The Future of Payment Transactions: The Convenience and Security of Mobile Payments

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Abstract

This study aims to evaluate the American consumers drive for payment choice. With cash, credit, and debit still covering most of the payment transactions that occur across the country every day, there has been a trend toward the use of mobile payments as the technology improves and more businesses have started to offer these capabilities. We use the Federal Reserve's Survey of Consumers' Use of Mobile Financial Services to analyze some of the most recent data pertaining to consumer payment preference in order to evaluate the importance of m-payment accessibility, convenience, comfort, and perceived level of security. Using a logistic regression analysis, this study finds that as one of the primary obstacles preventing the widespread adoption of mobile payments, security does play a major role in the consumers' decision to use (or not use) mobile payments today.

Keywords: mobile payments, consumer payment choice, adoption, security, convenience, ability, comfort, cash, credit, debit

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1. Introduction

On April 3, 1973, Martin Cooper, a senior engineer at an American multinational telecommunications company (Motorola), made a phone call to a competing telecommunications company (AT&T) to inform his chief competitor that he was calling from a cell phone. The significance of this event comes from the fact that this was the world's first mobile phone call. It took another ten years before the first mobile phone went on sale in the U.S. for just under $4,000. Today, not even five decades following this historic event, the state of cell phones has changed drastically. More people in the world have mobile phones than toilets as the total number of mobile phone users worldwide increased to an estimated 4.6 billion in 2016. The popularity of the mobile phone market growth can largely be attributed to the introduction of smartphones in the early 21st century as seen in 2014 with around 38% of all mobile phone users owning smartphones.

The prevalence of smartphones in the U.S. had psychologists and parents panicking at such data as the Pew Research Center's "U.S. Smartphone Use" survey in 2015 that found that roughly 47% of millennials use their phones to avoid people around them. There is even a new phobia that has been proposed that pertains to "the irrational fear of being without your mobile phone or being unable to use your phone for some reason, such as the absence of a signal or running out of minutes or battery power." [1] Despite some of these shocking consequences that have unraveled since Cooper's mobile phone call, some would argue that the mobile phone has changed society for the good beyond what anyone could have comprehended in 1973. With more computing power in a smartphone today than the computers used in the Apollo 11 moon landing,

[1] *http://whatis.techtarget.com/definition/nomophobia*

the evolution of the mobile phone has seen millions of different designs as the mobile phone industry was one of the fastest growing industries in modern history.

Although the technology advancements behind the mobile phone saw rapid development and widespread worldwide adoption, the history of payments has experienced a much more gradual evolutionary process of developing. Over the ages people have participated in the exchange of goods and services for payment, and not all transactions involved some form of monetary payment. From bartering and livestock to precious metal coins and paper money, payments have changed almost as drastically as the cell phone – but just over a few thousand more years. Fast forward past gold, silver, and the U.S. dollar into the 20th century where the introduction of credit cards revolutionized payment processes. With banks beginning to issue their own credit cards throughout the 1950s, it was companies like Visa that began to break the payments barrier and transform the consumer payment experience with an unprecedented level of convenience.

With the goal of mass acceptance driving payment processing companies like Visa and Mastercard, the credit card industry certainly faced its fair share of challenges and opposition over the years on both the issuer and merchant sides of transactions as was outlined in Hillel Black's 1961 book "Buy Now, Pay Later." From fraudulent charges on accounts and minimal credit card disclosures to cloudy interest rate policies, the only thing that was clear was that regulation needed to catch up with the rapid adoption of credit cards. Lawmakers stepped in with such legislation as the Truth in Lending Act and the Consumer Credit Protection Act of 1968, again adding steam to the already widespread adoption of this new payment process. It was during this time that consumers were first faced with a payments preference that would pit two concepts directly against each other: **convenience and security**.

When it comes to making purchases, history tells us that as consumers we prioritize convenience. In a world where cash is losing its preference, retailers are striving to meet consumer demand for faster, easier, and more convenient methods of paying. However, convenience doesn't always positively correlate with security. The mobile phone sits at the forefront of banking and payment technology as more Americans gain access to smartphones. Many individuals have become increasingly attached to and rely heavily on their smartphones for everyday activities, including managing finances and making purchases. There are conflicting arguments that suggest that because millennials have never really known a world without technology and data, they might not know the risks in this new and continuously evolving landscape – risks that were more apparent during the growing age of credit cards because of the physical process involved with swiping and being onsite for a transaction to take place.

Since 2011, the Federal Reserve Board has conducted a survey of how consumers use their mobile phones to interact with financial institutions, make payments, and manage their personal finances. We will use this data provided by the Board of Governors of the Federal Reserve in its annual Survey of Consumers' Use of Mobile Financial Services to dig into some of the most recent data that has gone largely unanalyzed in order to explore the question of whether **mobile payments have the potential to replace cash, check, and card as a universal payment device?**

In the U.S. today, credit, debit, and cash remain consumers' most preferred way to pay.[1] However, for the first time since the TSYS U.S. Consumer Payment Study was first conducted,

[1] *2015 cash usage made up 32% of all transactions, down from 40% in 2012*

credit cards replaced debit cards as the most preferred payment form.[1] This does, however, depend on what the consumer is paying for. Debit is the preferred payment type for everyday spend transactions, while credit is preferred for higher-dollar transactions, leaving cash as the preferred method for payments to individuals and at fast food restaurants.[2] Although 30-year-old predictions about the eventual abolition of cash have refused to become a reality, cash has definitely slipped in the consumer rankings as the preferred payment option (Tsys 2016 U.S. Consumer Payment Study). The resiliency of cash has been interesting as competing payment methods have entered the market with cash usage remaining relatively steady in the U.S. since 2003 at roughly 15% of total GDP.[3]

The survey provides some key findings that support much of the existing research on the continued adoption of mobile phones and the gradual increase in mobile payments. According to the 2016 survey, not only does 87% of the U.S. adult population own a mobile phone, but 77% of those mobile phones are smartphones with 24% of those mobile phone owners having made a mobile payment in the 12 months prior to taking the survey. The first mobile phone purchase was made in 1999 and was initially intended for movie tickets, but it wasn't long before 95 million cell phone users were making purchases using their mobile phone just four years later.

Included in the introduction to the findings of the survey is a clarified definition of mobile payments, which has taken on several different meanings over the past decade as the technologies behind smartphones has continuously evolved. A mobile payment is defined as

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[1] *In 2012, credit card transactions accounted for 21 percent of the total number of noncash transactions and debit cards accounted for 38 percent*

[2] *According to MasterCard's 2012 "World Beyond Cash" survey, 73% of Americans say they use less cash today than 10 years ago*

[3] *PYMNTS.com Report: In the U.S. Cash Is Sticking Around*

"purchases, bill payments, charitable donations, payments to another person, or any other payments made using your phone to pay for something in a store as well as payments made through an app, a mobile web browser, or a text message." Under this definition remains various forms of mobile payment options with the primary differentiating characteristic setting the process apart from all other payment transactions being that it takes place using one's mobile phone.

The technologies that allow for these different forms of payment have seen some recent developments and are important to note because of the impact they have had on the level of security involved with making payments using a mobile phone. The most popular method is an SMS payment, which is simply using SMS capabilities (or sending a text message) from a mobile phone. Most experts agree that the popularity behind this method mostly stems from its natural simplicity and the fact that a smartphone is not required in order to make this type of transaction. Near Field Communication (NFC) payments is a more recent technology that allows two devices (such as a smartphone or a payments terminal) to communicate to each other when they are within close proximity. Apple Pay, Android Pay, and Samsung Pay are some examples of NFC mobile payments that have recently been incorporated into smartphones using this encrypted technology to make instantaneous transfers of data between phones or phones and point of sale (POS) devices. Last among the most frequently used payment technologies today is the Wireless Application Protocol (WAP) payment process which uses a smartphone to connect to the internet and then utilizes an online payment method (e.g. PayPal, Google Wallet).

PayPal leads the digital wallet landscape with the most popular wallet in the U.S. despite the vastly increased awareness of Apple Pay and Samsung Pay swiftly making its way into the competitive sphere (STATISTA – Mobile payments in the United States). As online shopping

continues to see upward growth, the mobile phone continues to sit at the center of that growth with online stores such as Amazon and Wal-mart sitting atop the list of most frequently used mobile payment apps. This also correlates with the gradually increasing awareness of mobile payment systems in the United States such as Venmo, Square Cash, and Google Wallet. On the other side, however, sits the competing traditional bank which still receives 47% of consumers' trust over m-payments.

Although the first mobile payment was solely intended for movie ticket purchasing, the mobile payment industry realized the opportunity at hand and continued to expand the functions as smartphones and the payment technologies brought even more potential for financial services performed in the palm of a hand. According to the Consumer & Mobile Financial Services 2016 survey, the top three m-payment activities today include paying bills, purchasing physical items or digital content remotely, and paying for something in a store. A lot of the changes experienced by the mobile payment industry have taken place over the course of the survey's history as smartphone usage was initially only 44% at the first deployment of this mobile survey. Ultimately, the drive behind the Federal Reserve Boards interest in mobile banking and payments first came about at the realization of the impact that the mobile payment industry can have on consumer choice and financial interactions, and is consequently analyzed under three primary focus areas: m-payment adoption, activities, and motivation for use.

To best answer the question of whether m-payments have the potential to replace existing payment transaction methods it will be important to breakdown the two concepts that sit at the forefront of the decision making process when it comes to payments – convenience and security. For some countries and their people, mobile phones have acted as the first time they actually have access to a checking/savings account and shed a light on the impact that accessibility alone

can have on the adoption and use of m-payments around the world. For other countries, mobile payments have acted as a method to increase the efficiency of everyday events such as paying for transit. Despite the varying motivations behind mobile payment adoption in both emerging markets and developed countries, m-payments have not been widely adopted in the United States (at least to the levels predicted since its emergence).

The relevance of this research persists today as payments affect every business on a day-to-day basis, whether that be a small business or a large corporation. The payments ecosystem has experienced rapid change over the last decade, and trends continue to show that the ecosystem faces new challenges and provides new innovative solutions every year. The variety of stakeholders involved in this question of mobile payment adoption and the barrier of security versus the benefit of convenience can also point to the expansiveness of this topic as payments involve multiple entities throughout the process. The remainder of the paper is structured as follows: literature review, data, theoretical framework, empirical specification, findings, conclusion, and appendix.

2. Literature Review

Growth in the number of mobile devices owned in the United States has simultaneously been coupled with increased interest and analysis by economists around preferences and perceptions of mobile payments. While most industry experts predict the eventual wide acceptance and use of m-payments in the near future, there still seems to be several barriers to replacing current payment methods that have been particularly cumbersome in the United States (Hayashi, 2012). These barriers exist on both the supply and demand side of the industry as the

various stakeholders in the process look at the potential costs and benefits that come with mobile payments in the U.S.

2.1 Studies on Payments

Previous literature has shown correlation between consumer payment behavior and income/demographic characteristics (Connolly and Stavins, 2015). The Federal Reserve has also denoted a significant amount of resources and research into payment trends and most recently identified strong trends in card use in their 2016 Payment Systems study that both expanded and highlighted the previous literature that reflected increased desire for card payments since the first deployment of the study in 2012. With several options available for payment available to the average consumer today, researchers have explored linkages between choices of payment and overall satisfaction in order to better understand some of the driving forces that guide these decisions. Customer satisfaction with debit and credit cards, according to a 2009 Austrian study, is a product of the customer expectations, performance, and desires (Foscht et al., 2009). The importance of this research is rooted in the consumer behavior that comes from each of the different payment modes as was noted by Elizabeth Hirschman in her 1979 paper "Differences in consumer purchase behavior by credit card payment system." Despite a considerable amount of effort since Hirschman pointed out in 1979 that research efforts had failed to explore how consumers conduct their payment transactions, there is still a largely unexplored and unexamined space when it comes to this new age of mobile payments.

2.2 Studies on Payment Security

The concept of security in the payment process captures the extent to which a consumer perceives a particular payment instrument as secure. Regardless of the payment system, security has always been a key feature of the payments process. Security related incidents involving the "stealing of cards, counterfeit, skimming...and identity theft" have been of greater concern as the number of daily payment transactions has increased significantly since the turn of the century (Kahn & Roberds 2008, 251). This perception of security, as evidenced in the AARP Public Policy Institute's 2006 survey, has the potential to affect the decision process when it comes to a consumer's payment choice. Identity theft, in particular, has been of growing concern in America with millions of people becoming victims each year costing billions of dollars in losses (Kahn & Linares-Zegarra, 2016). As the consumer confidence level in the safety of a specific payment instrument decreases, they might convert to a less efficient payment method in order to compromise for the lack of confidence in the payment method (Cheney, 2010).

Although efforts have been made by payment processing companies and mobile service providers alike to increase protection and overall security for their services, data breaches continue to annually flood the news cycle and insight fear in millions of Americans with the threat of personal financial damage causing "decreasing efficiency throughout the economy" (Crooks 2004, 10). Despite the potential economic impact that data breaches and other security related incidents can have on the American consumer, the academic research related to these incidents and its effects on payment behavior is limited. This is in part because of the controversy surrounding the importance of security as a factor affecting payment behavior as some research has found no evidence that security plays a significant role in the decision process (Ching and Hayashi 2010).

In Ching and Hayashi's 2010 paper on consumer payment choice, they include explanatory variables of security perceptions in a model of payment choice and find no significant evidence of security as a driver of payment behavior. However, other studies such as Arango and Taylor's 2009 "The role of Convenience and Risk in Consumers' Means of Payment" found that perceived risk is a heavy determinant of consumer's payment method preference. While some studies have relied on survey data that investigates a consumers' choice of payment instrument and its links to security concerns, other papers have examined the role of safety through theoretical models. Ultimately, the literature shows the lack of conclusive answers regarding the impact that security issues can have on payment behavior. This paper will work to add to the existing literature on security concerns and its effect on consumer payment preference by using some of the most recent data on the issue following large data breaches and increased security technologies on the sides of payment processes and mobile devices.

2.3 Studies on Mobile Payments and Adoption

At the moment, there is minimal empirical evidence and research into mobile payment adoption and the determinants that influence a user's acceptance of mobile payments. The importance of studying the adoption of this new technology and a consumers' choice of payment instrument for transactional purposes has been studied for the purpose of measuring potential economic and social costs (Humphrey et al., 2001). The potential market disruptions that could come from widespread adoption and use of the technology could potentially threaten financial stability and impact market participants from banks and financial intermediaries to mobile network operators on the private side. Although there are a handful of studies looking specifically at the barriers to adoption of mobile payments/banking in the United States and

abroad, this new and under analyzed data set from the Federal Reserve Board's Division of Consumer and Community Affairs provides new insight the future of this new technology and the obstacles that exist today.

The effect that mobile payments have on traditional payment methods is a topic of importance in the overall discussion of moving away from cash/card and toward this new and continuously developing form of payment transactions. The adoption of new technology can come at several different paces, and for mobile payments that adoption rate has proven to be rather slow. A 2012 survey of consumer payment choice in the United States showed that mobile payments will likely not replace physical payment cards in the near future, but it is likely that mobile payments will act as a substitute for paper-based payment methods such as cash and checks (Trütsch, 2016). With the option of selecting among nine different payment instruments, consumers have more payment options than ever before. Companies like PayPal, Google, Apple, Square, and Venmo have entered the payments space and brought increased competition as nonfinancial companies in a traditional banking payment service industry.

Security, cost, and convenience are the primary factors smartphone owners consider when deciding to make a mobile payment (Shin et al., 2014). Some lessons can come from abroad in understanding why other countries like Japan and Korea have outpaced the U.S. over the past decade in m-payment use. As Shin et al. recognize, "the number of mobile device users is more than enough to offer a successful market for mobile payment solutions" in the U.S., yet this method is not nearly as common as the more traditional methods of payment (credit, debit, or cash). Some suggest that knowledge on mobile payment is one of the centric factors that might influence the adoption of mobile payment, while others point out that compatibility in a consumer's lifestyle is the most important factor (Kim et al., 2010; Chen, 2008).

With far fewer NFC- or RFID-capable POS terminals relative to population than either Japan or South Korea (about one terminal per 600 people in the United States, versus one per 130 in Japan and one per 100 in South Korea), there is clearly something stopping Americans from altering the way they have traditionally paid for goods and services. Similar to the issue with empirical research into the security links to payment choice, the majority of studies on mobile payments rely on individual-level survey data because of the lack of access to accurate transactional data. Several studies have also found that both socioeconomic and financial characteristics of a consumer are important factors relating to payment choice (Schuh & Stavins 2010). Other research also highlights the effect that different region/foreign background attributes have on consumer payment preference, mostly influenced by whatever method of payment was prevalent in their country of origin (Stavins 2001). The current literature doesn't reflect some of the most recent data collected on the issue.

3. Data

The Survey of Consumers' Use of Mobile Financial Services is an annual survey that was started in 2011 by the Federal Reserve Board's Division of Consumer and Community Affairs (DCCA). The fifth and most recent survey was conducted in 2015 and included a sample of respondents who had responded to both the 2013 and 2014 surveys along with a random sample of new respondents. The survey was administered by GfK, an online consumer research company, and was conducted in English using a sample of adults above the age of 18. The sample was weighted and designed to be representative of the U.S. population by KnowledgePanel using a proprietary, probability-based web panel of more than 50,000

individuals from randomly sampled households. The collection of the data took place between November 4th – 23rd, 2015. There was a total of 2,324 randomly selected individuals plus 1,364 previous survey participants contacted by e-mail of which 2,510 submitted qualified responses. This qualitative research has gone largely unanalyzed since its first release in 2011.

The data coming from the survey is organized based on the ordering of the questions presented to the participant. Background information was collected on all participants, including age, gender, income group, race/ethnicity, geographic residence, marital status, education level, household size, household ownership status, and labor force identification, each corresponding to a specific Case ID number that separate each participant in the data set. Additionally, sample weights are provided next to each Case ID, which were calculated and applied in the data set to ensure that the sample matches the U.S. adult population. The average age of the participant in this survey was approximately 52 years old (52.6) with a standard deviation of 16.8. 51.6% of the survey population identified as male with the remaining 48.4% female.[1] Only 12.0% of the full sample were between the age of 18-29, with 20.0% between 30-44, 29.5% between 45-59, and 38.0% above the age of 60. Restricting the age of millennials to those between the age the age of 18-35 only puts the millennial representation of the survey at 22.2%, which is approximately 8% below the estimated millennial population size in the United States today (Pew Research, 2016). This is a prime example of why sample weights were included in order to best represent the U.S. population in the data. Only 6% of the sample identified as receiving an education less than a high school level, with 26% at high school degree level, 30% completing some college, and 37% of the participants having received a bachelor's degree or higher.[2] An overwhelming majority of

[1] *Actual mean age in the United States is 38.1 according to Census Bureau Quick Fax*

[2] *In 2012 39.4% of Americans between 25-64 had at least a two-year college degree*

the participants were White (non-Hispanic) representing 76.5% of the sample, 7.8% Black, 9% Hispanic, 6.4% Other, and 2.6% more than two races. The income groups are generally evenly distributed when divided between those making less than $75,000 (50.9%) and those making more than $75,000 (49.1%).[1] Compared to the 2015 median household income, this survey's higher concentration of individuals over the median mark could potentially skew the data and favor the attitudes of those individuals on the upper side of the median mark.

Starting with the first question of the survey, the data is sequentially labeled all the way to the last question of the survey (Q1-Q60). Not all 60 questions obtain values for each participant because specific questions were presented depending on what the participant answered in previously presented questions. For example, the question of whether or not an individual password protects his/her smartphone was only presented to those individuals who had previously indicated in an earlier response that they owned a smartphone.

Our variables of interest start with the first question in which the participant is prompted with the following question: "Do you currently have a checking, savings, or money market account?" The original data set presents the data as either a "Yes" or "No" response, but was later recoded for the purpose of this paper to either "1" or "0" representing both of the response options.[2] As the survey continues, the questions range from specific inquiries into the interactions that the participant has had with his/her bank/credit union and the services that the bank/credit union provides. Most of the questions limit the scope of the participant's response to the previous 12 months leading up to the time of the survey.

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[1] *The median household income according to the 2015 U.S. census is $56,516*

[2] *See appendix for complete list of variables and recoding*

Although a majority of the questions provided have yes/no answers, there are several prompts that allow for the participant to choose between several options from a pre-set list of possible answers. For example, one question asks the participant: "Which type of smartphone do you have?" and allows the participant to choose between an Android, Blackberry, iPhone, Windows Mobile, or Other option where they are allowed to fill in a textbox with their customized answer. The participant is also given the option of "Don't Know" for questions with multiple possible answers. There is also one question that allow the individual taking the survey to choose up to three answers from the provided list as the participant is instructed to choose the answers he/she considers to be "the most important" to him/her.

Quantitative prompts are also presented, giving the participant the time to provide a numerical answer to questions such as "about how many times have you used your mobile phone to make any type of mobile payment" in the past month? Questions like this limited the possible answers to a number between 0-99. The final question type in the survey is one that prompted the participant with a grid that allowed them to choose "Yes" or "No" for each provided answer to a single question. One question, as an example, asked "have you done each of the following the past 12 moths?" allowing the participant to choose yes or no for anywhere between zero to all seven of the options.

The survey questions are generally divided into nine unique sections that are not all presented during the survey depending on how the participant responded to particular questions throughout the survey. The first section is presented to all respondents and deals mostly with banking questions that are meant to gauge whether the participant has some sort of money account with an institution and how they have interacted with that institution in the past year. The questions in this section also work to get an idea of how convenient the participant finds

their proximity to one of these institutions to be by asking how long it might take to get to a branch. The other main question of interest to this study that is categorized in this first section of the survey seeks to assess whether the participant has "regular access to the internet" both inside and outside of the home.

Mobile Phone Questions

The next section of the survey focusses in on the mobile phone by first asking whether the respondent owns a mobile phone, and whether that phone is a smartphone. These two questions act as the base for most of the questions to follow as a participant who responds "No" to whether they have access to a mobile phone will not be given a significant amount of the remaining questions pertaining to mobile payments and mobile banking. Those individuals that indicate that they do have regular access to a mobile phone are then asked about their comfort in utilizing the device, what specific type of device they use, what password capabilities they might use, and what other security measures they might have taken in the past year such as changing one's password or customizing personal privacy settings. The question on the participant's confidence in his/her ability to navigate the mobile phone technology showed a statistically significant difference between the mobile payment users and non-users at the 5% level. Of those that use m-payments, 97% of them expressed confidence in their ability to navigate the technology, with only 84% of non-users expressing that same level of comfort. The same can be observed in the statistically significant difference at the 5% level found between m-payment users that answered "Yes" to password protecting their mobile phones (82%) with only 62% of non-users taking that same precaution.

In fact, five of the possible answers to the security question regarding various safety precautions such as password protecting sensitive mobile applications, not accessing sensitive data over public WiFi networks, and installing updates to one's mobile operating system, all showed significant differences in the user and non-user responses with security measures being taken much more frequently by m-payment users.[1]

Mobile Banking Questions

Mobile banking users are the focus of the section that follows as the participant is prompted with what they will consider to be the definition of mobile banking for the purpose of the survey:

> *"Mobile banking uses a mobile phone to access your bank or credit union account. This can be done either by accessing your bank or credit union's web page through the web browser or your mobile phone, via text messaging, or by using an app download to your mobile phone."*

Given that those reading this definition have already indicated that they have both a mobile phone and some type of money account, the survey then works to gauge the individual's interaction with mobile banking over the past year or whether they plan to use mobile banking features in the year to come. There is a clear difference (supported by a rejection of the null hypothesis of independence) between the use of mobile banking for those we classify as m-payment users and non-users, with 84.6% of m-payment users also engaging in mobile banking,

[1] *Frequencies located in appendix*

yet only 28.1% of non-users using the services. Although the data supports the fact that m-banking is a more popular mobile financial interaction at the moment, non-users of mobile payments still show increased use of mobile banking and can indicate a trend toward adoption as more participants begin to utilize the mobile phone for such banking transactions. Question 32 is of particular interest to this study as it prompts the participants to pick "the main reason" why he/she might've started using mobile banking, with "I became comfortable with the security of mobile banking" and "I liked the convenience of mobile banking" as two of the options.

Mobile Payment and Convenience Questions

The section that follows provides a majority of the data that is used in this paper's analysis as it narrows the participants down to those that respond with "Yes" to having interacted in the past year with their definition of mobile payments:

> *"Mobile payments are purchases, bill payments, charitable donations, payments to another person, or any other payments made using a mobile phone. This includes using your phone to pay for something in a store as well as payments made through an app, a mobile web browser or a text message."*

The questions tease out some vital information from participants that have used a mobile payment in the past year by getting a feel for what situations might've prompted that individual to use a mobile payment, how frequently they use mobile payments, and the primary reason why they started using mobile payments in the first place. This once again pits security and convenience directly up against each another in question 39 where the participant must choose

between seven options that represent the primary reason for using mobile payments with "I became comfortable with the security of mobile payments" and "I liked the convenience of mobile payments" as possible choices again.

Mobile Banking/Payment Non-Users Questions

For those participants with a mobile phone and bank account but no indication of mobile banking use, the fifth portion of the survey was the next step. These "non-mobile banking users" were asked what reasons they believe to have played a role in their lack of m-banking use and whether they would consider downloading and using their banks mobile features in the future if their concerns were addressed. In this section, there is also a question for those that indicated that their bank did not offer mobile banking features, and for those that were unsure, ultimately asking the participant in this situation whether they would use mobile banking for specific features.

Those that have a mobile phone, bank account, but chose "No" when asked if they had engaged in mobile payments in the past year were directed to section six. As in the non-mobile banking section, this "non-mobile payments users" section attempts to assess potential reasons why the respondent elected not to use mobile payment features within the past 12 months. In particular, the survey answers of choice inquire about the survey-takers potential concerns about the security of mobile payments and availability of m-payments as a payment method. The purpose of these few questions really works to evaluate whether the non-mobile payment user finds other payment methods easier, the payment points presented to the participant don't offer the opportunity to make a mobile payment, the participant finds it difficult to set up and use m-payments, or if they are truly concerned about security. Just as in the non-mobile banking users

section, the participant is asked whether they would "be interested in" using mobile payments in anywhere between one of seven different scenarios.

Security Questions

The next section of questions helps to clearly highlight any of the security concerns that owners of mobile phones might have with the technology and processes. Question 46 directly asks how safe the participant believes his/her personal information is when using a mobile phone to pay for a purchase, with five options ranging from "Very Safe" to "Very Unsafe." Given that this study seeks to weigh the importance of security in the overall decision process when it comes to mobile payments, four different variables are of interest from this portion of the questionnaire. The questions asked here pursue those security concerns that are of the highest importance to the mobile phone owner and are asked of both those that indicated use of mobile payments and those that do not use the technology. The data shows a statistically significant difference between m-payment users and non-users at the 5% level with 65% of users indicating their belief in the safety of personal information when making mobile phone purchases, but only 29% of non-users feeling the same way.

The final two question categories deal with participant shopping behavior and financial management which are not of particular significance to this study, but can potentially be utilized in future research that narrows the scope of mobile payments to shopping and mobile banking to its alert features.

One of the biggest limitations of the study comes from the change in definition that occurred in this most recent survey. By adjusting the way that the survey defines mobile

payments, this could potentially affect the analytical ability to compare the data between the most recent survey and the previous ones.

To my knowledge, there is no data set as recent as this 2016 survey that focusses on the United States consumer perception and usage of mobile payments. This puts our analysis at the forefront of recent trends by analyzing largely untouched data during a potentially critical transition period in the payments ecosystem. Additionally, a primary concern with this survey is the potential underrepresentation of adults who may be comfortable with technology and therefore unable to take this online survey. This could pose a problem and a natural bias for the data because of the nature of the survey partially focusing on perception of technology, and those that might be the least likely to adapt to new technology are those that wouldn't go online to take such a survey.

4. Theoretical Framework

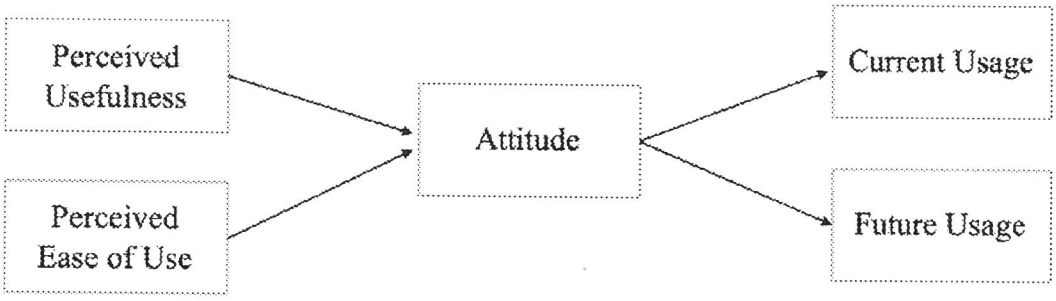
This paper's theoretical construct is based on the Technology Diffusion Theory (TAM). This model has been influential in predicting users' acceptance and adoption of a new technologically backed system (Davis, 1986).

Technology Acceptance Model

This model is based on theory of reasoned action and deals specifically with the prediction of the acceptability of an information system. This model suggests that the acceptability of an information system is determined by two main factors: perceived usefulness and perceived ease of use. **Perceived usefulness** is defined as being the degree to which a person believes that the use of a system will improve his performance. **Perceived ease of use** refers to the degree to

which a person believes that the use of a system will be effortless. This simple but important model will drive our empirical specification.

Our variables categorized in this study can be grouped into this model as perceived ease of use is represented by the convenience, ability, and comfort variables, and perceived usefulness represented by the security variables. The model follows the theory that the more convenient and available the participant views mobile payments, the more likely he/she is to make mobile payments today and in the future. Similarly, the higher the comfort level, the better attitude the participant has toward using m-payments. The more concerned the individual is with the security of making a mobile payment transaction, the less useful they perceive the payment method and the worse attitude they have toward choosing it.



5. Empirical Specification

5.1 Logistic Regression

Using a set of explanatory variables and a dependent variable, we use the logistic regression framework to investigate the relationship between the variables of convenience, security, ability, and comfort. Logistic regression is the linear regression analysis used in this study because the

dependent variable is dichotomous (binary) in addition to the dichotomous independent variables (recoded using dummy variables explained below).

The mean of our binomial data is denoted by P and the variance is denoted by P*(1-P)/n, where n is the number of observations, and P is the probability of the event occurring in any one case. Therefore, our logistic transformation to link the dependent variable to the set of explanatory variables is as follows:

$$Logit\ (P) = Log\ [\ P\ /\ (1\text{-}P)]$$

This equation gives us the probability of an event occurring. For this study, it would be the odds of an individual using a mobile payment today (Y1) or in the future (Y2).

Let:

$$P_i = \Pr(Y = 1 \mid X = x_i)$$

Logistic regression model:

$$\text{Log}\left(\frac{Pi}{1-Pi}\right) = \log it\ (P_i) = \beta_0 + \beta_1 x_i + \beta_2 x_i + \beta_3 x_i + \beta_4 x_i$$

β_1 corresponds to the ability variables, β_2 to comfort, β_3 to security, and β_4 to convenience. Although ordinary least squares (OLS) regression and logistic regression are the most common models used with binary outcomes, logistic regression estimates the log odds as a linear combination of the independent variables where the βs are maximum likelihood estimates of the logistic regression coefficients and are estimated iteratively. In OLS, the βs are instead regression coefficients interpreted as the change in the expected value of Y associated with a one-unit

increase in an independent variable (other independent variables held constant). The coefficients should not be interpreted the same way as in OLS and should also include marginal effects.

5.1.1 Dummy Variables

Given that some of the variables from the survey were categorical, we used dummy variables to contrast the different categories. A dummy variable is one that takes the value of either 0 or 1 to indicate the presence (or absence) of a categorical effect that may be expected to alter the dependent variables, or outcome. In our analysis, the dummy variables act as proxies for the qualitative data from the mobile survey.

Sometimes instead of a logit model for logistic regression, a probit model is used. However, a probit model would incorrectly assume a normal distribution of the probability of the event, while we need logit which assumes the log distribution from the relatively small sample.

5.1.2 Assumptions

There are six assumptions that underpin binomial logistic regression and if one of these six assumptions is not met, one might not be able to analyze the data using a binomial logistic regression (Laerd Statistics, 2017).

Assumption #1 – The dependent variable should consist of two categorical, independent (unrelated) groups. The dependent variables of this study come from questions 33 (Q33) and 34 (Q34A) of the survey. The dependent variable for question 33 is dichotomous with a response of either "Yes" or "No" as to the current use or non-use of mobile payments in the previous 12

months. Question 34 uses a proxy to represent whether the respondent plans to either "Yes" use mobile payments in the next 12 months, or "No" not use mobile payments in the next 12 months.

Assumption #2 – The two or more independent variables should be measured at the continuous or nominal level. Each of the independent variables gathered from the data set represent nominal data points.

Assumption #3 – There should be independence of observations, meaning no relationship between the observations.

Assumption #4 – The data should not show multicollinearity, which occurs when you have two or more independent variables that are highly correlated with each other.

Assumption #5 – There needs to be a linear relationship between any continuous independent variables and the logit transformation of the dependent variable.

Assumption #6 – There should be no significant outliers which represent observations in the data set that are particularly unusual.

5.2 Actual Specification

The actual specification is:

$$P(\text{m-payment use}) = f(\text{ability, comfort, security, convenience, demographics}) =$$

$$\sum \beta_0 + \beta_1 X_i + \beta_2 Y_1 + \beta_3 Z_i + \beta_4 W_1 + \text{error term}$$

The variable category represented by X_i includes the following survey questions used to assess the participant's **ability** to make a mobile payment:

- *Do you currently have a checking, savings, or money market account?*
- *Do you currently have regular access to the Internet at your home?*
- *Do you currently have regular access to the Internet outside your home?*
- *Do you own or have regular access to a mobile phone?*
- *Is your mobile phone a smartphone?*

The variable category represented by Y_1 includes the following survey question used to assess the participant's **comfort** in mobile payment technologies:

- *How confident are you in your ability to understand and navigate the technology and features of your mobile phone?*

The variable category represented by Z_i includes the following survey questions used to assess the participant's views on the security of mobile phones and payments:

- *Do you password protect your smartphone?*
- *In the past 12 months, have you taken any of the following actions with your smartphone?*
    - *Install updates to your mobile operating system or your apps*
    - *Change password on your phone or apps*
    - *Use anti-malware software/apps or other means to protect your smartphone*
    - *Download or install apps from sources outside the primary app store for your phone*
    - *Customize privacy settings*
    - *Password Protect apps that store sensitive data*
    - *Send or access sensitive data over public WiFi networks*
    - *Use an app or other service that allows you to locate, remotely access, erase, or disable your smartphone in case of loss or theft*
- *How safe do you believe people's personal information is when they use a mobile phone to pay for a purchase at a store?*
- *Which one of the following security aspects would cause you the most concern about using your mobile phone for financial transactions such as mobile banking or paying for a purchase in a store?*
    - *My phone getting hacked or someone intercepting my data*
    - *Someone using my phone without permission to access my account*

    - *Losing my phone or having my phone stolen*
    - *Malware or viruses being installed on my phone*
    - *Companies misusing my personal information*
    - *Companies not providing sufficient security to protect my mobile transactions*
    - *All of the above*
    - *No concerns/I think it is safe*
- *I am willing to allow my mobile phone to provide my location to companies I shop with regularly so that they can offer me discounts, promotions, or services based on where I am*
- *I am willing to answer security questions or provide additional information to my bank or credit union when I log into mobile banking so that my bank can enhance the security of my mobile transaction*

The variable category represented by W_1 includes the following survey question used to assess the participant's perception of **convenience** when first deciding to make a mobile payment:

- *What was the main reason why you started using mobile payments when you did?*
    - *I got a smartphone*
    - *I became comfortable with the security of mobile payments*
    - ***I liked the convenience of mobile payments***
    - *A store I visit started offering the service*
    - *To take advantage of loyalty or rewards points and discounts*

6. Findings

6.1 Univariate Analysis

Using Pearson's chi-squared test we are able to analyze some of the key differences between the mobile payment users and non-users.[1] With high statistical significance, the data has shown that participant's who have used mobile payments in the past 12 months and continue to use mobile payments in the next 12 months value security at a a much higher level than previous literature

[1] *See frequency tables and hypothesis testing in appendix*

suggests. Although many of these participants still see security concerns in the payment method, they take the proper measures to keep their information as safe as possible. This can best be observed in such survey questions as question 24 that explored the various methods by which a participant might have increased their mobile phones security in the past 12 months. This question highlighted how mobile payment users consistently took action to update and secure their phone and took precaution when using it for transactions related to sensitive information.

6.2 Logit Regression Analysis

The pseudo R^2 for this regression equals 0.21. Although this number is low, this is common in real-world examples, but could suggest improvement to the explanatory variables and regression model.

Looking first to the demographic explanatory variables included in the analysis we observe no statistically significant effect of gender on current or future use of mobile payments. This fits the existing literature that gender does not play a role in the overall trends of mobile payments given a roughly even distribution of males and females using (or not using) the payment transaction method. This also seems to fit the frequencies represented in the survey population with 89.0% of females and 85.8% of males indicating regular access to mobile phones, and approximately 76.0% of both males and females having a smartphone which, according to the logistic regression, increases an individual's probability of making a mobile payment by 5.14. Although one might assume that a higher income group might engage in more daily transactions and therefore increase the individual's likelihood of using an m-payment, the model indicates no statistically significant difference between those above and below the $75K income cut-off applied to the model. Despite the highest frequency of respondents in the "Less

than $25,000" annual salary category using mobile payments, 29% of individuals in the "Greater than $100,000" category still engage in mobile payments. The dummy variable dividing the five possible income groups likely played a role in limiting the analysis between the lower and upper extremes of income levels by mixing in the middle income groups. Future use of mobile payments was similarly insignificantly affected by the individual's income group. One's level of education follows a similar logic and shows no statistically significant impact on future or current use of mobile payments which is supported by the survey's approximately constant 25-30% participant use of m-payments at each of the four categories of education. This supports the improved "Perceived Ease of Use" characteristic crucial to our theoretical model of technology acceptance by showing that one's ability to adopt and use the technologies behind mobile payments does not differ based on education level.

Moving on to the remaining two measured demographics, we find statistically significant results for race and age on current and future use of mobile payments at the 5% level. Looking first to the age variable, this is supported in the previous existing literature that younger Americans are more likely to utilize mobile payments than older adults given their comfort with technology. With only 17.3% of individuals above the age 60 using mobile payments, this analysis could be open to further analysis using smaller categorical age ranges in order to evaluate whether or not there are statistically significant differences between the varying divisions of millennials that exist today. To no surprise, race/ethnicity does play an important role in the current and future use of mobile payments as there is a particularly large frequencies of non-White individuals who use mobile payments. In my research I did not find too many concrete studies that explored why this might be the case, but further studies could delve further into this understanding given that there is a clear effect on m-payment usage.

Now looking to the variables of convenience and security we see significant effect coming from the security questions of the mobile survey on current use, and less significance on future use. Specifically, the variables the correspond to Z_i all deal with the respondent's perception of security and positively affect the current use of m-payments. The more confident that the participant is in the security of the technology, the more likely they are to use it. Only 7.7% of respondents see no security concerns with financial transactions using your mobile phone, and overall confidence in the security level perceived by the survey participants plays a large role in the final decision of whether to use the technology or not. While this is mostly true for future use of mobile payments, question 47 does not seem to significantly effect one's future intent to use mobile payments.

Looking further into the variables of convenience and ability, some of the initial takeaways seem to fit the existing literature by showing that general accessibility to mobile payments does indeed lead to increased use of the technology. This is also supported by the 45% of individuals that indicated "convenience" as the primary reason why he/she started using mobile payments in the first place (as opposed to the only 7% who indicated that comfort with security was the primary reason). Additionally, 20% of participants chose "I got a smartphone" as the reason for starting, which points to the ability variable present in this study. Similar results are shown for the future use of mobile payments.

Fortunately, we do not have to concern ourselves with the interaction effect because of the lack of correlation in the data.[1] One important limitation to emphasize has to do with the number of individuals that were excluded from certain questions based on the sequence and base of the questionnaire. These missing observations exclude some potentially important information

[1] *See appendix for correlation matrix*

that could skew the data depending on the initial characteristics of those who were presented certain questions earlier in the survey. The overall data was ultimately smaller than I would have liked because of some of these missing data points.

Overall, the data ties in with the theoretical model showing that the higher the level of comfort, the better attitude that the participant shows toward mobile payments, and the higher likelihood that he/she chooses to use it during a payment transaction. Given panel data that tracks the participant's answers to the survey questions over several years, this analysis would further dive into the trends in mobile payments that could better indicate in which direction the U.S. population is headed. The security questions were constructed in a more explicit way that would have been beneficial had both the convenience and security questions been of a similar format. Additionally, the variable of trust was something that could have been explored as a potential indicator of future mobile technology use.

7. Conclusion

Compared to individuals outside of the United States, it still seems that cash, credit, and debit continue to dominant the payments space and will continue to do so for at least the next few years as mobile payments technologies continue to find their place in U.S. society. This recent data provided by the Federal Reserve points to the overall increase in mobile payment usage and the trend that is heading in the direction of increased adoption and usage. From this data we support the previous literature that emphasizes the importance that a consumer puts on the benefits of convenience, but add evidence to the discussion of the importance of security. Although the majority of participants recognized security issues that are important to address

when it comes to making mobile payments, a high frequency of those that currently use mobile payments make up those that still express concern with potential security issues. This goes to show that those security issues are often times not perceived to be threatening to the point of not using mobile payments all together, but further evidence would be required to prove that the reason for this comes from the participant's perception of convenience alone.

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9. Appendix

9.1 Correlation Matrix

	Q2	Q15_A	Q15_B	Q16_A	Q16_B	Q19	Q20	Q22	Q23	Q39	Q39_B	Q46	Q47	Q49	Q50	gender	inc	ppage	white	college
Q2	1																			
Q15_A	0.223419	1																		
Q15_B	0.094856	0.215927	1																	
Q16_A	0.070856	0.137833	0.14015	1																
Q16_B	0.048318	0.082981	0.477277	0.313761	1															
Q19	0.15992	0.189703	0.376437	0.145314	0.134366	1														
Q20	0.083382	0.125789	0.220873	0.186969	0.159661	#DIV/0!	1													
Q22	0.01433	0.0946	0.148535	0.158855	0.126055	#DIV/0!	0.253453	1												
Q23	0.022066	0.033915	0.100617	0.125332	0.118088	#DIV/0!	#DIV/0!	0.16576	1											
Q39_A	0.12895	0.099009	0.102718	-0.04303	0.04177	#DIV/0!	0.014737	0.050076	0.078523	1										
Q39_B	0.113458	0.067686	0.010617	0.03311	0.048249	#DIV/0!	-0.00612	-0.00269	-0.00281	0.029108	1									
Q46	0.077885	0.081176	0.167304	0.138005	0.11724	#DIV/0!	0.172529	0.196251	0.080239	0.04476	0.077189	1								
Q47	0.052306	0.061294	0.027922	0.048058	0.022215	#DIV/0!	0.043975	-0.00207	0.00625	0.003978	0.023462	0.048875	1							
Q49	0.01411	0.008391	0.085151	0.043964	0.089777	#DIV/0!	#DIV/0!	0.085301	0.064953	0.014132	0.032365	0.254973	0.017683	1						
Q50	0.096021	0.108191	0.146805	0.135695	0.095305	#DIV/0!	#DIV/0!	0.156497	0.109774	0.12019	0.114136	0.315062	0.125856	0.341956	1					
gender	0.017431	0.022706	-0.00841	0.017194	-0.01989	-0.02258	-0.01776	0.023738	0.034088	0.068373	-0.06484	0.065564	-0.0244	-0.03306	-0.01714	1				
inc	0.188925	0.248464	0.201697	0.152481	0.105666	0.133875	0.196925	0.083394	0.059456	0.106288	0.031245	0.148466	0.076651	-0.00111	0.122523	0.076722	1			
ppage	0.113845	-0.00035	-0.14379	-0.27267	-0.16644	-0.12361	-0.334	-0.26979	-0.1624	0.103077	-0.02135	-0.15977	0.036032	-0.13543	-0.14206	0.037241	0.014804	1		
white	0.144248	0.119948	-0.0413	-0.03756	-0.07305	-0.0203	-0.08712	-0.076	-0.11154	0.023648	0.039316	-0.02058	0.059986	-0.03627	0.053087	0.060682	0.168105	0.193411	1	
college	0.143208	0.151807	0.105339	0.177919	0.087713	0.076305	0.086159	0.076486	0.011541	0.018514	0.079245	0.101735	0.052146	0.014106	0.097434	0.040825	0.315592	0.013946	0.151296	1

9.2 Frequencies Tables and Chi-Square tests for significance

Q33 – Have you made a mobile payment in the past 12 months?	**Yes (users)**	**No (non-users)**	**Statistical Significance Test (Chi-square test of independence)**
Q22: How confident are you in your ability to understand and navigate the technology and features of your mobile phone?	Confident: 97% Not confident: 2.3%	Confident: 84% Not confident: 14%	Reject the null ($p<0.05$) that CONFIDENCE and mobile payment usage is independent
Q23: Do you password protect your smartphone?	Yes: 82% No: 16.7%	Yes: 62% No: 37%	Reject the null ($p<0.05$) that PASSWORD PROTECTION ("YES") is independent of mobile payment usage
Q24_A: In the past 12 months, have you installed updates to	Yes: 93.7% No: 5.8%	Yes 79.4% No: 20.48%	Reject the null ($p<0.05$) to answering "Yes"

your mobile operating system or your apps?			
Q24_B: In the past 12 months, have you changed the password on your phone or apps?	Yes: 61.79% No: 37.71%	Yes: 35.13% No: 67.75%	Reject the null ($p<0.05$) to answering "Yes"
Q24_F: Do you password protect apps that store sensitive data?	Yes: 56.6% No: 42.8%	Yes: 31.7% No: 67.75%	Reject the null ($p<0.05$) to answering "Yes"
Q24_G: Do you send or access sensitive data over public WiFi networks?	Yes: 36% No: 62.96%	Yes: 15.88% No: 84.12%	Reject the null ($p<0.05$) to answering "Yes"
Q24_H: Do you use an app or other service that allows you to locate, remotely access, erase, or disable your smartphone in case of loss or theft (e.g., Apple "Find my iPhone" or BullGuard)?	Yes: 46.68% No: 52.66%	Yes: 27.47% No: 72.04%	Reject the null ($p<0.05$) to answering "Yes"
Q26: Have you used mobile banking in the past 12 months?	Yes: 84.56% No: 14.93%	Yes: 28.06% No: 71.48%	Reject the null ($p<0.05$) to answering "Yes"
Q34_A: Using your mobile phone, in the past 12 months have you sent money to relatives or friends within the U.S.?	Yes: 21.51% No: 78.19%		
Q34_B: Using your mobile phone, in the past 12 months have you sent money to relatives or friends outside of the U.S.?	Yes: 4.76% No: 94.32%		
Q34_C: Using your mobile phone, in the past 12 months have	Yes: 32.57% No: 66.97%		

you paid for something in a store using your mobile phone/app instead of cash or a physical payment card?			
Q34_D: Using your mobile phone, in the past 12 months have you paid for parking, a taxi, car service, or public transit?	Yes: 15.67% No: 83.72%		
Q34_E: Using your mobile phone, in the past 12 months have you paid a bill using your mobile phone's web browser or an app?	Yes: 63.44% No: 35.94%		
Q34_F: Using your mobile phone, in the past 12 months have you purchased a physical item or digital content remotely by using your mobile phone's web browswer or an app?	Yes: 41.63% No: 57.91%		
Q34_G: Using your mobile phone, in the past 12 months have you made a donation or other payment using a text message?	Yes: 10.6% No: 88.33%		
Q46: How safe do you believe people's personal information is when they use a mobile phone to pay for a purchase at a store?	Safe: 65% Unsafe: 26%	Safe: 29% Unsafe: 55%	Reject the null ($p<0.05$) to answering "Yes"
Q34A: You indicated that you have not		Yes: 15.6% No: 84%	

made a mobile payment in a store in the past 12 months. Do you plan to use your mobile phone to make a payment in a store in the next 12 months?			
Q43: Reasons why you do not use mobile payments (top choices)		67.1% - I'm concerned about the security of mobile payments 80% - It's easier to pay with cash or credit/debit card 65% - I don't see any benefit from using mobile payments 47.5% - I don't trust the technology	
Q44: Assuming that the reason(s) why you do not currently use mobile payments was addressed, would you be interested in doing any of the following activities with your mobile phone?		74.2% chose "None, I don't want to use mobile payments"	

Q20: A smartphone is a mobile phone with features that may enable it to access the web, send e-mails, download apps, and interact with computers. Smartphones include the iPhone, Blackberry, as well as Android and Windows Mobile powered devices.	**Yes**	**No**	**Statistical Significance Test (Chi-square test of independence)**

Is your mobile phone a smartphone?			
Q33: Have you made a mobile payment in the past 12 months?	Yes: 27% No: 72%	Yes: 6.7% No: 93%	Reject the null ($p<0.05$) to answering "Yes"
Q33: ANDROID USERS	Yes: 25.9% No: 73.74%		
Q33: IPHONE USERS	Yes: 31% No: 68%		

9.3 Logistic Regression

Q33	Odds Ratio	Std. Error	z	P>|z|	95% conf. interval	
Q1	1.06	0.32	0.18	0.86	0.58	1.93
Q15_A	**0.41**	**0.08**	**-4.51**	**0.00**	**0.27**	**0.60**
Q15_B	**1.61**	**0.24**	**3.23**	**0.00**	**1.21**	**2.14**
Q16_A	1.15	0.17	0.96	0.34	0.87	1.52
Q16_B	1.27	0.18	1.71	0.09	0.96	1.68
Q22	**6.45**	**4.73**	**2.54**	**0.01**	**1.53**	**27.13**
Q23	**2.04**	**0.30**	**4.89**	**0.00**	**1.53**	**2.72**
Q46	**3.82**	**0.50**	**10.30**	**0.00**	**1.61**	**5.08**
Q47	**2.86**	**0.84**	**3.60**	**0.00**	**1.61**	**5.08**
Q49	**1.40**	**0.17**	**2.74**	**0.01**	**1.10**	**1.78**
Q50	**2.14**	**0.39**	**4.17**	**0.00**	**1.50**	**3.06**
gender	0.86	0.10	-1.22	0.22	0.68	1.09
inc	0.98	0.13	-0.16	0.87	0.75	1.28
white	**0.52**	**0.07**	**-5.21**	**0.00**	**0.41**	**0.67**
college	0.99	0.13	-0.11	0.91	0.76	1.28
ppage	**0.98**	**0.00**	**-4.06**	**0.00**	**0.98**	**0.99**
constant	0.01	0.01	-5.03	0.00	0.00	0.07

Q34A	Odds Ratio	Std. Err.	z	P>|z|	95% Conf. Interval	
Q1	0.73	0.26	-0.89	0.38	0.37	1.45
Q15_A	0.68	0.16	-1.70	0.09	0.43	1.06
Q15_B	1.16	0.20	0.89	0.37	0.83	1.63
Q16_A	**1.72**	**0.30**	**3.16**	**0.00**	**1.23**	**2.41**
Q16_B	1.32	0.22	1.66	0.10	0.95	1.84
Q22	1.99	1.08	1.28	0.20	0.69	5.75
Q23	**1.92**	**0.32**	**3.85**	**0.00**	**1.38**	**2.67**
Q46	**3.52**	**0.54**	**8.26**	**0.00**	**2.61**	**4.75**
Q47	1.03	0.30	0.10	0.92	0.58	1.82
Q49	**2.36**	**0.34**	**5.94**	**0.00**	**1.78**	**3.13**
Q50	**2.51**	**0.57**	**4.06**	**0.00**	**1.61**	**3.92**
gender	0.89	0.13	-0.79	0.43	0.68	1.18
inc	0.99	0.16	-0.04	0.97	0.73	1.36
white	**0.51**	**0.07**	**-4.60**	**0.00**	**0.38**	**0.68**
college	0.82	0.13	-1.27	0.20	0.60	1.11
ppage	**0.99**	**0.01**	**-2.33**	**0.02**	**0.98**	**1.00**
constant	0.04	0.03	-4.40	0.00	0.01	0.16

9.4 Number of observations

Variable	# observations
Q1	2510
Q15	2510
Q16	2510
Q19	2510
Q20	2244
Q22	2244
Q23	1680
Q39	436
Q46	2244
Q47	2244
Q49	1680
Q50	1680
Q33	2244
Q34A	2045

9.5 Variables and Recoding

Category	Variable Label (Survey question # → assigned variable name)	Description	Type	Adaption	Sign
Ability	Q1 → X_1	Do you currently have a checking, savings or money market account? *Yes or No*	dummy	Yes = 1 No = 0	positive
	Q15_A and Q15_B → X_2 and → X_3	Do you currently have regular access to the internet at your home that is not provided by GfK? 1. Using a computer? 2. Using a tablet? *Yes or No [GRID]*	dummy	Only single YES for either Q15_A or Q15_B needed	positive
	Q16_A and Q16_B → X_4 and → X_5	Do you currently have regular access to the internet outside your home (e.g., at school, work, public library, etc.)? 1. Using a computer? 2. Using a tablet? *Yes or No [GRID]*	dummy	Only single YES for either Q16_A or Q16_B needed	positive
	Q19 → X_6	Do you own or have regular access to a mobile phone (cell phone)?	Dummy	Yes = 1 No = 0	positive

		Yes or No			
	Q20 → X_7	Is your mobile phone a smartphone? *Yes or No*	Dummy	Yes = 1 No = 0	positive

Comfort	Q22 → Y_1	How confident are you in your ability to understand and navigate technology and features of your mobile phone? 1. Very confident 2. Somewhat confident 3. Not confident	Dummy	Option 1&2 = YES, comfortable Option 3 = NO, not comfortable	positive

Convenience	Q39_A → W_1	What was the **main** reason why you started using mobile payments when you did? **3. I became comfortable with the security of mobile payments**	Dummy	Yes = 1 No = 0	Positive
	Q39_B → W_1	What was the **main** reason why you started using mobile payments when you did? **4. I liked the convenience of mobile payments**	Dummy	Yes = 1 No = 0	Positive

Security	Q23 → Z_1	Do you password protect your smart phone? *Yes or No*	Dummy	Yes = 1 No = 0	neutral
	Q24 → Z_2	In the past 12 months, have you taken any of the following actions with your smartphone? 1. Install updates to your mobile operating system or your apps 2. Change password on your phone or apps 3. Use anti-malware software or other means to protect your smartphone 4. Download or install apps from sources **outside** the primary app store for your phone 5. Customize privacy settings 6. Password protect apps that store sensitive data 7. Send or access sensitive	Dummy	Yes = 1 No = 0 For each individual response	positive

		data over public WiFi networks 8. Use an app or other service that allows you to locate, remotely access, erase, or disable your smartphone in case of loss or theft *Yes or No to each option*			
	Q46 → Z_3	How safe do you believe people's personal information is when they use a mobile phone to pay for a purchase at a store? 1. Very safe 2. Somewhat safe 3. Somewhat unsafe 4. Very unsafe *Choose one option*	Dummy	Options 1&2 = FEEL SAFE Options 3&4 = FEEL UNSAFE	FEEL SAFE = positive FEEL UNSAFE = negative
	Q47 → Z_4	Which one of the following security aspects would cause you the **most concern** about using your mobile phone for financial transactions	Dummy	Options 1-8 = YES concerns = 1 Option 9 = NO concerns = 0	negative

		such as mobile banking or paying for purchase in a store? 1. My phone getting hacked or someone intercepting my data 2. Someone using my phone without permission to access my account 3. Losing my phone or having my phone stolen 4. Malware or viruses being installed on my phone 5. Companies misusing my personal information 6. Companies (merchants, banks, third parties) not providing sufficient security to protect my mobile transactions 7. All of the above 8. Other (please specify) 9. No concerns/I think it is safe			

	Q49 → Z_5	I am willing to allow my mobile phone to provide my location to companies I shop with regularly so that they can offer me discounts, promotions, or services based on where I am. 1. Strongly agree 2. Agree 3. Disagree 4. Strongly disagree *Choose one option*	Dummy	Options 1&2 = AGREE Options 3&4 = DISAGREE	AGREE = positive DISAGREE = negative
	Q50 → Z_6	I am willing to answer security questions or provide additional information to my bank or credit union when I log into mobile banking so that my bank can enhance the security of my mobile transaction 1. Strongly agree 2. Agree 3. Disagree 4. Strongly disagree	Dummy	Options 1&2 = AGREE Options 3&4 = DISAGREE	AGREE = positive DISAGREE = negative

Demographics	ppage (age)	How old are you?	Scale		
	gender	Male or Female	Dummy	0 = female 1 = male	neutral
	college (education level)	Less than high school, high school degree, some college, bachelor's degree or higher	Dummy	0 = less than bachelor's degree 1 = bachelor's degree or higher	neutral
	white (race/ethnicity)	White (non-hispanic), Black (non-hispanic), Other (non-hispanic), Hispanic, 2+ races (non-hispanic)	Dummy	0 = non-White 1 = White	negative
	inc (income group)	Less than $25K, $25-39.9K, $40-74.9K, $75-99.9K, Greater than $100K	Dummy	0 = Less than $75K 1 = Greater than $75K	Positive

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