly, they argue, a larger effort should be made to understand use beyond adoption, as it can provide observations that inform policy or to lead the development of better products and services: "more advanced models could distinguish between people who simply utilize an m-banking/m-payments system for occasional transfers and those who begin to actually treat their mobile as a wallet" (p. 327). According to the authors, the existing theories of technology use are sufficiently robust to handle mobile money as a technological innovation, and that the current challenge is to find ways to inform and strengthen the assessment of impact, diffusion, design, and policy.

Ducombe and Boateng (2009) also review literature available about mobile money services in developing countries. These authors recognize four kinds of studies: needs or requirements assessment, design and application of mobile financial services, adoption and adaption, and impact assessment studies. The authors conclude that research in the field is still in the early stages of deep theory: much of what is produced at the time is based on framework- or model-based approaches, without a solid theoretical ground.

Shaikh and Karjaluoto (2015) took a more recent look at the literature on mobile banking adoption, identifying the most common models, geographical regions, and adoption determinants. Among the most used models, TAM and its variant were still at the top, followed by diffusion of innovations; the most visited regions were South East Asia, East Asia, and Africa; and the most used determinants were PEOU, PU, and trust. The authors conclude that since 2009 there has been a growth in the research, both empirical and conceptual, on mobile money, but that the corpus remains heterogeneous, with over 11 models, theories, or frameworks used and over 84 determinants of adoption being identified.

Use Beyond Adoption

As stated earlier, one of main gaps in mobile money research is the lack of studies addressing use beyond adoption. Mobile money services are an ensemble of functionalities, ranging from sending money, through paying bills, to connect the system with a formal bank account. This makes it possible for users to adopt any subset of services and ignore the rest. In order to characterize the diffusion process properly, traditional definitions of adoption must be expanded beyond the binary "adoption/rejection", considering other variables as well. As stated by Robertson and Gatignon (1986), "Adoption is not the only relevant concern of diffusion research. The degree of use of [a] technology is also an important variable that describes the extent of diffusion of that innovation" (p. 3).

Shih and Venkatesh (2004) explore the issue of use beyond adoption by framing it from the perspective of the use-diffusion model, which switches the focus from timing or rate of adoption, to the rate and variety of use. Variety of use refers to the different ways in which the product is used, and according to the authors, it assumes a more central position than rate of use. Variety of use is considered by the authors as one of the key elements of use innovativeness, playing a significant role in identifying intense users. The authors apply the model to use-diffusion of home computers in United States, finding evidence that this theory allows for a more complete representation of users, providing for better categorization and market segmentation, and conclude that the conceptual model can be easily adapted to a wide range of innovations that have multiuse potential, beyond personal computers.

Mobile money literature dealing with use beyond adoption is very limited, and usually lacks of a theoretical grounding. Shaikh and Karjaluoto (2015) find that the main dependent variables in the literature are, in descending order of appearance, attitude towards mobile money, intention to use, and use. Use as a dependent variable was present in three articles, in various degrees of complexity: Zhou, Lu, and Wang (2010) adapt an intention to use scale developed by Venkatesh et al. (2003) to inquire about three possible usages of mobile banking (manage account, transfer money, and make payments); Zhou (2011) measures use as usage frequency in a single-item variable; and Bankole, Bankole, and Brown (2011) measure user behavior, but do not define how the measure was constructed.

Social Influences on Mobile Money Adoption

Another issue in the mobile money literature that several authors have pointed out is the need to better define the social influences that determine the decision to adopt mobile money services.

Most research on this topic is based on TAM and TAM-like models, which have been criticized by how they define and understand social influences (see Bagozzi, 2007). TAM models follow a definition of social influence in lines with the one provided by Venkatesh et al. (2003), that is, "the degree to which an individual perceives that important others believe he or she should use the system" (p. 451), and they include one or more of the following root constructs: compliance or social norm, the perception that most people who are important to the individual think he or she should or should not use it; internalization or social factors; and image or identification, the degree to which use of the system is perceived to enhance one's status within the social system.

And indeed, empirical studies of intention to use and adoption of mobile money services have shown that social influences have an important role in the diffusion process. Song (2014) found out that interpersonal influences had positive effects on the social gains and social loss avoidance, increasing the intention to adopt mobile money services. Similarly, Singh, Srivastava, and Srivastava (2010) found a positive effect of the subjective norms in intention to adopt mobile money services.

However, not all studies have been able to find evidence that social influence have a role in the adoption of mobile money services. For example, Oliveira, Faria, Thomas, and Popovič (2014) explore mobile banking adoption with an extension of UTAUT and found that social influence had no significant effect in intention to adopt, which they explain arguing that mobile banking as a service is rather personal and sensitive, so the need for privacy and security supersede any social influence.

A possible explanation for this inconsistency refers back to the points made by Bagozzi (2007), who argues against the limited scope of TAM-like models in their definition of social influences. In the author's perspective, much of the literature extending TAM has been to broaden the approach by introducing additional predictors for PEOU, PU, or intentions, but not to deepen the understanding of how social influences can explain these variables.

Addressing the Gap on Mobile Money Adoption Research

A possible solution for this theoretical conundrum comes from the analysis of social networks. In Rogers' theory, *diffusion networks* are a core concept: "the heart of the diffusion process is the modeling and imitation by potential adopters of their near peers' experiences with new ideas" (2003, p. 330). However, mobile money research using this approach has focused on categorizing adopters (see Laukkanen & Pasanen, 2007; Kim, Mirusmonov, & Lee, 2010) or characteristics of the innovation (see Mallat, 2007; Yang, Lu, Gupta, Cao, & Zhang, 2012; Hanafizadeh, Behboudi, Abedini Koshksaray, & Jalilvand Shirkhani Tabar, 2014) rather than on looking at the social system or diffusion networks; and research based on TAM-like models has ignored social structure completely, opting instead for focusing on social influences as defined above.

A social network, as defined by Valente (1995), is "the pattern of friendship, advice, communication or support that exists among members of a social system" (p. 31). The relationship of an individual embedded in a social network will increase its opportunities or constraint its actions (Hanneman & Riddle, 2005).

The issue, then, is to try to define what kind of influence social networks have in the adoption and use of mobile money services for an individual embedded in them. Three mechanisms drawn from the literature on network analysis are brought forth as possible sources of social influences in the adoption process of mobile money services: contagion, social learning, and interactivity.

Social contagion can be defined as the process by which consumers influence each other to adopt or use a product (Langley, Bijmont, Ortt, & Pals, 2012), and represents the idea that people adopt when they come in contact with others who have already adopted, that is, innovation spreads like epidemics (Young, 2009). The key concept behind social contagion is, then, exposure: more adopters within a person's network means a higher chance of that person copying the behavior. Social contagion emerges from the social structure (Burt, 1987) and makes individuals in similar positions in the social network judge the benefits and risks of adoption similarly. This phenomenon is rooted on the concept of homophily, that is, the degree to which a pair of individuals who communicate are similar to each other. Proposed by Lazarsfeld and Merton in 1954, but with its origin in philosophy and classical sociology (McPherson, Smith-Lovin, & Cook, 2001), the idea of

homophily is an important part of diffusion of innovations theory, as according to Rogers, interpersonal diffusion networks are mostly homophilous: "the more homophilous that two individuals are, the more likely that their communication will be effective" (Rogers, 2003, p. 306).

Social learning, on the other hand, is the view that people are not directly influenced, but rather individuals learn by observing others using mobile money. They will adopt once they have enough evidence that the innovation is worth adopting (Young, 2009). Unlike with social contagion, the key concept here is utility maximization: a potential adopter will observe the experiences of other people to gather enough information before making a decision on whether or not to adopt the technology. More actively, social learning implies a process by which observation, communication and tutoring improve the skills of the individual in using the system.

A third possible source of social influence comes from interactivity. An interactive innovation is an innovation where the likelihood of adoption depends on the number of others who have already adopted the innovation (Mahler & Rogers, 1999). This is sometimes called *network effects* or *network externalities* in network analysis (Mallat, 2007). The telephone is a good example of an interactive innovation: if nobody else uses one, then it is useless. Mallat (2007) indicates that network externalities can have a positive effect in the adoption of mobile money services, depending on whether or not the system is perceived as having enough users.

These three mechanisms provide a perspective on the effect of social influences in adoption of mobile money that is based in the adoption of other people in the social network of a specific individual. Through the social contagion argument, when a peer of a person adopts mobile money or uses a particular services provided by the system, this person will be likely to copy this behavior, and hence will be more likely to adopt the system or a new services provided by mobile money. This is especially true for closer ties within the network. Through social learning, when a peer of a person adopts, this person will be observing and learning from the usage of his or her peer, and hence will be more likely to adopt mobile money as well. Finally, through the argument of interactivity, the more people in a person's network are using mobile money services, the more useful mobile money will be to this individual, since his or her peers may have financial exchange with the user as well.

These arguments, then, bring forth the two main hypotheses of this research:

Hypothesis 1: *the more peers adopt mobile money services within a person's social network, the more likely he or she will be to adopt mobile money.*

Hypothesis 2: *Given that a person adopted mobile money services, the more peers have also adopted mobile money, the more varied his or her use of mobile money will be.*

Both hypotheses explore the role of social influences in adoption and use of mobile money services in a way that has never been done before. Thus, rather than trying to isolate the specific mechanisms acting over mobile money adoption and variety of use, this study focuses on testing the existence of an effect of peer adoption. Similarly, and in order to connect with the previous works on mobile money adoption research, this study also considers variables that have been proved to predict adoption and use of these services, with a special interest in two of the most common variables in the literature: the TAM variables of PEOU and PU.

Next chapter presents the methodology of a research carried out in Uganda to test the effect of peer adoption on the adoption of mobile money services and the validity of the hypotheses presented above.

Chapter Three

Methods

Data collection for this research occurred in May 2015 in the context of the project 'Changing the Mindset of Ugandan Entrepreneurs: From Muppets to Gazelles' funded by the Netherlands Organization for Scientific Research (NWO). It is the first of a two stage process to characterize social network influences on mobile money adoption in Uganda. The first stage focuses on urban adoption and the second in the rural context, and will be explored in a future research.

A survey based study was designed and carried out in urban Uganda, more specifically in Wakiso district in central Uganda. This district was purposely selected as it is the largest district of the country (second only in population to the city of Kampala), and it has the largest urban area of all, with a highly urbanized and accessible population.

The development of the survey included a back-and-forth process with pilot testing in order to hone the questionnaire and evaluate whether or not they were reliable and valid in the Ugandan context.

Data collection was done by six trained Ugandan interviewers who visited participants' homes and collected all information using the SurveyGizmo tool (SurveyGizmo, 2006) in tablet computers.

Pre-Study Preparation

A first version of the survey was tested in late April by three researchers, the author of this thesis and two more interviewers who participated in the final data collection. The main idea was to test the online survey tool, the flow of the interview, and detect possible issues with the scales. Data collection took place in different areas of Kampala (Mengo, Kira, Kireka, Kyaliwajjala, Luzira, and Kyambogo) by approaching bystanders who agreed to be interviewed. In total, twenty data points

were collected, and analyzed by looking at descriptive statistics. The original version of this survey included, among other variables, personality measures. After testing two different personality scales, however, these were removed from the survey due to high levels of social desirability in the answers. Other scales included in the instrument were deemed to be effective and suffered only small modifications.

Once the instrument was finished, six interviewers were selected and trained for a day and a half in the usage of the tablet computers, the objectives of the data collection, and general techniques for managing the interviews (probing, facilitation, etc.). All interviewers had some previous experience with social research.

Sampling

The sample was selected using a multistage cluster process. Uganda is divided hierarchically in administrative units starting with regions (Central, Western, Eastern, and Northern) and within those regions, districts. Urban districts are divided in municipalities, divisions, wards, and cells or sub-wards.

Simple randomization was used to select one municipality within the Wakiso district, one division within the selected municipality, one ward within the selected division, and finally a fully randomized list of sub-wards. From this list, the first five sub-wards were selected for the data collection. If for any reason the sub-ward could not be accessed, then it was skipped and the next one was considered. Within each sub-ward, a systematic sampling of 50 participants was done based on the sub-ward's population, as provided by the sub-ward's local council. This resulted in a sample size was 250. One person per household was interviewed as long as they were above 16 years old. The selection of the individual within the household was by convenience: if the person that opened the door was over 16 years old, he or she would be asked to participate, if not, interviewers would ask for an adult/caretaker to participate. As data collection occurred during the day in workdays, it was not very common to find more than one person in each household.

In order to reduce bias, a true randomization tool developed by Haar (1998) was used in each stage. A summary of the results of this randomization process can be seen in Table 1.

TABLE 1: RESULTS FROM THE SIMPLE RANDOMIZATION PROCESS. VISITED AREAS IN UGANDA ARE BOLDED.

Stage 1: Municipality	Stage 2: Division	Stage 3: Ward	Stage 4: Sub-wards
1. Kakiri	**1. Division A**	**1. Central**	**1. Bugongo**
2. Wakiso	**2. Division B**	**2. Katabi**	**2. Kakeeka**
3. Entebbe MC			**3. Kitaasa**
4. Kira			**4. Lunyo central**
5. Nabweru			**5. Nakasamba**
			6. Nakiwogo
			7. Nsamizi
			8. Post office
			9. Virus
			Randomized Number List:
Random Number: 3	**Random Number: 1**	**Random Number: 1**	**7, 5, 8, 4, 6, 9, 3, 8, 2.**

Procedure

Team leaders approached the sub-ward local council chairperson for permission to work in his or her constituency and receive the sub-ward registers which included all households in the community. Local council chairpersons were approached in the order determined by the randomization process.

Two sub-wards had to be skipped despite of being among the initial five selected, Lunyo central and Virus, because the former had a non-cooperative chairperson, and the latter's was absent at the moment of the data collection. Kitaasa, the last sub-ward in the randomization list, had a limited number of household (20), as most inhabitants of this sub-ward live in the city's army barracks, which were included in the data collection for this location.

Using the number of households of each sub-ward, the n^{th} household was selected for interview in order to get the 50 cases required. Table 2 summarizes the final sampling results.

Interviews were conducted in the language most comfortable for the participant. Used languages included Swahili, English, Luganda and Runyankole. All participants were given a paper notebook to reward their collaboration with the study.

TABLE 2: RESULTS FROM THE STRUCTURED SAMPLING PROCEDURE BY SUB-WARD.

Sub-ward	Total Households	Selected n^{th} number
Nakiwogo	576	11^{th}
Post Office	150	3^{rd}
Nsamizi	400	8^{th}
Nakasamba	100	2^{nd}
Kitaasa	20 + Army Barracks	

During the data collection, 47 of the initially sampled household refused to participate in the study. Some of the reasons for non-cooperation were the fact that the household head was not around and the potential participant wasn't authorized to talk to strangers; lack of time or being busy at the moment of the interview; and some people refused to continue the interview after being asked about some demographics (e.g. age). If a household was found to have no individual to interview or a non-cooperative individual, then the next household was considered for interviewing.

At the end of the data collection, a total of 249 interviews were finished, but issues with internet access and human errors by the interviewers caused that 47 surveys were lost or partially completed. These broken data points were excluded from further analysis. The final number of valid interviews is, then, 202.

TABLE 3: NUMBER OF PARTICIPANTS BY SUB-WARD.

Sub-ward	Frequency	Percent
Nakiwogo	34	16.8
Post Office	29	14.4
Nsamizi	48	23.8
Nakasamba	48	23.8
Kitaasa	43	21.3
Total	**202**	**100**

Research Instrument

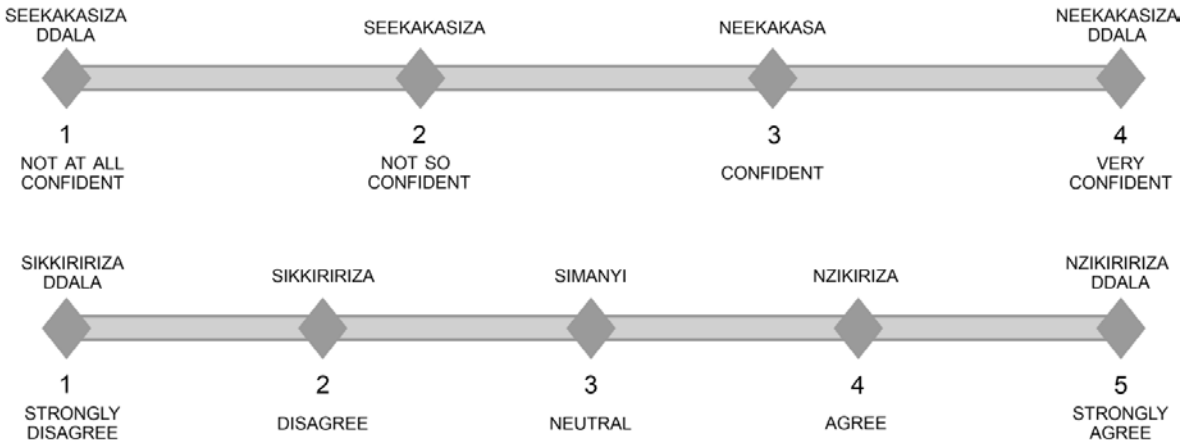
The questionnaire used in this research was divided in multiple sections: general information, that inquired about the participants' demographics; information about mobile money account, that explored whether the participant has or not an account and since when; questions specific for non-adopters, that explored reasons for not adoption and intention to adopt; questions about mobile

money usage for adopters; perceptions about mobile money; personal characteristics; and network characteristics.

The instrument was available in both English and Luganda, the main spoken language in Central Uganda. The translation was carried out by a certified translator who helped adapting it not only by providing a literal translation, but also one that would be culturally meaningful. Many English words do not have an exact counterpart in Luganda, so an item by item discussion with the local research team and interviewers was necessary to arrive to a final version. The questionnaire was never shown to the participant, but the Luganda translation ensured that the same instructions were given to all participants.

Another cultural adaptation of the instrument for this research had to do with the items of Likert scales: during the pilot, many participants had difficulties to specify the degree to which they would agree or disagree with these items without any visual clue. As such, two visual scales were developed and provided for the participants to point out when they were inquired about such items. Figure 1 shows said scales.

FIGURE 1: FOUR-POINT AND FIVE-POINT VISUAL SCALES THAT INTERVIEWERS SHOWED PARTICIPANTS TO HELP THEM IN ANSWERING ITEMS OF LIKERT SCALES.



Dependent Variables

Mobile Money Adoption

Hypothesis 1 deals with the decision of using or not mobile money. The single choice question "do you currently use mobile money?" was asked to participants of the study, with the possible answers being "yes" and "no".

Variety of Use of Mobile Money

Variety of use was measured considering the different services available for mobile money in Uganda at the time of the data collection. Participants were asked whether they use or not the following services: buy airtime, receive money, send money, deposit / withdraw money, store / save money, pay for goods / receive payment for goods, pay for bills (TV, YAKA, water, etc.) / pay school fees, and transfer money to/from bank account. Ndiwalana, Morawczynski, and Popov (2010) used a similar list of transaction types to describe the usage of mobile money in the country. In their survey results, they find that the most used services are, in descending order, buy airtime for self, send money, receive money, buy airtime for another person, receive payment for goods, pay for goods, pay school fees, pay bills, transfer money to bank account, and transfer money from bank account.

The data from Ndiwalana et al. (2010) and the results obtained during the pilot testing of this study suggest that there is a hierarchy in the probability of an individual to use the services available in mobile money. In other words, a user who accesses more 'difficult' services (e.g. pay for bills or transfer money from/to bank account) is likely to use the 'easier' services as well (e.g. buy airtime). If this claim holds, then the total sum of services used by an individual provides a fair representation of the kind of adopter the person is, with regards to his or her use of the system.

A simple yet sound way to assess the unidimensionality of the scale and its validity to measure the latent trait (i.e. variety of use) is through the Mokken scale analysis (Gillespie, Tenvergert, & Kingma, 1987). A Mokken scale is a non-parametric, probabilistic analysis based in the item response theory and Guttman scaling (van Schuur, 2003). The end result of the analysis is a measure of homogeneity for the scale (H) and each item (Hi), and test-retest reliability (ρ).

Recommended values for H and H_i go as follow: $H < 0.3$ suggest no scale, $0.3 < H < 0.4$ suggest a weak scale, $0.4 < H < 0.5$ suggest a medium scale, and $H > 0.5$ suggest a strong scale (Gillespie et al. 1987). With regards to reliability, $\rho > 0.7$ is suggested (Watson, Wang, Ski, & Thompson, 2012).

Mokken scaling is based in a specific relationship between the items and latent traits based in the assumption of double monotonicity. In this model, items must conform to the following assumptions: they must measure a latent unidimensional trait; they must be locally stochastically independent; the probability of a positive response must be a monotonously non-decreasing function of the latent scale value; and item response functions must not intersect (Matzat, 2001). To test these assumptions, the following procedure must be taken: first, check the H-value for the whole scale and pair of items in such a way that they suggest scaling (as mentioned above); analyze the P++ and P-- matrices; and check the success probabilities of two item steps for different restscore groups. In the current study, the scale was tested using the software MSPWIN version 5.0 (Molenaar & Sijtsma, 2000).

If all items are considered, there is a weak scaling and reliability, and not all assumptions are met. In order to account for this, the item "send money" is excluded, which increases all H coefficients to $H > 0.40$, which suggest a medium/medium-strong scale. Likewise, analysis of P++ and P-- matrices by ensuring that columns increase and decrease respectively, showed no violation of the model assumptions. Finally, automated analysis of restscore groups done by the software showed no violations. Table 4 presents the result of the Mokken scaling for variety of use. The final measure for variety of use does not consider the use of sending money with the mobile money service.

TABLE 4: RESULTS OF MOKKEN SCALING FOR ITEMS IN VARIETY OF USE. ANALYSIS WAS RUN TWICE, EXCLUDING IN THE SECOND RUN THE ITEM "SEND MONEY".

	Mean	First Run H_i coefficient	Final Result H_i coefficient
Receive Money	91%	.29	.45
Send Money	87%	.18	Excluded
Deposit Money	85%	.30	.41
Buy Airtime	73%	.39	.45
Pay Bills	29%	.29	.42
Pay Goods	20%	.20	.46
Bank Transfers	6%	.53	.59
Scale H		.36	.45
Scale ρ		.58	.61

Independent Variable

Peer Adoption

Accessing personal network data can be difficult and sometimes unmanageable; Campbell and Lee (1991) highlight that it's not as simple as asking 'who do you know?' as adults can sometimes name upward 1,500 acquaintances. A common survey method to deal with this problem is the so called name-generator method. This approach has been used before in Uganda to explore the influence of network structure on innovative performance in entrepreneurs (Rooks, Szirmai, & Sserwanga, 2012). The process is relatively straightforward: first, participants are asked 'Looking back over the last six months – who are the people whom you have discussed important matters with? Think of people in your family, in your work, your friends, etc. It can be anyone who you talked recently and whose opinion you consider to be important'. Second, the participant is questioned about specific characteristics of each individual he or she named.

A common practice in the usage of name-generators is limiting the number of contacts a person can give, as limiting the number of alters is a standard way to cope with time constraints in a survey while maintaining measurement precision and minimizing measurement bias. For purpose of this study, the name-generator was limited to ten names.

Several questions were asked to the participant for each contact in the name-generator, this study will consider only the following: 'what kind of relationship you have with this person' (family, friend, other), and 'does this person uses mobile money' (yes/no/I don't know).

Peer adoption was calculated by the total sum of people within the network that were reported to use mobile money.

Control Variables

Several variables are included to control for possible cofounding effects. These variables were selected considering existing literature on mobile money adoption.

Income

The amount of money that an individual receives periodically is expected to have some influence on mobile money adoption. Crabbe, Standing, Standing, and Karjaluoto (2009) find that income had an influence in the sustained use of mobile banking in Ghana. As mobile money is a financial service, users with a higher income are expected to have more possibilities to use the system and in more varied ways. Additionally, as stated before by Farrar (2012), Uganda suffers from high inequality, so controlling for income allows accounting for the effects derived from it.

Income was measured by asking the question "What is your current average monthly income?" In order to control for social desirability and privacy, the participant was not asked to provide the exact amount, but was given the following brackets: 0-100,000 UGX; 100,001-250,000 UGX; 250,001-500,000 UGX; 500,001-1,000,000 UGX; 1,000,001-2,000,000 UGX; > 2,000,000 UGX.

English Literacy

In Uganda, mobile money services are only provided in English and through a text-based interface using the USSD protocol. In a study of design gaps of mobile money in the country, Baguma (2013) highlights English literacy as one of the main factors by which low-literate users abandon or reject the system. Likewise, Medhi, Ratan, and Toyama (2009) study the effect of low-literacy in adoption and use of mobile money services in multiple countries, and find that these types of user

have barriers not only in understanding and sending messages to the service, but also in navigating through the different menu options.

English literacy was measured by the single self-report question "How well can you read English?" In order to control for social desirability, the participant was given the following options: not at all, a little, good, very good. The variable was later dichotomized before including it in the analysis.

First Use of Mobile Money

As stated by Rogers (2003), time of adoption is a major component to be considered when analyzing any diffusion process. People who adopt early have had more time to experiment, interact, and familiarize themselves with the system. Additionally, innovators and early adopters tend to have higher levels of personal innovativeness (Rogers, 2003) than late adopters, which according to Shih and Venkatesh (2004) is associated with a different profile of use of the system: people with more personal innovativeness tend to present a higher variety of use.

First use of mobile money was asked to participants who currently use mobile money with the question "What year did you first start to use mobile money?"

Network Size

The size of the network is the number of unique contacts mentioned by the participant, being in this study zero the minimum and ten the maximum. Controlling for network size allows isolating the effect of peer adoption.

Personal Innovativeness

Personal innovativeness is defined by Kim et al. (2010) as the inclination of an individual to try out any new information system. Yi, Fiedler, and Park (2006) found that domain specific personal innovativeness predicts the adoption of IT innovations. Personal innovativeness was measured using three items in a five-point Likert Scale developed by Kim et al. (2010). Score is calculated by taking a simple sum of all items.

A reliability analysis of the scale resulted in Cronbach's $\alpha = 0.572$, item correlations with the total scale ranging from 0.781 to 0.666, and inter-item correlations ranging from 0.474 to 0.260.

Perceived Risk

The perceived risk model assumes that consumer act to minimize any expected negative utility associated with the adoption behavior (Yang et al., 2012). In the literature review done by Shaikh and Karjaluoto (2015), perceived risk was one of eight most common independent variables used to predict adoption of mobile banking systems. Perceived risk was measured using a three item five-point Likert Scale developed by Yang et al. (2012). Score is calculated by taking a simple sum of all items.

A reliability analysis of the scale resulted in Cronbach's $\alpha = 0.684$, item correlations with the total scale ranging from 0.742 to 0.837, and inter-item correlations ranging from 0.433 to 0.627.

Mobile Phone Skills

One of the main arguments against TAM-like models is that the antecedents for the perceptions of usability and usefulness are often ignored (Benbasat & Barki, 2007). In this sense, one possible antecedent that has not been studied very often in the literature of mobile money adoption, but that it is theorized to be important, is the ability to use the technology (i.e. mobile phone) needed to access the services. Mac Callum, Jeffrey, and Kinshuk (2014) explore the influence of mobile literacy and ICT literacy in the adoption of mobile learning, finding both mediated and direct effects in the intention to adopt this kind of systems.

In order to test the participant's actual mobile phone skills, instead of the users' perceptions, a 12 item scale was developed based on the Actual Digital Skills questionnaire developed by the European Computer Driving Licence (ECDL) in their 2009 report on digital literacy (ECDL, 2009). The instrument focuses on personal computer skills, and includes questions like "Which one of the following is a portable storage device?" and "Where would you click to attach a file to an email?" The version developed for this study focuses on mobile phone skills, with questions about hardware ("Which of these is most likely failing if your phone loses power quickly?") and software alike ("You want to send a picture from your phone to a friend, which of these systems does not allow you to do that?"), with various degrees of difficulty. All items had five possible options, only one of which is correct. Participants had the option to say they don't know the correct answer. At

the end of the survey, all answers were recoded to 'correct' or 'incorrect'. The full list of this scale's items and choices can be seen in the appendix.

A pilot was done to evaluate the performance of the scale, collecting ten data points. No major issues were identified in the flow or in any of the questions' clarity, so the instrument didn't suffer any modifications.

Like with variety of use, validity and reliability of the instrument was checked using a Mokken scale analysis.

When all items are considered, the assumptions for Mokken scaling are not met. MSPWIN suggested the removal of three items, which increases all H coefficients to H > 0.35, which suggests a weak/weak-medium scaling. Analysis of P++ and P-- matrices shows three points of intersection (see Table 5 and Table 6). The violations coefficients were, however, small. Minimum violations in the analysis were set at 0.03, and resulted non-significant at $\alpha = 0.05$, which suggests that these violations can be explained by chance. Finally, automated analysis of restcore groups done by the software showed no violations.

TABLE 5: P-- MATRIX FOR THE SECOND RUN OF MOBILE PHONE SKILLS SCALE SHOWING PROBABILITIES FOR ALL PAIRED ITEM STEPS. VIOLATIONS ARE SHOWN IN RED AND BOLDED. FOR A FULL DESCRIPTION OF THE ITEMS, PLEASE SEE THE APPENDIX.

		It. 6	It. 9	It. 10	It. 12	It. 1	It. 3	It. 5	It. 4	It. 8
		0.91	0.86	0.81	0.55	0.51	0.28	0.17	0.06	0.04
	1-P									
Item 6	0.91		0.8	0.75	0.51	0.48	0.27	0.17	0.06	0.04
Item 9	0.86	0.8		0.73	**0.54**	0.48	**0.28**	0.17	0.06	0.04
Item 10	0.81	0.75	0.73		0.5	0.46	0.27	0.17	0.06	0.04
Item 12	0.55	0.51	0.54	0.5		0.3	0.22	0.14	0.06	0.03
Item 1	0.51	0.48	0.48	0.46	0.3		0.21	0.14	0.05	0.03
Item 3	0.28	0.27	0.28	0.27	0.22	0.21		0.11	0.05	0.02
Item 5	0.17	0.17	0.17	0.17	0.14	0.14	0.11		0.06	0.02
Item 4	0.06	0.06	0.06	0.06	0.06	0.05	0.05	0.06		0
Item 8	0.04	0.04	0.04	0.04	0.03	0.03	0.02	0.02	0	

TABLE 6: P++ MATRIX FOR THE SECOND RUN OF MOBILE PHONE SKILLS SCALE SHOWING PROBABILITIES AND ESTIMATION OF RELIABILITY (MARKED *). VIOLATIONS ARE SHOWN IN RED AND BOLDED. FOR A FULL DESCRIPTION OF THE ITEMS, PLEASE SEE THE APPENDIX.

		It. 6	It. 9	It. 10	It. 12	It. 1	It. 3	It. 5	It. 4	It. 8
	P	0.09	0.14	0.19	0.45	0.49	0.72	0.83	0.94	0.96
Item 6	0.09	0.03*	0.03	0.04	0.05	0.06	0.09	0.09	0.09	0.09
Item 9	0.14	0.03	0.05*	0.06	0.13	0.11	0.14	0.14	0.14	0.14
Item 10	0.19	0.04	0.06	0.09*	0.14	0.14	0.19	0.19	0.19	0.19
Item 12	0.45	0.05	0.13	0.14	0.25*	0.24	0.39	0.41	0.44	0.44
Item 1	0.49	0.06	**0.11**	0.14	0.24	0.29*	0.43	0.45	0.48	0.48
Item 3	0.72	0.09	0.14	0.19	0.39	0.43	0.60*	0.66	0.71	0.71
Item 5	0.83	0.09	0.14	0.19	0.41	0.45	0.66	0.75*	0.82	0.81
Item 4	0.94	0.09	0.14	0.19	0.44	0.48	0.71	0.82	0.90*	0.9
Item 8	0.96	0.09	0.14	0.19	0.44	0.48	0.71	0.81	0.9	0.93*

Table 7 presents the result of the Mokken scaling for mobile phone skills. The final scale contains a high homogeneity and reliability. The final score is calculated by a simple sum of all correct answers.

TABLE 7: RESULTS OF MOKKEN SCALING FOR ITEMS IN MOBILE PHONE SKILLS. FOR A FULL DESCRIPTION OF THE ITEMS, PLEASE SEE THE APPENDIX. ANALYSIS WAS RUN TWICE, EXCLUDING IN THE SECOND RUN ITEMS 7, 2, AND 11.

		First Run	Final Result
	Mean	H_i coefficient	H_i coefficient
Item 8	96%	.46	.45
Item 2	94%	.62	.69
Item 5	83%	.53	.64
Item 7	82%	.29	Excluded
Item 3	72%	.56	.61
Item 1	49%	.35	.37
Item 12	45%	.41	.4
Item 10	19%	.45	.54
Item 2	16%	.35	Excluded
Item 9	14%	.53	.56
Item 6	9%	.34	.37
Item 11	2%	.54	Excluded
Scale H		.44	.50
Scale ρ		.73	.72

TAM variables

As most research on adoption of mobile money has been done using TAM-like models, it was deemed necessary to control for these variables as well. Both PEOU and PU were measured with four items in a five-point Likert scale, the former based in Faqih and Jaradat (2015) and the latter in Shaw (2014). Score of both scales are calculated by a simple sum of all items.

In order to ensure reliability, discriminability, and validity, a confirmatory factor analysis is carried out following the oblique multiple group (OMG) method, as suggested by Stuive, Kiers, Timmerman, and Berge (2008). This method looks at correlations between items and subscales, controlling for autocorrelation. The first step is to construct subtests by taking simple sums of the items that are assigned to the same subset. Next, the correlation of each item with each subtest is computed. The highest correlation indicates to what subtest the item should be assigned to. Autocorrelation is corrected by computing the correlation between an item and the sum of all items that belong to the subset, except for that specific item.

All items correlate significantly with both subscales, and in the case of PEOU4 and PU1, both of these items have their highest correlation with the opposite subscales. For this reason, these two items are excluded in the calculation of the final scores.

TABLE 8: CORRELATIONS BETWEEN ITEMS AND PEOU AND PU SUBSCALES. BOLDED COEFFICIENTS SHOW TO WHICH SUBSCALE THE OMG ANALYSIS SUGGEST THE ITEM IS ASSIGNED TO. RED COEFFICIENTS REPRESENT ITEMS WITH THE HIGHEST CORRELATION ON THE OPPOSITE SUBSCALE. * SIGNIFICANT WITH $P < 0.001$.

Item	PEOU Subscale	PU Subscale
PEOU1	**.480***	.424*
PEOU2	**.444***	.237*
PEOU3	**.600***	.442*
PEOU4	.485*	**.619***
PU1	**.434***	.418*
PU2	.489*	**.549***
PU3	.440*	**.520***
PU4	.328*	**.532***

OMG analysis does not produce model fit indices, but according to a comparison of this method with confirmatory common factor method done by Stuive et al. (2008), both produce similar results, with OMG being better to verify whether an item assignment is correct or incorrect.

Without considering the excluded items, reliability analyses of PEOU and PU scales resulted in Cronbach's $\alpha = 0.631$, item correlations with the total scale ranging from 0.415 to 0.499, and inter-item correlations ranging from 0.302 to 0.415 for the former; and Cronbach's $\alpha = 0.696$, item correlations with the total scale ranging from 0.492 to 0.535, and inter-item correlations ranging from 0.404 to 0.461 for the latter.

Means of Analysis

In order to test the hypotheses, this study builds several regression models. For each hypothesis, first, a baseline regression is built in which all the control variables are included. In a second step, the predictor (peer adoption) is added to the model. The changes in coefficients and significance are compared and used as evidence of the effect of the independent variable. A similar approach is used by Bandiera and Rasul (2006) to measure the effect of social learning through peers on agricultural technology adoption in rural Mozambique.

Hypothesis 1 is modeled with binary logistic regression, and hypothesis 2 with multiple linear regression.

Chapter Four

Results

This chapter presents both a descriptive summary of the data collected and the regression models that test the validity of the hypothesis.

Descriptive Results

Demographics

From the total of 202 participants, 55% were female. Age ranged from 16 to 73 years, with an average of 32 years (*SD_age* = 12 years). Most participants (48.5%) were in the income bracket of 0-100,000 UGX (less than 30 EUR a month), but all income levels were accounted for, with people earning 1,000,000-2,000,000 UGX being the less represented (2.5%). The majority of participants (81.3%) finished at least secondary education. Likewise, a 60.9% of the participants were employed or self-employed. A 36.1% of them reported to not being able to read English and 106 participants (52%) reported to have a bank account. Table 9 presents a summary of the sample's demographics.

Networks

Network sizes ranged from 1 to 10, with an average size of 5.985 (*SD_networkSize* = 2.242). The average number of peers that have adopted mobile money for each network was 4.210 (*SD_peerAdoption* = 2.218), ranging from no adopters, to all peers having adopted. Most of these adopters (51%) were family contacts, followed by friends (36%), and other contacts (13%). Table 10 summarizes the descriptive statistics of the network measures.

TABLE 9: FREQUENCY TABLE FOR PARTICIPANTS' DEMOGRAPHICS. NOTE THAT N = 202.

Descriptive	Total	Percentage
Gender		
Male	91	45
Female	111	55
Education		
None	9	4.0
Primary	32	14.4
Secondary	92	45.0
College or University	66	32.7
Postgraduate	9	4.0
Occupation		
Unemployed	33	16.3
Student	18	8.9
Stay at home wife/husband	28	13.9
Employed	90	44.6
Self-employed	33	16.3
Average monthly income		
0-100,000 UGX	98	48.5
100,001-250,000 UGX	27	13.4
250,001-500,000 UGX	35	17.3
500,001-1,000,000 UGX	30	14.9
1,000,001-2,000,000 UGX	5	2.5
> 2,000,000 UGX	7	3.5
Age		
16-25 years old	54	27
26-35 years old	77	38
36-45 years old	36	18
46-55 years old	7	6
> 56 years old	13	11

TABLE 10: DESCRIPTIVE STATISTICS FOR NETWORK VARIABLES INCLUDED IN THIS STUDY. NOTE THAT N = 202.

	M	SD	Min	Max
Network Size	5.985	2.242	1	10
Peer Adoption	4.210	2.218	0	10
Adopters: Family	2.138	1.678	0	8
Adopters: Friends	1.505	1.599	0	7
Adopters: Others	.524	.957	0	5

Mobile Money Services

Of the 202 participants, 173 reported to currently use mobile money. The average year of starting to use the system is 2011 (*SD_firstUse* = 2.685), ranging from 2002 to 2015. It is important to note that although mobile money services were officially launched in Uganda in 2009, the existence of M-PESA agents in the country and other international services makes it possible for a very motivated user to have started with the system before the official date of launch. And indeed, only eight participants (4.6%) reported to have used mobile money before 2007.

Of all participants that reported to currently use mobile money, 23 of them did not have an active mobile money account. This is because for sending and receiving mobile money a person does not necessarily need to have an active account, and because many mobile money "users" actually do all transactions through the accounts of family and friends.

Only three of the mobile money services were accounted for in this study: MTN with 129 users, Airtel with 62, and M-Sente with 4.

When it comes to specific mobile money services, all services were used by some subset of the sample. In descending order of popularity in this study: receiving money (154), sending money (148), depositing or withdrawing money (145), buying airtime (123), storing or saving money (87), paying for bills (49), receiving payment for goods (35), and transferring money from and/or to a bank account (11).

Other Measurements

A summary of the descriptive statistics for the total scores of perceived risk, personal innovativeness, mobile phone skills, PEOU, PU, and variety of use can be seen in Table 11.

With regards to variety of use of mobile money, there were nine participants who scored zero in the scale, that is, they didn't use any of the specific services of the system, despite of having a mobile money account and reporting to use the system. On the other hand, there were six participants who reported to use all mobile money services. Most participants (134), however, ranged from two to four uses of the system.

TABLE 11: DESCRIPTIVE STATISTICS FOR FINAL SCORES OF DIFFERENT SUBSCALES INCLUDED IN THIS STUDY. NOTE THAT N = 202 FOR ALL VARIABLES EXCEPT VARIETY OF USE, WHICH HAS N = 173.

	M	SD	Min	Max
Perceived risk	.990	2.742	-6.0	6.0
Personal innovativeness	-.113	2.294	-5.0	6.0
Mobile phone skills	4.841	1.791	0.0	9.0
Perceived usefulness	2.381	1.969	-6.0	6.0
Perceived ease of use	2.351	1.944	-6.0	6.0
Variety of use	2.988	1.298	0.0	6.0

Correlations

As shown in Table 12, mobile money adoption correlates positively with education, English literacy, mobile phone skills, PEOU, PU, peer adoption in general, and friends and family adoption specifically. On the other hand, variety of use correlates with income, education, English literacy, mobile phone skills, personal innovativeness, PU, peer adoption in general, and friends and other ties' adoption specifically. These results suggest that the selection of control and independent variables are relevant for the prediction of the dependent variables, and provide evidence for proceeding further with the analysis.

Some of the relationships between predictors are expected, for example, English literacy, education, and income all correlate with each other; but others are less evident. Consider first PEOU and PU: as stated in the OMG analysis, these two variables correlate with each other, which should not be the case according to the original formulation of TAM. However, this observation is not without precedents in the study of mobile money, for example, Kim et al. (2010) find a relationship between these two variables while studying intention to use mobile payments in South Korea. Another interesting relationship in the present study is that while mobile phone skills correlates with English literacy, income, and education, it does not seem to have any relationship with PEOU, PU, or perceived risk, which suggest that perceptions of mobile money are not affected by how savvy the individual is with his or her mobile phone. Finally, it is worth to note that the quality of the ties, that is, the kind relationship that exists between the participant and the adopters in his or her network, seems to be relevant, as different kind of ties correlate differently with mobile money adoption and variety of use.

TABLE 12: BIVARIATE CORRELATION TABLE FOR ALL VARIABLES USED IN THE STUDY. BOLDED CELLS ARE SIGNIFICANT CORRELATIONS AT P < 0.05.

	Adoption	Variety of use	Income	Education	English Literacy	Network Size	Mob. Phone Skills	PI	Risk	PEOU	PU	Peer Adoption	Family Adoption	Friends Adoption	Other Ties Adoption
Adoption	1														
	202														
Variety of use		1													
		173													
Income	.077	**.304**	1												
	.273	**.000**													
	202	**173**	202												
Education	**.314**	**.328**	**.395**	1											
	.000	**.000**	**.000**												
	202	**173**	**202**	202											
English Literacy	**.309**	**.267**	**.274**	**.586**	1										
	.000	**.000**	**.000**	**.000**											
	202	**173**	**202**	**202**	202										
Network Size	-.053	.116	.090	**.200**	.110	1									
	.452	.127	.201	**.004**	.119										
	202	173	202	**202**	202	202									
Mob. Phone Skills	**.414**	**.291**	**.203**	**.536**	**.406**	**.143**	1								
	.000	**.000**	**.004**	**.000**	**.000**	**.042**									
	202	**173**	**202**	**202**	**202**	**202**	202								
PI	.010	**.168**	.059	.113	.062	-.030	.106	1							
	.882	**.027**	.403	.110	.384	.669	.134								
	202	**173**	202	202	202	202	202	202							
Risk	.087	-.143	.041	**.149**	.121	.054	.126	-.069	1						
	.218	.060	.561	**.035**	.085	.448	.075	.332							
	202	173	202	**202**	202	202	202	202	202						
PEOU	**.271**	.119	**.224**	**.179**	.078	**-.139**	.135	.098	.000	1					
	.000	.119	**.001**	**.011**	.271	**.048**	.056	.164	1.000						
	202	173	**202**	**202**	202	**202**	202	202	202	202					
PU	**.302**	**.263**	**.194**	**.217**	.125	-.112	.127	**.247**	-.119	**.440**	1				
	.000	**.000**	**.006**	**.002**	.076	.111	.071	**.000**	.091	**.000**					
	202	**173**	**202**	**202**	202	202	202	**202**	202	**202**	202				
Peer Adoption	**.251**	**.272**	**.168**	**.351**	**.227**	**.676**	**.285**	-.054	.065	-.056	.046	1			
	.000	**.000**	**.017**	**.000**	**.001**	**.000**	**.000**	.444	.357	.431	.514				
	202	**173**	**202**	**202**	**202**	**202**	**202**	202	202	202	202	202			
Family Adoption	**.152**	.015	-.024	.102	.038	**.390**	.031	.048	.050	-.024	.043	**.535**	1		
	.031	.849	.732	.150	.595	**.000**	.666	.497	.480	.733	.547	**.000**			
	202	173	202	202	202	**202**	202	202	202	202	202	**202**	202		
Friends Adoption	**.156**	**.211**	.035	**.269**	**.206**	**.390**	**.280**	-.060	-.010	-.054	-.012	**.585**	**-.236**	1	
	.027	**.005**	.624	**.000**	**.003**	**.000**	**.000**	.395	.884	.444	.860	**.000**	**.001**		
	202	**173**	202	**202**	**202**	**202**	**202**	202	202	202	202	**202**	**202**	202	
Other Ties Adoption	.062	**.227**	**.378**	**.194**	.122	**.249**	**.147**	-.111	.082	.002	.054	**.430**	-.104	.115	1
	.378	**.003**	**.000**	**.006**	.084	**.000**	**.036**	.117	.244	.978	.443	**.000**	.140	.103	
	202	**173**	**202**	**202**	202	**202**	**202**	202	202	202	202	**202**	202	202	202

Hypothesis Testing

Hypothesis 1

Logistic regression was conducted to assess the effect of peer adoption on mobile money adoption. When only control variables were considered, they significantly predict the adoption of the services, with $\chi^2 = 64.152$, df = 8, N = 202, $p < 0.001$. By adding peer adoption, the predictive power of the model increases significantly, with change of $\chi^2 = 20.140$, df = 1, $p < 0.001$.

The effect of peer adoption on mobile money adoption can also be seen by comparing the classification tables: overall prediction increases from 88.1% in the model with only control variables to 91.6% with peer adoption. Table 13 presents both classification tables.

TABLE 13: CLASSIFICATION TABLE FOR LOGISTIC REGRESSIONS WITH CONTROL VARIABLES (MODEL 1), AND WITH CONTROL VARIABLES AND PEER ADOPTION (MODEL 2). BOTH MODELS HAVE A CUT VALUE OF .500. N = 202.

	Predictions Model 1			Predictions Model 2		
Observed	No	Yes	% Correct	No	Yes	% Correct
No	12	17	41.4	17	12	58.6
Yes	7	166	96.0	5	168	97.1
Overall			**88.1**			**91.6**

From observation of the classification tables, an element to consider is that most of the incorrect predictions come from non-adopters. It is important to note the relative low amount of non-users in the sample (29 non users vs. 173 adopters).

Table 14 summarizes both two logistic regression models, presenting odd ratios, which suggest significant effects from peer adoption, network size, mobile phone skills, perceived usefulness and English literacy.

The statistically significant effect of peer adoption supports hypothesis 1, that is, the more peers have adopted mobile money within a person's network, the more likely he or she will be to adopt mobile money.

TABLE 14: COMPARISON OF MODELS OF LOGISTIC REGRESSION. MODEL 1 SERVES AS A BASELINE, AND MODEL 2 SHOWS THE EFFECTS OF PEER ADOPTION. N = 202.

	Model 1: Baseline Regression				Model 2: Peer Adoption			
	B	SE	Odds Ratio	p	B	SE	Odds Ratio	p
Constant	-1.435	.889	.238	.106	-1.145	.960	.318	.233
Income	-.362	.226	.697	.110	-.430	.249	.651	.084
English Literacy	1.412	.601	4.105	.019	1.461	.673	4.309	.030
Network Size	-.219	.120	.803	.068	-.734	.206	.480	.000
Mobile Phone Skills	.793	.190	2.210	.000	.851	.226	2.341	.000
Personal Innovativeness	-.103	.129	.902	.425	-.073	.150	.929	.625
Perceived Risk	.165	.101	1.180	.101	.124	.109	1.132	.255
PEOU	.151	.159	1.163	.342	.260	.178	1.297	.144
PU	.441	.172	1.554	.010	.457	.190	1.580	.016
Peer Adoption					.731	.188	2.077	.000
Cox & Snell R^2				**.272**				**.341**

Also important to note is that the effect of network size in the regression model only becomes significant when peer adoption is included, impacting adoption negatively, which suggest an interaction between peer adoption and network size. When peer adoption is not included, network size is not significant because it includes the effect of peer adoption within it (i.e. the number of adopters is also part of the network size). As peer adoption has a positive effect in adoption by the user, when it is included in the model, it takes that variance and shows that the influence of network size is negative.

Mobile phone skills, on the other hand, have a positive effect in mobile money adoption with or without considering the effect of peer adoption, and with regards to the traditional TAM variables, that is, PEOU and PU, only PU was found to be significant in the decision of adopting mobile money.

When looking at coefficients, it is possible to compare effect sizes of a logistic regression by standardizing them to Y, that is, mobile money adoption. Of the coefficients that resulted significant in the second model (i.e. including peer adoption), the largest is English literacy (0.423), followed by mobile phone skills (0.246), network size (-0.213), peer adoption (0.212), and finally PU (0.132).

Hypothesis 2

Multiple linear regression was conducted to assess the effect of peer adoption in the variety of use of a mobile money user. When only control variables were considered, they significantly predict variety of use, $F(9,163) = 7.267$, $p < 0.001$, adjusted $R^2 = 0.247$. When peer adoption is included to the regression model, the predictive power of the model increases to an adjusted $R^2 = 0.274$, $F(10,162) = 7.489$, $p < 0.001$, which represents a statistically significant change of $R^2 = 0.03$, $F(1,162) = 7.050$, $p = 0.009$. Table 15 summarizes these two multiple regression models.

TABLE 15: COMPARISON OF MODELS OF MULTIPLE LINEAR REGRESSION. MODEL 1 SERVES AS A BASELINE, AND MODEL 2 SHOWS THE EFFECTS OF PEER ADOPTION. N = 202.

	Model 1: Baseline Regression				Model 2: Peer Adoption			
	B	SE	β	p	B	SE	β	p
Constant	190.539	67.727		.006	171.683	66.882		.011
Income	.132	.066	.148	.046	.125	.064	.139	.055
English Literacy	.337	.206	.119	.104	.316	.202	.112	.121
First Use Mobile Money	-.094	.034	-.195	.006	-.085	.033	-.175	.012
Network Size	.057	.041	.096	.162	-.055	.058	-.092	.348
Mobile Phone Skills	.156	.057	.197	.007	.137	.057	.172	.017
Personal Innovativeness	.041	.038	.074	.281	.051	.037	.092	.175
Perceived Risk	-.072	.034	-.146	.032	-.077	.033	-.156	.020
PEOU	.024	.052	.033	.642	.032	.051	.043	.536
PU	.117	.054	.160	.032	.096	.054	.131	.076
Peer Adoption					.156	.059	.263	.009
R^2				**.286**				**.316**
Adjusted R^2				**.247**				**.274**

The statistically significant effect of peer adoption supports hypothesis 2, that is, the more peers that have adopted mobile money within the network of a user, the more varied his or her use of the system will be.

Unlike in the regression for predicting mobile money adoption, though, English literacy and network size have no significant effect in variety of use. On the contrary, income was not significant for mobile money adoption, but it is for variety of use when peer adoption is not considered. However, even in the model that considers peer adoption, income's significance is at

the "cutting point" ($p = 0.055$), which suggests that nevertheless it is an important determinant for how varied is the use of the system.

First use of mobile money has a negative effect in variety of use that is significant in both models. This means that the earlier a person has started to use mobile money, the more varied the use given by that user will be. Perceived risk behaves similarly: it is significant in both models and has a negative effect: the lower a user evaluates the risk of using mobile money, the more services he or she will use. It is important to note as well that risk was not a statistically significant predictor for adoption, but it is for variety of use.

Like with the testing of the previous hypothesis, mobile phone skills have a positive effect in mobile money adoption with or without considering the effect of peer adoption.

Another result that is important to note is the role of the traditional TAM variables in variety of use. There is a significant effect of PU in variety of use when peer adoption is not accounted for, but this effect becomes non-significant as soon the variable is added to the model. PEOU, on the other hand, remains non-significant for variety of use, just like it was not significant for adoption of mobile money.

Finally, when it comes to the effect sizes, the largest effect in predicting variety of use of mobile money comes from peer adoption ($\beta = 0.263$, $p = 0.009$), followed by first use of mobile money ($\beta = -0.175$, $p = 0.012$), mobile phone skills ($\beta = 0.172$, $p = 0.017$), perceived risk ($\beta = -0.156$, $p = 0.020$), and finally income ($\beta = 0.139$, $p = 0.055$).

Chapter Five

Exploring the Influence of Social Networks

The previous chapter provided evidence to support the claim that social networks, specifically peer adoption, have an effect on mobile money adoption and variety of use. However, the exact mechanisms by which peer adoption affects mobile money adoption and variety of use remain not defined. In order to address this issue, the following chapter presents two exploratory approaches to better understand the influence of social networks on mobile money adoption and variety of use.

Distinguishing Between Mechanisms

The regression models in Chapter 4 show the direct effects of peer adoption in both mobile money adoption and variety of use. As stated in Chapter 2, three ways by which social networks can affect adoption are social learning, interactivity or network externalities, and social contagion.

Support provided by social learning implies that an individual will increase his or her understanding of mobile money services by having access to people who he or she can observe and learn from, and that can even teach him or her. A person with a large network of adopters is then, more likely to have acquire the skills necessaries to use mobile money. It can be argued, then, that if the underlying mechanism for the influence of peer adoption on mobile money adoption and variety of use is social learning, then the system should be perceived as easier to use, as the user can easily access social capital in his or her network to correctly learn how to operate it.

On the other hand, if the underlying mechanism is instead interactivity, then the perceived usefulness of the system increases. An individual with a large network of adopters will have more opportunities of using the system, which in turn will make it more useful in his or her daily life.

A possible way to measure these indirect effects is by mediation analysis: if peer adoption has an effect in PEOU, and PEOU has an effect in mobile money adoption and/or variety of use, then it could be argued that a process of social learning was causing the direct effect of peer adoption in mobile money adoption / variety of use. Likewise, if peer adoption has an effect in PU, and PU has an effect in mobile money adoption and/or variety of use, then the direct effect of peer adoption is due to network externalities.

Social contagion, however, is harder to grasp, as the effect comes from exposure rather than a change in perception; individuals adopt because others have adopted. In the current study, it is not possible to test social contagion through mediating variables. Nevertheless, there exists a workaround, and is to look at the strength of the ties; differentiating peer adopters by their type of relationship with the participant prompts the influence of social contagion as a mechanism in the adoption and/or use of mobile money. As stated earlier in Chapter 2, social contagion tends to be stronger in homophilous communication, and the stronger the tie, the higher degree of homophily (Gatignon & Robertson, 1985).

Testing the Mechanisms

To test for the existence of mediation between peer adoption with PEOU and PU, the first step is to check for the existence of correlations between these variables. However, as it can be seen the results presented in Table 12 (to facilitate the reading, Table 16 is included below, and it shows only the coefficients and significance test between peer adoption with PEOU and PU), no significant correlation is found between the given variables. To proceed with a more robust statistical analysis is, thus, meaningless. No argument for social learning or network externalities as underlying mechanisms can be made.

TABLE 16: CORRELATION COEFFICIENTS FOR PEER ADOPTION WITH PEOU AND PU.

		PEOU	PU
Peer Adoption	Pearson's r	-.056	.046
	Significance	.431	.514

Given that neither social learning nor network externalities are mediating the effect of peer adoption in mobile money adoption and variety of use, the next step is to consider the type of ties to explore the role of social contagion. Granovetter (1973) differentiates two types of ties: strong ties and weak ties. The strength of a tie is a combination of the amount of time, emotional intensity, intimacy, and reciprocal services which characterize the tie. Strong ties bring social capital in the form of support and cohesion, but also tend to be redundant. In Granovetter's perspective, only weak ties can "bridge" between networks, giving access to new information.

A common approach to determine the strength of ties is to look at the relationship type. Family and friends are considered to be strong ties whereas colleagues (classmates or co-workers) and acquaintances tend to be weaker ties.

The regression models presented in the previous chapter are adapted to consider the relationship type between the participant and the adopters in his or her network. Instead of considering peer adoption in total, adopters are divided by relationship type: family, friends, and other contacts (work, education, acquaintances).

Adoption of Mobile Money

Table 17 presents the results of the model obtained in the previous stage, that is, considering peer adoption, and a third model that separates the adopters in different types.

No change in significance of any of the predictors occurs when the relationship type is accounted for. However, unlike family and friends (the two strongest social ties) other type of relationships (that is, weak ties) did not contribute to the decision of adopting mobile money.

When comparing the standardized coefficients, the first two remain the same, English literacy first (0.377), then followed by mobile phone skills (0.258), however, family adoption (0.242) and friends adoption (0.225) take precedence over network size (-0.214), while PU remains last (-0.214).

TABLE 17: COMPARISON OF MODELS OF LOGISTIC REGRESSION. MODEL 3 SEPARATES PEER ADOPTION BY THE TYPE OF RELATIONSHIP TO THE EGO. N = 202.

	Model 2: Peer Adoption				Model 3: Relationship Type			
	B	SE	Odds Ratio	p	B	SE	Odds Ratio	p
Constant	-1.145	.960	.318	.233	-1.318	1.004	.268	.189
Income	-.430	.249	.651	.084	-.342	.264	.710	.195
English Literacy	1.461	.673	4.309	.030	1.322	.666	3.753	.047
Network Size	-.734	.206	.480	.000	-.751	.209	.472	.000
Mobile Phone Skills	.851	.226	2.341	.000	.904	.242	2.471	.000
Personal Innovativeness	-.073	.150	.929	.625	-.088	.155	.915	.569
Perceived Risk	.124	.109	1.132	.255	.145	.113	1.156	.201
PEOU	.260	.178	1.297	.144	.233	.189	1.262	.219
PU	.457	.190	1.580	.016	.459	.194	1.582	.018
Peer Adoption	.731	.188	2.077	.000				
Family Adoption					.850	.228	2.339	.000
Friends Adoption					.788	.301	2.199	.009
Others Adoption					.323	.374	1.381	.388
Cox & Snell R^2				**.341**				**.346**

Variety of Use

Table 18 presents the results of the model obtained in the previous stage, that is, considering peer adoption, and a third model that separates the adopters in different types.

The reverse is opposite for this model: whereas adoption from weak ties has no influence in the decision of an individual to use mobile money services, variety of use is influenced by both friends and other type of relationships, but not families.

The fact that family adoption has an effect in the decision to adopt mobile money but not for the variety of use of the system supports the intuition presented above about social contagion. These results suggest that homophily is important in the decision making regarding the adoption, but less important in the process of using different services within the system.

The implications of these and the previous results are discussed in more depth during the next chapter.

TABLE 18: COMPARISON OF MODELS OF MULTIPLE LINEAR REGRESSION. MODEL 3 SEPARATES PEER ADOPTION BY THE TYPE OF RELATIONSHIP TO THE EGO. N = 202.

	Model 2: Peer Adoption				Model 3: Relationship Type			
	B	SE	β	p	B	SE	β	p
Constant	171.683	66.882		.011	182.625	67.521		.008
Income	.125	.064	.139	.055	.104	.069	.117	.131
English Literacy	.316	.202	.112	.121	.306	.203	.108	.135
First Use Mobile Money	-.085	.033	-.175	.012	-.090	.034	-.186	.008
Network Size	-.055	.058	-.092	.348	-.047	.058	-.080	.417
Mobile Phone Skills	.137	.057	.172	.017	.127	.057	.159	.029
Personal Innovativeness	.051	.037	.092	.175	.057	.038	.104	.132
Perceived Risk	-.077	.033	-.156	.020	-.074	.033	-.149	.028
PEOU	.032	.051	.043	.536	.032	.051	.044	.534
PU	.096	.054	.131	.076	.097	.054	.132	.075
Peer Adoption	.156	.059	.263	.009				
Family Adoption					.104	.071	.135	.142
Friends Adoption					.173	.070	.221	.015
Others Adoption					.211	.103	.158	.042
R^2				**.316**				**.324**
Adjusted R^2				**.274**				**.273**

Chapter Six

Discussion

The present thesis analyzed the effects of social networks, specifically peer adoption, in the adoption and variety of use of mobile money services in the context of Uganda. It presented a summary of existing literature on adoption theory and mobile money, emphasizing two existing gaps in research: the limited scope of how social influences have been approached in mobile money adoption research, and the lack of studies about use beyond adoption. It continued by presenting the design and results of a survey based research carried out in urban Uganda, exploring the ego-network structures of mobile money adopters and non-adopters.

This thesis' main argument is that social networks influence mobile money adoption and variety of use, and the regression models presented earlier provide support for this argument. People with more peers using mobile money not only have a higher chance of adopting the service themselves, but those who have adopted have a higher variety of use of the system.

Furthermore, in case of mobile money adoption, the effect of peer adoption was the third largest in the model, just below mobile phone skills and English literacy, and in the case of variety of use, the effect of peer adoption was the largest of them all. The implications of these results are especially important for adoption researchers, and should provide an appeal to focus beyond TAM-like models and bring forth an argument for a deeper understanding and operationalization of social influences. When TAM was initially proposed, social influences were eliminated for parsimony and simplicity (Davis, 1986), but now, as stated by Benbasat and Barki (2007) extensions to TAM and TAM-like models (e.g. UTAUT) have brought these variables back, but in the process of doing so, they have been included disjointedly.

This is not to say that studies using TAM and TAM-like models don't have any merit, but rather the idea is to make a point that adoption research must move beyond these models and go deeper

into understanding use and adoption. Chin and Marcolin (2001) argue that "rather than expending our research efforts primarily on yet additional attitude constructs and personality factors [...] researchers might consider focusing on the technological context and interactions such as interface design, data structures, training, and actual usage behavior that influences adoption" (p. 9). TAM has been called a "middle range theory" (Benbasat & Barki, 2007), which means that it provides a potentially useful bridge to antecedents and consequences of adoption, but it cannot be an end in itself, or else adoption research will never reach a full understanding of determinants in the adoption or rejection and use of technological innovations. The invitation is then to move beyond TAM in research of mobile money adoption, as the field is mature enough to produce deeper understandings of both diffusion and use processes.

Scientific Relevance

To the best knowledge of the researcher, this is the first study that brings forth the structural analysis of social networks to the adoption of mobile money. By including social network influences, that is, peer adoption, this study finds significant effects with large explanatory power, especially when compared to other variables found in previous literature and used here as controls. The results of this study should serve as a case in point for future research using the network perspective. In this sense, the analysis presented earlier about strong and weak ties effects on adoption and use of mobile money provides a set of initial findings that may be important to explore in more depth.

When peer adoption was divided into type of adopter within the network, different effects could be seen in the models of both mobile money adoption and variety of use. For adoption, it was family and friends that explain the influence of peer adoption; for variety of use, on the other hand, it was friends and other relationships instead.

These results would suggest that there is social contagion by cohesion in the decision of adopting mobile money, but not necessarily in how it is used. In other words, a person would look at his or her significant others for information on the decision to whether or not to adopt mobile money, but when it comes to the actual use, that decision will depend on the network at large, that is, on

how many people use mobile money beyond the closer ties. If this is the case, then it seems that adoption of mobile money has less to do with the specifics of how to use it, but rather with reducing uncertainty regarding the consequences of the system. In Rogers (2003), consequences are the changes that occur as a result of the adoption, and they are a main force in the diffusion process. Potential adopters will try to be as informed as possible about the advantages and disadvantages of the system, in order to be aware of as many consequences as possible before making a decision. Strong ties that have adopted provide a security that reduces the uncertainty of adoption.

When it comes to variety of use, however, family ties don't have an effect, but other types of ties do. As stated earlier, weak ties are the only ones who can bridge new information: strong ties tend to make people homogeneous and information becomes redundant. Having contacts using mobile money outside of an individual's close network may expose him or her to new ways of using the system. In other words, having people outside of the close network may provide with opportunities to use mobile money differently. This claim, however, cannot be proven in the context of this study, as no information regarding the variety of use of peers was collected. A possible way to test this could be by reaching participants' peers and collecting information about their use of the system.

It is important to note, however, that friends do have an influence in both adoption and variety of use. This can be explained by the ambiguity of what a friend is. The concepts of friendship may differ according to individualism or collectivism of societies or individuals (González, Moreno, & Schneider, 2004). Thus, individuals may use the concept of friendship to refer to what are, in practice, weak or strong ties.

Alternatively, this could be explained by use patterns: if while using mobile money services, interactions between a user and his or her family are somewhat lower in comparison to the interactions between him or her and other people in the network, then this could explain the non-significant effect of family ties in variety of use. This, however, is beyond the scope of this research, and it implies collecting information about users' interactions (e.g. who sends money to whom).

On the other hand, this is one of the few researches on mobile money adoption that tries to understand use beyond adoption. As stated in previous chapters, most research in the field has been done by looking at intention to adopt (Shaikh & Karjaluoto, 2015) and the very few who do focus on use don't define clearly on what elements of use they focus. In contrast, this study takes its definition of use from the Use-Diffusion model as presented by Shih and Venkatesh (2004) and focuses in one specific aspect, variety of use, building a scale for measuring it and providing a sound statistical analysis to assess the validity of the instrument through Mokken scaling.

Policy and Implementation Implications

Beyond the effects of peer adoption on mobile money adoption and use, there were several other statistically significant findings with implications for both policy making and implementation of mobile money services.

An important result is that of the two main TAM variables, PEOU and PU, only PU had a significant effect in mobile money adoption. This finding suggests that adoption is driven by needs. Potential users are able to overcome barriers and adopt the system if they feel it will help them in their daily life. Much of the research on mobile money barriers in developing contexts (see Baguma, 2013; Medhi et al. 2009) has focused on usability issues: interfaces, language, etc. The results of this research, thus suggest that it is better to focus on the antecedents of usefulness. It is important to note, however, that the confirmatory factor analysis on PEOU and PU pointed out that both concepts where correlated, which means that when the system is perceived as easier to use, it is also perceived as more useful. This indirect affect should be considered for future research in the field.

As stated earlier, one of the main design barriers studied in mobile money adoption in developing countries, is language and literacy. This study shows that English literacy has a high impact in the decision to adopt mobile money, but not in variety of use. This could have two possible explanations, either the users who have adopted mobile money have the English needed for using the system at the same level, or that once the system is adopted, language actually is not an issue in using more features. A possible reason for the latter can be seen in Medhi et al. (2009):

> "Despite having their own M-PESA accounts, for instance, 3 of 8 M-PESA users transacted on their account only through peers or their local agents. They did not access the application on their own device, instead handing over their money and sometimes their phone to a peer or agent, and having them perform the transaction" (p. 491).

That is, once the user is aware of what the system can do, he or she may ask people within his or her network to operate it in his or her behalf. Thus, English is not a barrier for variety of use.

Mobile money services in Uganda are in English, and this has been recognized as a barrier in the diffusion of mobile money, especially among the people at the bottom of the pyramid, which tend to speak only the local language and may not even know how to read and write. Comparing the influence of this variable in the adoption of services like M-Pesa in Kenya (which is available in Swahili) may shed light on how much of a barrier is. Similarly, general literacy should be explored in further studies, as most research about this population has been done only through usability and qualitative research. This is especially important if we consider the inception of mobile money as a social innovation: these services are marketed as a mean of bridging the economical gap in developing countries, so the usability needs of the unbanked population must be prioritized; else, the service becomes only available for the more educated population, which usually has more resources. Ducombe and Boateng (2009) actually determine that adoption of mobile finances services in developing countries has been confined to more affluent users. In this research, however, income had no effect in adoption, but it did in variety of use.

Perceived risk, on the other hand, wasn't significant in the adoption of mobile money, but it was in the different services used. This makes sense, as creating a mobile money account is a very simple process (in Uganda, any person with a mobile phone account can just press a command in their phone or access the SIM card menu and activate mobile money), but using different functionalities of mobile money require more interaction with mobile money agents and the service itself. In the usability studies and during the interviews and pilots for this research, users have pointed out problems with the connection and other service errors, leading to failed transactions, which increase the risk for the user. Additionally, some of the more difficult items in the Mokken scale require

personal information (like bank account or electricity/water account information), which demands a level of disclosure to which many users may not feel comfortable with.

Limitations

As with any research, the findings of this one are bounded to certain limitations. First, with regards to the approach, this study did not dealt with the issue of network autocorrelation in adoption. The main argument of this thesis is about the influence of peers in the decision of an individual to use and adopt mobile money; however, this is not a one-way relationship: the decisions of the individual affect those of his or her peers as well. Social relationships are complex, and this research assumes a simplified model in order to provide clarity in the argumentation. This, however, does not negates the results and conclusions, as similar methodologies have been used before to model social network influences (see Bandiera & Rasul, 2006). The main implication of this research is that studying mobile money adoption using social network analysis is not only possible but worth it, and in order to provide a full picture of the phenomenon, further study with higher levels of complexity is required to deepen the understanding of social networks in mobile money adoption.

Regarding the design, an important limitation is that the present study did not observe adoption and diffusion over time, but rather controlled the effects of this variable by asking participants when the first time they used mobile money was. As stated by Rogers (2003), time is one of the main variables in the diffusion process, and much of the effort in diffusion theory is to explore the rate of adoption of an innovation. To the best knowledge of the researcher, this remains an open issue that hasn't been explored in the literature, and that remains somewhat conflicting, with authors saying that diffusion of mobile money has been slow and controlled (Ducombe & Boateng, 2009), and others stating the opposite (Morawczynski, 2011). This is beyond the scope of the research, but from the observations and data collection, it seems that mobile money services, at least in Uganda, have had a rather vertiginous rate of adoption.

With respect to data collection, there are two main issues to consider. First, the fact that all information collected was done through self-report. This implies that much of the data is vulnerable to a recall and common method bias. This may be one of the reasons why some

participants reported to have started to use mobile money before its official launch in the country, instead of them being highly motivated early adopters that started using international systems like M-PESA. Similarly, when participants provide the information about their peers, it is possible that they do not remember whether the person has or not mobile money. This is a second issue in the data collection: the information collected about the participants' peers is limited. Consider, for example, the fact that much of the argumentation in this research is about looking at use beyond adoption, yet, no measure was collected about the use given by peers of the participants. Future research looking at social network should look at alternative sampling methods, trying to extend beyond the ego network towards a full or partial network analysis. A possible solution can come from snowball sampling, in which information about a set of participants is collected, and then information about the listed peers is collected as well.

Finally, the main limitation of this research comes from its scope: it aimed to test the existence of an influence of social networks in the adoption and use of mobile money, but not to characterize it and/or define how exactly it is enacted. It shed some light in this problem by approaching the three mechanisms of social influence (social contagion, social learning, and interactivity), but more rigorous testing is necessary before arriving to a final conclusion. Likewise, the testing of contagion by relationship type provides an initial understanding of the phenomenon, but better modelling is necessary before proceeding further.

Future Research

Future research should move beyond TAM and TAM-like models, and approach the issue of social influences from the network perspective. By bringing more profound structural analysis into the field of mobile money adoption and use, the specific mechanisms of social influence can be determined with more clarity, and a better understanding of the process as a whole can be obtained.

Again, this does not implies to stop considering what has been learned through the use of TAM, and variables like PU and PEOU can still provide good understanding of mobile money adoption, as long as they are framed from a network perspective and consider some of the results obtained in this research. For instance, PU was only significant when peer adoption is not included in the

models explaining variety of use. Although no correlation could be found between PU and peer adoption, this may suggest that some variance is shared between the two variables. This provides some evidence for the effect of interactivity and network externalities: mobile money is perceived more useful because more people within the persons' network are using it. However, it cannot be determined with confidence in this research, and future studies may want to explore the network externalities on mobile money adoption and use more in depth.

Looking beyond network analysis, a variable that is consistently significant through this research is the concept of mobile phone skills. This is especially interesting, because research on this field hasn't considered it before, but its counterpart, digital literacy or internet skills, has become a pivotal concept in the study of technology and society.

In this research, the more knowledgeable an individual is with his or her mobile phone, the more likely it is to adopt mobile money. As mobile money services don't require advance knowledge of how mobile phones work, and as time passes and experience with phones in developing countries becomes more natural, this variable could reduce its importance, as people will organically increase their abilities in using the phones by just interacting them and including them in their daily lives. This observation, although supported by literature on digital skills (see Eshet-Alkalai & Chajut, 2009), is out of the scope of this research, and puts forward the importance of research on mobile money with a more longitudinal focus, a conclusion that Donner and Tellez (2008) also bring when analyzing the gaps in the literature of mobile money research. According to these authors, modelling the effect of social networks in time and studying diffusion patterns can provide a greater understanding on the underlying mechanisms influencing adoption and use of the services.

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Appendix

Scales

Variety of Use of Mobile Money

Scale developed for this study based on mobile money services available in Uganda.

Item	Answers
Do you buy airtime using mobile money?	Yes
	No
Do you receive money using mobile money?	Yes
	No
Do you send money using mobile money? **(excluded)**	Yes
	No
Do you deposit or withdraw money using mobile money?	Yes
	No
Do you store or save money using mobile money?	Yes
	No
Do you pay or get goods using mobile money?	Yes
	No
Do you pay bills (TV, YAKA, water, etc.) and/or school fees using mobile money?	Yes No
Do you transfer money to and/or from a bank account using mobile money?	Yes No

Personal Innovativeness

Scale based in Kim et al. (2010).

I know more about new products before other people do				
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I am usually among the first to try new products				
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
New products excite me				
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

Perceived Risk

Scale based in Kim et al. (2010).

I would not feel totally safe providing personal privacy information over the mobile money system				
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I am worried to use mobile money because other people may be able to access my account				
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I would not feel secure sending sensitive information across the mobile money system				
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

Mobile Phone Skills

Scale developed based in ECDL (2009). Correct answers are marked with a red checkmark. Questions that were included in the final questionnaire are marked as excluded.

Which of the following could be a SIM PIN code?				
1234ab	1234 ✓	ab1234	abcd	I don't know

Which of the following definitions explains better what a PUK code is? **(excluded)**				
Same as a PIN code	The code you use before the PIN code	The code you use if a PIN code fails ✓	The code used to get money from the bank	I don't know

Which of the following icons is the one used to represent "Bluetooth"?

Which of these buttons has the "hash" symbol?

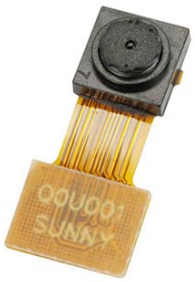
Which of these buttons would you press to make a space while texting?

The following symbol appears in your phone:

What does it mean and what action would you take?

It means I received a new SMS. I check my SMS inbox	It means I received a new voicemail. I call my voicemail box ✓	It means I have a missed call. I'll check the recent calls log	It means the signal is lost. I wait for it to return or look for a place with stronger network	I don't know

Mobile Phone Skills (continued)

Which of these is most likely failing if your phone loses power quickly? **(excluded)**				
		 ✓		I DON'T KNOW
Which of the following images shows a SIM card?				
	 ✓			I DON'T KNOW
What are iTunes Store and Google Play?				
Physical places to buy new mobile phones.	Virtual marketplace for mobile phone applications. ✓	Websites where you can find the latest news about mobile phones.	Search engines for browsing the web.	I don't know
If you want to connect a mobile phone to a computer, which of the following options <u>does not</u> work?				
Bluetooth	Wi-Fi	USB	Ethernet ✓	I don't know
Which of these technologies is <u>not</u> a 3G technology? (excluded)				
EDGE	CDMA2000	GSM ✓	HSPA+	I don't know
You want to send a picture from your phone to a friend, which of these systems <u>does not</u> allow you to do that?				
MMS	Facebook Messenger	WhatsApp	SMS ✓	I don't know

Perceived Ease of Use

Scale based in Faqih and Jaradat (2015).

Mobile money seems clear and understandable				
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Using mobile money does not require a lot of mental effort				
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Mobile money seems easy to use				
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I think I would find it easy to use mobile money to do what I want to do **(excluded)**				
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

Perceived Usefulness

Scale based in Shaw (2014).

Using mobile money is useful **(excluded)**				
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Using mobile money would be more convenient for me				
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Using mobile money would increase my efficiency				
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Using mobile money would help me pay more quickly				
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree