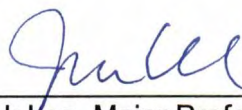


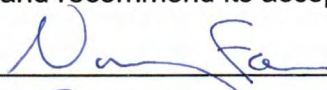
To the Graduate Council:

I am submitting herewith a dissertation written by Eun-Ju Lee entitled "Consumer Adoption and Diffusion of Technological Innovations: A Case of Electronic Banking Technologies." I have examined the final copy of this dissertation for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy, with a major in Human Ecology.

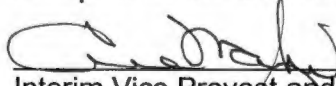


Jinkook Lee, Major Professor

We have read this dissertation
and recommend its acceptance:



Accepted for the Council:



Interim Vice Provost and
Dean of The Graduate School

CONSUMER ADOPTION AND DIFFUSION OF
TECHNOLOGICAL INNOVATIONS: A CASE OF ELECTRONIC
BANKING TECHNOLOGIES

A Dissertation
Presented for the
Doctor of Philosophy
Degree
The University of Tennessee, Knoxville

Eun-Ju Lee
December 2000

Copyright © Eun-Ju Lee, 2000

All rights reserved

DEDICATION

This dissertation is dedicated to Sung Keun Lee,
Dr. Kwang-Bae Lee and Oak Kyung Hwang -- my family.

ACKNOWLEDGMENTS

There are many people to whom I am grateful for their encouragement and guidance during the entire process of this dissertation research project. I owe a special thanks to my Dissertation Committee, Dr. Jinkook Lee, Dr. David Schumann, Dr. David Eastwood, and Dr. Nancy Fair for their expertise, support, and encouragement. This project could not have been possible without this wonderful team of people. I especially thank for Dr. Lee's persistence and determination to encourage me to do the good work. I also thank Dr. Eastwood, who spent numerous hours with me to teach me how to conduct econometric analysis and prepare a manuscript properly. I appreciate Dr. David Schumann, who is not only a role model of professorship, but also a true mentor to me. I am grateful to Dr. Nancy Fair, who always made important suggestions during the meetings. I would like to thank Jeanne Hogarth, Jane Kolodinsky, and Jeffrey Shue for their help in survey development.

I would also like to thank my Father and Mother for their encouragement. Thank you for never giving up your belief that I could make a difference.

It is to my husband, Sung Keun Lee, that I am most grateful for his understanding and emotional support throughout my doctoral studies. Without his encouragement, I could not have finished this dissertation project. Thank you Sung Keun, for your warmth, love, and endurance.

ABSTRACT

Today, technological advancements occur rather constantly as companies introduce innovative products and services to consumers. Consequently, technological innovations have brought fundamental changes in many areas of consumers' lives. One such area is exchange, transactions, and contacts mediated by electronic technology.

Among many technological innovations, electronic banking is currently one of the most available technological options to consumers. Electronic banking technologies refer to all the financial activities involving electronic media such as Automated Teller Machines (ATMs), debit cards, direct deposit/payment, smart cards, and computer banking. Using these electronic banking technologies, consumers can conduct fast and convenient financial transaction activities and obtain their account information without paying a visit to bank branches.

This study presents a model of consumer adoption and diffusion of technological innovations. This model conceptualizes that an individual consumer's adoption of a technological innovation is influenced by consumer, innovation, and communication factors. First, consumer factors refer to characteristics of consumers such as demographic and socioeconomic characteristics. Consumers' particular characteristics may affect their decision to adopt technological innovations. Second, innovation factors include consumers' perceived innovation characteristics. How consumers perceive a technology, e.g., as useful, reliable, secure is believed to influence their decision to adopt and use the technology. Finally, communication factors refer to how the information about technological innovation is passed on to consumers. Channel and mode of communication are considered to have impacts on consumer adoption of technological innovations.

Three research objectives are generated from the conceptual model. The first objective is to examine the extent to which consumers adopt a variety of electronic banking technologies and to describe the characteristics of adopters and non-adopters of electronic banking technologies. The second objective is to identify the underlying factors that affect consumer adoption of electronic banking technologies accurately. The third objective is to investigate the role of communication in consumer adoption of electronic banking technologies. In order to address each objective, three independent yet related studies were conducted employing two nationally representative databases: The 1995 *Survey of Consumer Finances* (SCF) commissioned by Federal Reserve Board and the 1999 University of Michigan *Survey of Consumers*.

The first study examined the diffusion of various electronic banking technologies, such as ATMs, debit cards, smart cards, direct deposit, and direct payment, along with the characteristics of adopters and non-adopters of those technologies. Using the 1995 Survey of Consumer Finances, it was found that, in general, more educated, more affluent, and younger consumers who are likely to communicate with professional information providers tend to adopt electronic banking technologies more readily than their counterparts. However, the specific factors that affect the adopters' decision varied across different types of banking technologies.

The second study investigated the impacts of innovation and consumer factors on adoption of both mature and newer innovations, i.e., ATMs and computer banking. Accessibility is an important factor that needs to be accounted for in modeling consumer adoption of computer banking because a consumer's decision to adopt the electronic banking technologies can be restricted by whether the consumer has access to the technologies. Therefore, accessibility was explicitly incorporated in modeling consumer

adoption of computer banking. An adjustment to avoid biased estimation was made by employing a censored probit model. Using a national sample of 890 consumers, the empirical model estimated the effects of perceived innovation characteristics and consumer characteristics on the adoption computer banking and the ATM.

Results suggested that there was significant sample selection bias with regard to access when estimating the consumer adoption of computer banking. It was found that individual socioeconomic characteristics were significant predictors of accessibility to computer banking. Perceived innovation characteristics were highly significant in influencing consumers' adoption of both computer banking and ATMs. The results suggest the importance of communication strategies to change consumers' perceptions of electronic banking technologies as secure, reliable, convenient, and easy-to-use.

The third study explored communication strategies to facilitate diffusion of innovations. More specifically, the effects of channel and communication mode on consumers' adoption of electronic banking innovations were examined with the proposed taxonomy of channel and communication mode. Using data from the 1999 University of Michigan Survey of Consumers, consumers were classified into five electronic-banking-user clusters. Individual consumers' adoption was influenced by communication patterns, and innovators and laggards were found to have different preferences for channel and communication mode. Therefore, innovators and laggards can be reached effectively by adopting the right channel and communication mode. Laggards need tailored communication efforts that consider their preference for interpersonal, conversational communication. Innovators can be reached relatively easily via written communication from professional information sources.

In sum, the three research studies reveal that consumer adoption and diffusion of electronic banking technologies are influenced by joint influences of consumer, innovation, and communication factors. Among these factors, consumers' perceptions of innovations are a more important determining factor of their adoption decisions than consumers' demographic characteristics. In addition, when predicting adoption of newer innovations such as computer banking, accessibility also needs to be considered in order to adjust for sample selection bias. Communication is the process that diffusion agents, such as financial institutions and the government, can use to influence consumer adoption of electronic banking technologies. In order to facilitate consumer adoption, it is necessary to promote convenient, secure, reliable, and easy-to-use features to potential adopters by employing appropriate channels and communication modes. Finally, implications for practitioners, policy makers, and future research are discussed.

TABLE OF CONTENTS

CHAPTER	PAGE
PART I: OVERVIEW	
1. INTRODUCTION	1.
2. THEORETICAL FRAMEWORK.....	4.
3. PURPOSE OF THE RESEARCH	8
4. DISSERTATION ORGANIZATION	10
REFERENCES	12
PART II: HAVEN'T ADOPTED ELECTRONIC FINANCIAL SERVICES YET?	
THE ACCEPTANCE AND DIFFUSION OF ELECTRONIC BANKING TECHNOLOGIES	
1. BACKGROUND	16
2. LITERATURE REVIEW	19
Characteristics of Adopters and Non-adopters.....	20
3. METHODOLOGY.....	23
Data	23
Dependent variables	24
Explanatory variables	24
Analysis	26
4. RESULTS.....	28
The Extent of Consumer Adoption.....	28
Demographic Profiles of Adopters and Non-adopters.....	28
Multivariate Analysis of Adoption Factors.....	31
5. DISCUSSION.....	34
6. CONCLUSIONS AND IMPLICATIONS.....	37
REFERENCES	40

**PART III: A CENSORED PROBIT MODEL OF CONSUMER ADOPTION OF
INNOVATION: A CASE OF ELECTRONIC BANKING TECHNOLOGIES**

1. INTRODUCTION	50
2. CONCEPTUAL MODEL	53
Access to Electronic Banking Technologies	53
Adoption of Electronic Banking Technologies	53
Perceived Innovation Characteristics	54
Individual Characteristics	58
3. EMPIRICAL MODEL: SAMPLE SELECTION AND TWO STEP ESTIMATION	60
Data and Sample Characteristics	63
Measures	63
Analysis	64
4. RESULTS	66
Descriptive Analysis	66
Factor Analysis	67
Probit Analysis	67
5. DISCUSSION	69
6. CONCLUSIONS AND IMPLICATIONS	72
REFERENCES	75

**PART IV: EFFECTS OF CHANNEL AND COMMUNICATION MODE ON CONSUMER
ADOPTION OF ELECTRONIC BANKING INNOVATIONS**

1. INTRODUCTION	92
2. BACKGROUND: DIFFUSION OF ELECTRONIC BANKING INNOVATIONS	94
3. LITERATURE REVIEW	95
Communication Channels/ Information Sources	95
Communication Mode: Written Versus Conversational	97
Adopter Categories and Channel Preferences	98
Relationships among Communication Channels and Modes	99

CHAPTER	PAGE
4. METHODOLOGY.....	101
Data	101
Measures.....	101
Analysis	103
5. RESULTS.....	105
Cluster Analysis and Descriptive Analyses.....	105
Communication Pattern.....	107
Multinomial Logit Analysis	110
6. DISCUSSION, CONCLUSIONS, AND IMPLICATIONS.....	114
REFERENCES	117

PART IV: SUMMARY

1. SUMMARY AND CONCLUSIONS.....	133
2. IMPLICATIONS.....	137
Implications for Practitioners.....	137
Implications for Policy Makers.....	140
Implications for Academicians and Future Research.....	141
VITA	144

LIST OF TABLES

CHAPTER	PAGE
PART II: HAVEN'T ADOPTED ELECTRONIC FINANCIAL SERVICES YET?	
THE ACCEPTANCE AND DIFFUSION OF ELECTRONIC BANKING TECHNOLOGIES	
II-1. Description of Variables	44
II-2. Adopters and Non-Adopters of Electronic Banking Technologies	45
II-3. Adoption Rate of Five Electronic Banking Technologies Across Demographic Characteristics	46
II-4. RII (Repeated Imputed Inferences) Results of Logistic Regression of Adoption of Electronic Financial Services.....	48
PART III: A CENSORED PROBIT MODEL OF CONSUMER ADOPTION OF	
INNOVATION: A CASE OF ELECTRONIC BANKING TECHNOLOGIES	
III-1. Frequencies of Access and Adoption (N=890).....	81
III-2. Descriptive Statistics	82
III-3a. Results of Factor Analysis with Varimax Rotation: Factor Scores Used For Computer Banking Adoption.....	84
III-3b. Results of Factor Analysis with Varimax Rotation: Factor Scores Used for ATM Adoption	85
III-4. Results of Probit Analyses: Computer Banking and ATM.....	86

CHAPTER	PAGE
III-5a. Frequencies of Actual and Predicted Outcomes:Computer Banking Access.....	87
III-5b. Frequencies of Actual and Predicted Outcomes: Computer Banking Adoption (Based on N=531).....	87
III-5c. Frequencies of Actual and Predicted Outcomes: ATM Adoption.....	88
III-6. Summary of Hypotheses Testing.....	89
PART IV: EFFECTS OF CHANNEL AND COMMUNICATION MODE ON CONSUMER ADOPTION OF ELECTRONIC BANKING INNOVATIONS	
IV-1. Taxonomy of Channels and Communication Modes.....	122
IV-2. Variables	123
IV-3. Results of Cluster Analysis: Percentage of Respondents Who Used a Particular Electronic Banking Technology during the Past 12 Months.....	124
IV-4. Demographic Characteristics by Cluster.....	125
IV-5. Percentage of Respondents Who Received a Particular Type of Information....	126
IV-6. Perceived Usefulness of Information Among Consumers Who Received Information	127
IV-7. Communication Mode and Perceived Usefulness	128
IV-8. Results of Multinomial Logit Analysis: Maximum Likelihood Analysis.....	129

LIST OF FIGURES

CHAPTER	PAGE
PART 1: OVERVIEW	
I-1. A Conceptual Model of Consumer Adoption and Diffusion of Technological Innovations.....	13
PART III: A CENSORED PROBIT MODEL OF CONSUMER ADOPTION OF INNOVATION: A CASE OF ELECTRONIC BANKING TECHNOLOGIES	
III-1. The Conceptual Model.....	90
PART IV: EFFECTS OF CHANNEL AND COMMUNICATION MODE ON CONSUMER ADOPTION OF ELECTRONIC BANKING INNOVATIONS	
IV-1. Odds Ratios: The Effect of Receiving Information from Family and Friends on Adoption of Electronic Banking Technologies.....	130
IV-2. Odds Ratios: The Effect of Receiving Conversational Information from Financial Institutions on Adoption of Electronic Banking Technologie.....	131

PART I

OVERVIEW

CHAPTER 1

INTRODUCTION

Technological progress is a mechanism by which society is able to produce greater efficiency and wealth. Today, technological advancements occur rather constantly as companies introduce innovative products and services to consumers. Robertson (1971) notes that "product innovation is critical to growth of American firms ... The pace of technological advances, coupled with the American consumer's receptivity of progress and "newness" is shortening the life cycles of products" (p.3). Consequently, technological innovations have brought fundamental changes in many areas of consumers' lives. One such area is exchange, transactions, and contacts mediated by electronic technology (Dalton 1999).

Among many technological innovations, electronic banking is increasingly available to consumers. Electronic banking technologies refer to all the financial activities involving electronic media such as Automated Teller Machines (ATMs), debit cards, direct deposit, direct payment, smart cards, and computer banking. Using these electronic banking technologies, consumers can conduct fast and convenient financial transaction activities and obtain their account information without paying a visit to bank branches. Advantages of electronic banking technologies include saving time, convenience, increased access to information on their bank accounts, and effective management of personal finances.

Financial institutions seek diffusion of electronic banking technologies to their customers as they anticipate efficiency in operating costs. The costs of processing electronic checks are only a fraction of the costs involved in paper checks (Sheth and

Sisodia 1999). In addition, providing convenient, innovative services to customers is a viable company strategy to achieve customer loyalty and a competitive advantage over existing and potential rivals. Many financial institutions' enthusiasm for electronic payment system is also shared by public policy makers. Recently, the federal government initiated a set of plans to facilitate paper check conversion to electronic payment technology. For example, the Electronic Fund Transfer (EFT) Act mandates electronic disbursement of Social Security benefits through the Automated Clearing House (ACH) network (Department of Treasury 1999).

As alternative electronic banking options become available, an increasing number of consumers are expected to use them. However, paper checks still dominate the U.S. payment system (Bank for International Settlements 1995), although the relative importance of electronic payments has increased. Using the 1995 Survey of Consumer Finances, Kennickell and Kwast (1997) reported how households prefer to conduct their business with financial institutions. Among the households that use at least one financial institution, the majority (87%) of households preferred to conduct their banking business in person to as opposed to using electronic banking technologies.

The evidence for consumers' reluctance to use electronic banking technologies calls for a scholarly inquiry about the underlying factors influencing individual consumers' decisions to adopt electronic banking technologies. In the literature, consumers' adoption of technological innovations is consistent with the theory of diffusion of innovations. In the next section, an overview of the theory of diffusion of innovations and a conceptual model of consumer adoption and diffusion of technological innovations as depicted in Figure I-1* are presented.

* All tables and figures can be found in the appendices.

CHAPTER 2

THEORETICAL FRAMEWORK

The diffusion of innovation theory has been applied as a powerful theoretical framework to explain how technological innovations spread across consumers in a society (Gatignon and Robertson 1985). Rogers defines diffusion of innovation as "the process by which an innovation is communicated through certain channels over time among the members of a social system" (p.10). Given this definition, diffusion of innovation involves four main elements: innovation, communication channels, time, and the social system.

Innovation. An innovation is "an idea, practice, or object that is perceived as new by an individual or other unit of adoption" (Rogers 1995, p.11). Here, innovation is defined as a subjective perception rather than an objective entity. In fact, individuals can have different perceptions about a particular technological innovation. The perceived characteristics of innovations, such as relative advantage, compatibility, complexity, triability, and observability, are proposed to determine individual consumers' decision to adopt technological innovations (Rogers 1995). The diffusion theory suggests that one's adoption of an innovation depends on how one perceives the innovation as "better than the idea it supercedes" (relative advantage), "consistent with the existing values, past experiences, and needs of potential adopters" (compatibility), and easy to understand and use as opposed to difficult (complexity). Adoption of the innovation increases when

a consumer has an opportunity to try it before actual adoption (trialability), and when the results of the innovation are visible to others (observability) (p. 15-16).¹

Communication. An innovation is first introduced to early adopters through professional or specialized channels of communication. Once the innovation is introduced to consumers, communication must take place for the innovation to be diffused across many consumers, and finally, to reach the critical mass.²

Communication is "a process in which participants create and share information with one another in order to reach a mutual understanding" (Rogers 1995, p.6). Rogers notes that "the essence of the diffusion process is the information exchange through which one individual communicates a new idea to one or several others" (p.17-18). Information about a technological innovation can travel through a variety of *channels* of communication to be diffused among the members of a social system. At the micro level, a communication channel is the means by which messages travel from one point to another, mostly through contacts between members in a communication dyad. At the macro level, communication is the process by which individuals' cumulative adoptions amount to an aggregate demand for a given innovation -- *diffusion* of innovations. As such, communication is the process of aggregation leading to collective adoption, or diffusion of innovations.

The nature of communication channels and the exchange relationship between the parties involved in communication often determine the effect of transfer on adoption. Diffusion researchers have been interested in identifying the sources of influence within

¹ A more detailed discussion of these characteristics is presented in Part III, pages 54-58.

communication channel analysis. For example, Bass and his colleagues (1969, 1990) make a distinction between innovators and imitators based on the source of influence. Rogers (1995) suggests that a diffusion effect defined as the cumulatively increasing degree of influence upon an individual to adopt or reject an innovation, results from the activation of relevant information or interpersonal networks about the innovation.

Time. It takes time for innovations to be diffused and adopted within a population of consumers. The amount of time taken for an innovation to be adopted or rejected has been one of the important research issues in the innovation and diffusion literature (Olshavsky 1980). Consumers vary in "Innovativeness" -- the degree to which an individual is relatively early in adopting a technological innovation (Rogers 1995, p. 22) and can be classified into five groups of adopters according to a continuum of innovativeness: innovators, early adopters, early majority, late majority, and laggards (p. 262). At the earliest stage of diffusion, only innovators, who compose about 2.5 percent of total population, have adopted the innovation. At the second stage of diffusion, early adopters (the next 13.5 percent) begin to adopt the innovation. In the third stage of diffusion, about one-half of the total population including early majority, early adopters, and innovators adopts the innovation. The next stage of diffusion involves adoption by most members of the society (up to 84 percent) except laggards (the last 16 percent). Finally, cumulative adopter distributions tend to follow an S-shaped curve that approaches the cumulative normal distribution over time.

² The *critical mass* occurs "at the point in which enough individuals have adopted an innovation so that the innovation's further rate of adoption becomes self-sustaining" (Rogers 1995, p.313)

Social System. Diffusion takes place within a social system where individuals are linked by interpersonal networks. The rate of adoption of an innovation is influenced by macroscopic factors, such as social structure, cultural norms and values, and the nature of interpersonal networks (Rogers 1995). For example, in a collective social system, the decision to adopt a particular innovation is often guided by groups or the authority, whereas in an individualistic system, the decision is more autonomous. However, the macroscopic variables of social system have not been extensively analyzed in the consumer behavior literature.

Based on the above discussion, a conceptual model of consumer adoption and diffusion of technological innovations is presented (see Figure I-1). This model conceptualizes that, in a given social system, an individual consumer's adoption of a technological innovation is influenced by consumer factors, innovation factors, and communication factors. When individual consumers' decisions to adopt or reject an innovation are aggregated, it amounts to diffusion in the social system. As an overview of the dissertation, the proposed model depicts the scope of inquiry for this research project. In addition, the objectives of research are also generated from the conceptual model. Continuous lines in Figure I-1 represent the paths investigated in this study, and dotted lines correspond to the relationships that are not explicitly examined in this particular study.

CHAPTER 3

PURPOSE OF THE RESEARCH

The primary purpose of this dissertation is to investigate consumer adoption and diffusion of technological innovations. Electronic banking technologies are chosen for this investigation because of their theoretical and temporal relevance. The category of "electronic banking" includes various technological innovations that are currently at different diffusion stages. For example, ATM has been in the market over 30 years, whereas computer banking was introduced only recently. Temporal diversity within the category of electronic banking technologies allows a theoretical examination of impacts of consumer, innovation, and communication factors on adoption of technological innovations at different stages.

The examination of consumer, innovation, and communication factors in consumer adoption of electronic banking technologies comprises the objective of this research project (Figure I-1). Specifically, the objectives of research are threefold. The first objective is to examine consumer factors -- specifically the extent to which consumers adopt a variety of electronic banking technologies and the characteristics of adopters and non-adopters of electronic banking technologies. The examination of consumer factors is presented in Part II and, to a lesser extent, in part III.

The second objective is to investigate innovation factors, especially the effects of perceived innovation characteristics on consumer adoption of electronic banking technologies. Selected innovation factors and their impacts on consumer adoption are examined in Part III.

The third objective is to investigate communication factors. Examination of the effects of channel and communication modes on consumer adoption of electronic banking technologies makes up Part IV. Consumers' use of professional information sources is also partly investigated in Part II.

CHAPTER 4

DISSERTATION ORGANIZATION

The aforementioned research objectives tap into three distinct aspects of diffusion of technological innovations. In order to achieve these research objectives, this dissertation is organized into five parts. A brief description of each part is presented below.

Part I introduces the impetus for studying the phenomenon of consumer adoption and diffusion of electronic banking technologies, and provides an overview of the dissertation with a conceptual model based on the theory of diffusion of innovations.

Part II investigates the current status of consumer acceptance and diffusion of electronic banking technologies, and the effects of consumer factors on their adoption decisions. Specifically, the extent to which consumers have adopted various electronic banking technologies is examined and the profiles of adopters and non-adopters are presented.

Part III examines the effect of innovation factors, specifically, perceived innovation characteristics, using an advanced modeling technique for estimating consumer adoption of computer banking and ATM. Especially, in the case of adoption of newer innovation, i.e., computer banking, limited accessibility can cause selection bias in parameter estimation. A two-step censored probit model is presented in this section to predict consumer adoption adjusting for sample selection bias. In addition to perceived innovation characteristics, individual socioeconomic characteristics are also included in investigation.

Part IV examines communication factors as potential facilitators of consumers' adoption of electronic banking technologies. Specifically, the effects of channel and communication modes on consumers' adoption of electronic banking technologies are investigated and implications for communication strategies are discussed.

Tables and figures appear in appendix at the end of each chapter.

REFERENCES

- Bass, Frank M. (1969), "A New Product Growth Model for Consumer Durables," *Management Science*, 15 (January), 215-227.
- Dalton, Grogory (1999, April 19), "E-Bills Arrive," *IW* [WWW Document] URL <http://www.informationweek.com> [viewed June 7, 2000].
- Gatignon, Humbert and Thomas S. Robertson (1985), "A Propositional Inventory for New Diffusion Research," *Journal of Consumer Research*, 11 (March), 849-867.
- Kennickell, Arthur. B. and M. L. Kwast, (1997). *Who uses electronic banking? Results from the 1995 Survey of Consumer Finances*. Paper presented at the Annual Meeting of the Western Economic Association, July, Seattle, Washington.
- Mahajan, Vijay, Eitan Muller, and Frank M. Bass (1990), "New Product Diffusion Models in Marketing: A Review and Directions for Research," *Journal of Marketing*, 54 (January), 1-26.
- Olshavsky, R. W. (1980) "Time and the Rate of Adoption of Innovations," *Journal of Consumer Research*, 6 (March), 425-428.
- Robertson, Thomas S. (1971), *Innovative Behavior and Communications*, New York, Holt, Rinehart & Winston.
- Rogers, Everett M (1995), *Diffusion of Innovations*, 4th edition. New York, The Free Press.
- Sheth, Jagdish N., and Rajendra S. Sisodia (1999), "Revisiting Marketing's Lawlike Generalizations," *Journal of the Academy of Marketing Science*, 27 (1), 71-87.
- U.S. Department of Treasury (1999, October 19). *Electronic Benefits Transfer*. [WWW Document] URL <http://www.fms.treas.gov/ebt/index.html> [viewed July 2, 2000].

APPENDIX

TABLES AND FIGURES

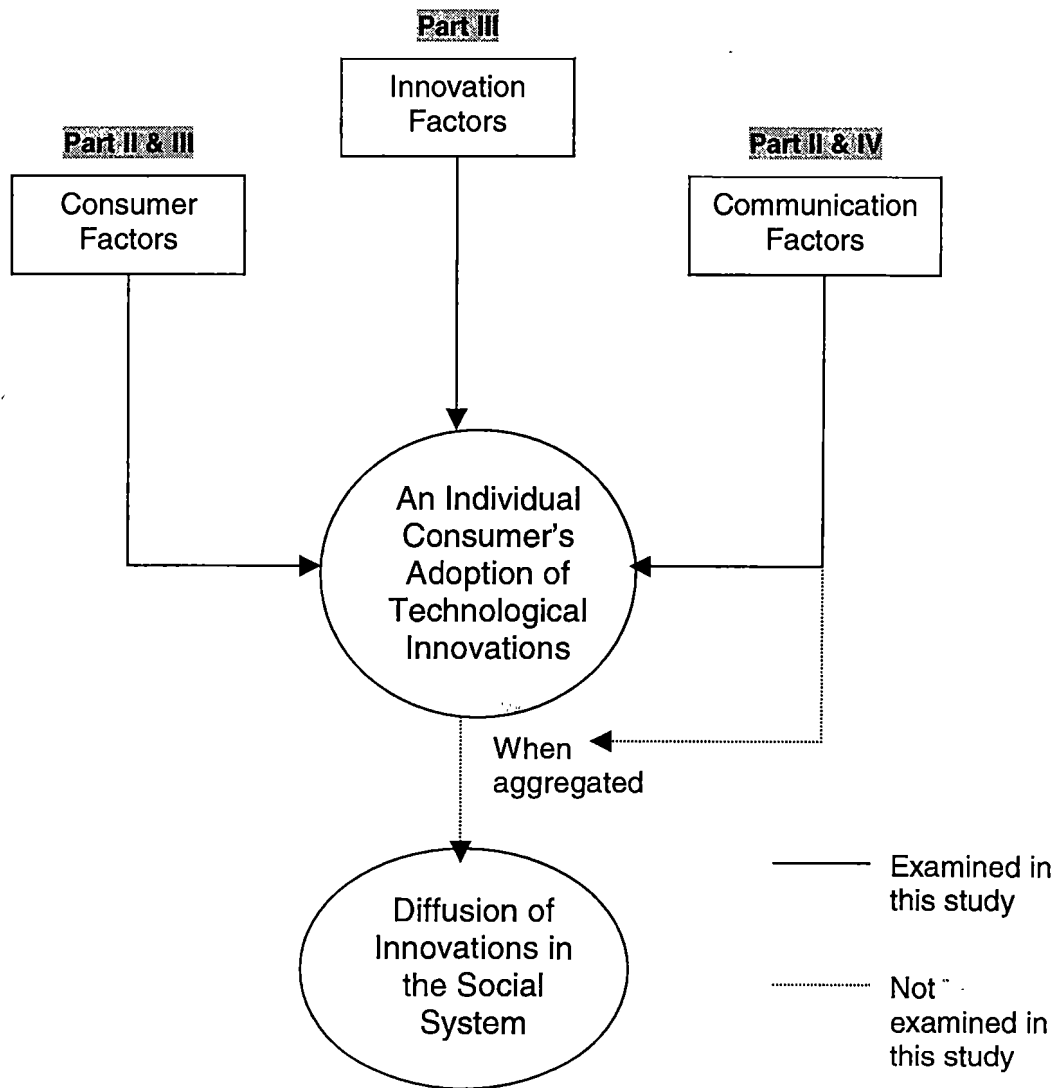


Figure I-1. A Conceptual Model of Consumer Adoption and Diffusion of Technological Innovations

PART II

HAVEN'T ADOPTED ELECTRONIC FINANCIAL SERVICES YET? THE ACCEPTANCE AND DIFFUSION OF ELECTRONIC BANKING TECHNOLOGIES

CHAPTER 1

BACKGROUND

Fueled by improvements in electronic technology, the financial services sector in the United States is experiencing an era of rapid innovation. Consequently, innovative electronic financial services have received ever-increasing attention in a wide variety of forums, including the financial industry, the government, academic institutions, and the press (Clinton and Gore 1998; Congressional Budget Office 1996; Group of Ten 1997; Kennickell and Kwast 1997; Pitofsky 1996; White 1996).

Technological innovation has played a central role in the evolution of the financial services industry over the past fifty years. In fact, firms in various sub-sectors of finance (e.g., banking, securities, insurance, etc.) have a long history of developing new instruments and services and improving processes, both to reduce the costs of existing services and to offer new services. The pace of innovation has increased dramatically since the late 1960s, particularly with the advances in information processing and communications technologies (FRB 1997; White 1996). Unlike many of the older technological changes and innovations, which focused on production and “back office” functions, many of these new technologies involve banks’ retail transactions and contacts with their customers.

Consequently, recent technological changes have altered the nature of consumer interactions with providers of financial services, reducing the importance of physical location and face-to-face interactions. Many financial services are now available through

ATM networks, over telephone lines, or via the Internet. Electronic banking, in its various forms, provides a convenient, low-cost alternative to the traditional bank visit.

While diffusion of innovation is, in general, one of the most studied topics in the literature (Mahajan, Muller and Bass 1990), the theory of diffusion has not been applied to financial innovations, including electronic banking technology. Therefore, our current understanding of consumers' adoption of electronic financial services such as ATMs, debit cards, smart cards, direct deposit, and direct payment is extremely limited. In this study, we examine the extent to which consumers adopt or avoid electronic financial services and the characteristics of adopters and non-adopters, using the 1995 Survey of Consumer Finance (SCF) commissioned by the Federal Reserve Board.

Furthermore, the discussion on electronic financial services in the literature has focused heavily on the supply side of the market and potential application to public policy, while little attention has been paid to the demand side of the market (Kennickell and Kwast 1997). The emphasis on supply-side factors is at least partly due to financial experts' presumption that consumers would adopt electronic banking technologies as quickly the new technologies became available to them. However, despite industry predictions in the 1970s that electronic payments would rapidly replace traditional payment methods of cash and paper checks, the retail payment system in the United States continues to be heavily dependent on paper-based transactions (Federal Reserve Board 1997).

In fact, some consumer researchers have already warned enthusiastic policy makers and financial institutions that a significant number of consumers might not be willing to adopt electronic banking technologies (Herbig and Kramer 1994; Hirschman 1987; Ram and Jung 1991; Ram and Sheth 1989). Hirschman (1987) pointed out that

consumers have difficulty in following changes when innovation is introduced before consumers are ready. Also, when innovative alternatives multiply too rapidly, some consumers may experience "innovation overload" and refuse to adopt new technologies. Considering the speed and variety of recent developments in electronic banking technologies, we suspect the occurrence of innovation overload.

A better understanding of the extent to which consumers adopt new technologies and the characteristics describing adopters versus non-adopters will enable financial service providers to develop a more realistic understanding of the current status of consumer adoption of a variety of electronic banking technologies. Unrealistic expectations can only misguide financial service providers to undertake investments that are not ready to give adequate returns. They also lead to policy decisions which force consumers to embrace the technologies that they are not ready to use. By recognizing the characteristics of adopters versus non-adopters of electronic banking technologies, financial institutions can also develop better-targeted programs for encouraging the diffusion of technologies.

CHAPTER 2

LITERATURE REVIEW

Over the past three decades, the pace of technological innovation has changed the structure of the U.S. financial services sector. This ongoing transition to electronic payment system was initiated by financial institutions striving to achieve competitive advantages through delivering innovative financial services and also by the U.S. government anticipating to lower processing costs involved with paper checks. Recently, the federal government started a number of initiatives to facilitate paper check conversion to electronic payment technology. For example, in 1996, the Department of Treasury obtained the services of a commercial bank to use electronic benefits transfer (EBT) using debit card technology. EBT provides an option to Federal benefits recipients to access their benefits at ATMs, and point of sale (POS) devices (Department of Treasury 1999b). The Electronic Fund Transfer (EFT) Act mandates electronic disbursement of Social Security benefits through the ACH network (DOT 1999a). In addition, the Department of Treasury launched the "paper check conversion project" in several government agencies to assess the potential of this new payment system (DOT, 2000).

While the pressures for change have mainly come from the supply side, creating significant changes in the distribution of electronic banking technologies (Devlin 1995), the demand side -- how willing consumers are to adopt this variety of financial innovations-- is likely to be the key to the successful diffusion of electronic banking technologies. However, general acceptance of electronic banking technologies by

consumers, especially low income, low educated government benefits recipients, is still an untapped question. Therefore, there is a need to investigate consumer acceptance of the electronic banking technologies. Responding to this call, the current study investigated consumer characteristics of adopters versus non-adopters of the five electronic banking technologies under the theoretical framework of diffusion of innovations.

Characteristics of Adopters and Non-adopters

A set of general characteristics of adopter/non-adopters has emerged from diffusion research. Adopters tend to have the following characteristics compared to non-adopters (Dickerson and Gentry 1983; Gatignon and Robertson 1985; Gilly and Zeithaml 1985; Kennedy 1983; Midgley and Dowling, 1978 Rogers 1995; Zeithaml and Gilly 1987): more venturesome; more educated; higher level of cognition and intelligence; more affluent; greater upward social mobility; more favorable attitude toward risk; more active social participation; and greater opinion leadership.

Regarding communication patterns, Gatignon and Robertson (1985) propose that early adopters tend to be heavy users of diverse products within the product category and are more likely to use information from the mass media or various information sources beyond their immediate interpersonal network. Both the heavy usage of a particular product group and communication with professional information providers, such as reading magazines or newspapers or consulting with third party experts, are expected to provide consumers with more exposure to innovations, thus encouraging their adoption of innovations. Zaithaml and Gilly (1987) and Roger (1995) supported the differences in communication behavior between adopters and non-adopters.

However, there is inconsistent evidence about the relationship between age and innovativeness. About half of the 228 studies on this issue show no relationship, 19% show that early adopters are younger than late adopters, and 33% indicate that they are older (Rogers 1995, p. 269). When Gilly and Zeithaml (1985) examined consumer usage patterns of ATM and electronic funds transfer (EFT), they found that age influenced consumers' likelihood of adopting ATM versus EFT differently. Specifically, elderly consumers were less likely to adopt ATM, but more likely to adopt EFT, than younger consumers. This finding suggests that general adopter characteristics for electronic banking technology may not apply to specific individual innovation.

Several researchers have investigated demographic characteristics of ATM adopters. Amel (1986) and Taube (1988) found that ATM users are more likely to be young, and have above average incomes, and at least some high school education. Marshall and Heslop (1991), El-Haddan and Almahmeed (1992), and Swinyard and Ghee (1984) obtained consistent results of adopter characteristics of ATM using Canadian, Kuwaiti, and Southeast Asian samples, respectively.

Kennickell and Kwast (1997) investigated the characteristics of adopters of electronic banking technology and found that income, level of financial assets, age, and education level play important roles in a household's use of electronic banking technologies. They found the positive income, financial assets, and education impact on adoption of electronic banking technology. They also found that age has varying effects on adoption. Specifically, household heads under the age of 35 are considerably more likely to use computerized banking, ATMs, and debit cards than are older consumers, while consumers' use of direct deposit increases with age. By far, Kennickell and Kwast's (1997) study has been the most comprehensive study on consumers' adoption

of electronic banking technology. Their study presents a useful profile of adopters of a variety of electronic banking technologies, but is not grounded in theory, and thus fails to shed additional insights on consumers' adoption decision. Building on Kennickell and Kwast's profile, we will provide additional insights on consumers' adoption of various electronic banking technologies based on the theory of innovation and diffusion.

Specifically, this study (1) examines the extent to which consumer adopt electronic banking technologies; (2) identifies adopters and non-adopters of electronic banking technologies; and (3) investigates the factors that describe characteristics of adopters and non-adopters based on the theory of innovation and diffusion. In this study, the following five types of electronic banking technologies are examined: ATM, debit cards, direct deposit, direct payment, and smart cards.

CHAPTER 3

METHODOLOGY

Data

The Survey of Consumer Finances (SCF) is a triennial survey sponsored by the Federal Reserve Board with the cooperation of the Statistics of Income Division of the Internal Revenue Service (Kennickell, McManus and Woodburn 1996; Kennickell and Woodburn 1997). It is designed to provide detailed information on U.S. families' balance sheets, their use of financial services, and demographics. For the 1995 SCF survey, 4,299 households were interviewed by the National Opinion Research center at the University of Chicago between July and December.

The SCF collects information on the number of financial institutions with which a respondent (or the respondent's family member living in the same household) currently has accounts or loans or regularly does personal financial business. Financial institutions include banks, savings and loans, credit unions, brokerages, loan companies, and so forth, but not institutions where consumers only have credit cards or business accounts. In this study, only the respondents who are affiliated with at least one financial institution are included in the sample, because consumers who have no financial affiliation cannot make electronic financial transactions.

Dependent variables

The probabilities of a consumer's adoption of specific electronic banking technologies are employed as a set of separate dependent variables of this study. Specifically, each factor affecting consumers' adoption of the five specific electronic banking technologies is investigated separately because of the possibility that the effects of explanatory variables could vary across the type of electronic services. That is, the dependent variables include a set of binary variables indicating whether or not a respondent (or his/her family member living in the same household) has adopted each of the five electronic banking technologies: ATMs, debit cards, direct deposit, direct payment, and smart cards.

We created an additional dependent variable to identify those consumers who resist all electronic banking technologies. This dependent variable indicates whether or not a respondent (or his/her family member living in the same household) has adopted any of the above five electronic banking technologies.

Explanatory variables

The following variables were included as explanatory variables in this study: education, income, age, communication patterns, and other demographic variables.

Education. To reduce potential multicollinearity with income and financial asset variables as well as to examine potential non-linearity of educational impact, a set of dummy variables was included with high school graduates or equivalent as the base. Other categories were less than high school education, some college, bachelor's degree, and graduate degree.

Income. To reduce heteroskedacity (unequal variance of the disturbances), the natural logarithm of the reconciled annual total household income before tax was employed.

Age. The respondents' age was recorded and employed as a continuous variable.

Communication Patterns. A set of two binary variables was employed to identify consumers' communication patterns in acquiring financial information: communication with professional information providers and/or personal sources (1=communicated, 0=didn't communicate). Communication with professional information providers included reading magazines and newspapers and consulting with financial planners, accountants, or bankers, while communication with personal sources included consulting family and friends.

Finally, a set of demographic variables was included for following two reasons. First, by including this set of variables, we can control statistically their potential effects on the probability of adopting electronic banking technologies and therefore more correctly estimate the incremental impacts of the proposed explanatory variables. Second, by examining the potential demographic differences, we can develop a detailed profile of non-adopters from which to draw implications. Specifically, the following demographic variables were included: female-headed household, race-ethnicity, and marital status.

Female-headed household. Male-headed household was the base.

Race-ethnicity. The respondents' race was categorized into Hispanics, Blacks, other non-Whites, and non-Hispanic Whites (base).

Marital Status. Three binary variables -- divorced or separated, widowed, and never been married -- were included, with married or living with a partner as the base (see Table II-1).

Analysis

Because of the sampling frame, the data had to be weighted when generating descriptive statistics. In the multivariate analysis, repeated-imputation inferences (RII) had to be employed to account for the five implicate data sets (see Rubin (1987) and Montalto and Sung (1996) for a more detailed discussion of RII). In order to examine the extent of consumers' adoption of electronic banking technologies, the descriptive statistics of the extent to which consumers adopted each of the five electronic banking technologies are reported. The second research objective is to identify adopters and non-adopters of electronic financial innovation.

Therefore, the demographic characteristics of adopters and non-adopters of electronic financial innovation are presented with bivariate statistics. To further examine individual group differences, we conducted pair-wise tests using SAS PROC GLM with LS Means option and adopted Bonferroni adjustments to reduce the type 1 error.

Third, to investigate the effects of potential determinants on consumers' adoption of financial innovation, multivariate analyses were run to estimate the probability of consumers' adoption of each of the five electronic banking technologies. Because all of the dependent variables were binary, a probit or logit analysis was appropriate. Therefore, separate logistic analyses were run for each of the five implicates, using SAS PROC LOGISTIC procedures. Then, using the RII technique, estimates were derived from all five implicates, and the variability in the data due to missing values and

imputation was incorporated in the estimation. SAS/IML programming was utilized for implementing the RII.

CHAPTER 4

RESULTS

The Extent of Consumer Adoption

The extent to which consumers adopted electronic banking technologies is presented in Table II-2. Among the five electronic banking technologies, the ATM is the most diffused electronic service, followed by direct deposit. Almost two-thirds of the households with a financial affiliation have used or are using ATMs. While half of the financially affiliated households have adopted direct deposit, less than one-fourth of these households use direct payment services. For debit and smart cards, 19.2% of the financially affiliated households reported using debit cards, while only 1.2% reported using smart cards. All together, 17.0% of the households with a financial affiliation were found not to have adopted any of the five electronic banking technologies.

Demographic Profiles of Adopters and Non-adopters

The demographic profiles of adopters and non-adopters of electronic financial innovation are presented with bivariate statistics in Table II-3. First, non-adopters of electronic financial services tend to have a lower level of education compared to adopters. This trend is consistent across all five electronic financial services. In the case of ATM usage, about 80% of consumers with college degree or graduate degree who are affiliated with any financial institution adopted ATMs, whereas only 42% of

financially affiliated consumers with less than high school education adopted ATMs. Ad-hoc tests of multiple pair-wise comparisons with Bonferroni adjustment reveal that having at least some college education makes significant differences in consumers' adoption of electronic financial services compared to having high school or equivalent education. Also, having a graduate degree has a significant effect upon a consumer's willingness to adopt ATMs, direct deposit, and direct payment.

Consumers who report more active communication with professional information providers are more likely to be adopters of electronic banking technologies. For example, 73% consumers who have communicated with financial professionals have adopted ATMs, whereas only 59% of consumers who have not communicated with financial professionals have adopted ATMs. The differences were also significant for debit cards, direct deposit, direct payment, and smart cards. However, communication with friends or family members does not have a significant effect on consumers' adoption of most electronic banking technologies, with the exception of ATMs.

Non-adopters of electronic financial services appear to be less affluent than adopters of all five financial innovations. The mean and median annual household income of non-adopters is \$31,783 and \$20,000, respectively, compared to \$49,395 and \$34,000 for adopters. Households with an annual income of less than \$30,000 are significantly less likely to adopt electronic financial services in general, and are particularly less likely to adopt direct deposit

Interestingly, the relationship between age and likelihood of consumer adoption of financial innovation varies across different innovations. In general, older consumers are more resistant to adopting ATMs and debit cards than younger consumers. For example, consumers age 55 or older are not as likely to adopt ATMs and debit cards as

their younger counterparts. However, age 55 or older consumers are more likely to adopt direct deposit than younger consumers. Multiple comparison tests show that middle-aged consumers (30-54) are more likely to adopt direct payment than consumers in their 20s and older consumers (55+). The mean and median age of adopters of ATMs is 45 and 43, respectively, compared to 56 and 57 for non-adopters. However, the mean and median age of adopters of direct deposit is 52 and 49, respectively, compared to 45 and 43 for non-adopters.

The relationship between marital status and the adoption of financial innovation also varies across different innovations. Regarding ATM adoption, 78% of separated or divorced households adopt ATMs, while only 41% of widowed households adopt ATMs. On the other hand, widowed households are more likely to use direct deposit than never married households are.

No impact of race/ethnicity was found with regard to ATM or smart card adoption. Regarding debit cards, Hispanics are more likely to adopt debit cards than blacks or non-Hispanic whites. Also, there is a significant difference between whites and blacks in their adoption of direct payment, 26% and 15%, respectively.

Female-headed households are less likely to adopt ATMs, debit cards, and direct payment than male-headed households are. However, female-headed households are more likely to adopt debit cards. This result may be due to the fact that many elderly females have Social Security checks deposited directly. Gender difference was not significant for household adoption of smart cards.

Multivariate Analysis of Adoption Factors

To investigate the determinants of consumers' adoption of different electronic financial services, a set of logistic regressions was conducted for individual electronic banking technologies, excluding smart cards. Logistic regression on smart cards was not feasible because of the small cell size of smart card adopters (only 1.2%). Thus, four separate logistic regressions were conducted for each of four dependent variables: ATMs, debit cards, direct deposit, and direct payment. Repeated Imputation Inference (RII) results of logistics regressions on each electronic financial service are presented in Table II-4. For each dependent variable, the results were consistent across the five separate imputates, confirming the RII results. The levels of significance are generally more stringent under the RII because the error from the multiple imputation is also added to the error term of the full model.

ATM. Level of education, communication with a professional information provider, age, and marital status were found to influence a consumer's probability of adopting ATMs. The more highly educated a consumer is, the more likely he or she is to adopt ATMs, a result that supports findings of previous studies (Amel 1986; Taube 1988; Marshall and Heslop 1991). As hypothesized, consumers who communicate with a professional information provider are more likely to adopt ATMs than those who do not obtain information from professional sources, while communication with a personal source of information did not have a statistically significant effect on ATM adoption. Regarding age, the younger a consumer is, the more likely he/she is to adopt ATMs. One explanation for this negative age effect on ATM adoption is that older consumers tend to have limited eyesight. Low illumination of screens and less experience with computers may complicate older consumers' use of ATMs.^a On the other hand, the

effects of income and race on ATM adoption are found to be insignificant. Married households are more likely to adopt ATMs than widowed households are, but the gender of the household head does not influence the adoption of ATMs.

Debit cards. The RII results of logistic regression on debit card adoption reveal a similar pattern to that of ATM adoption with regard to communication with a professional information provider, and age, but shows a different pattern in terms of education, race, and marital status. While education has a consistently positive effect on the adoption of debit cards, no difference in the likelihood to adopt debit cards was found between high school graduates and those with less than a high school education. Consumers with at least some college education are more likely to adopt debit cards than those without a college education. Communication with a professional information provider also has a significantly positive influence on the adoption of debit cards, while communication with a personal source of information does not influence the adoption of debit cards. Younger consumers are more likely to adopt debit cards than are older consumers, and Hispanic consumers are more likely to adopt debit cards than are non-Hispanic whites. Other demographic variables, such as income, marital status, and female-headed household, have no significant effect on the adoption of debit cards.

Direct deposit. Among the independent variables, only level of education, and age were found to influence consumers' likelihood of adopting direct deposit, while communication with a professional information provider or personal source of information did not have statistically significant effects. More educated consumers are more likely to adopt direct deposit. In contrast to the age effect on the likelihood to adopt other financial innovations, older consumers are more likely to adopt direct deposit.

Direct payment. Level of education, communication with a professional information provider, age, income, race, and marital status were found to significantly influence consumers' adoption of direct payment. High school graduates' likelihood of adopting direct payment does not differ from that of the consumers with less than a high school education or some college education; however, high school graduates are less likely to adopt direct payments than consumers with a bachelor's degree or more education. Communication with financial information providers also has a positive effect on consumers' likelihood of adopting direct payment, while communication with personal source of information has an insignificant effect. Those who communicate with a professional information provider are about 19%³ more likely to adopt direct payment than those who do not communicate with a professional information provider. The more affluent consumers are, the more likely they are to adopt direct payment. Non-Hispanic whites were more likely to adopt direct payment than are Hispanics and Blacks. In addition, married households are more likely to adopt direct payment than are divorced/separated households.

³ The odds ratio for this dichotomous variable is calculated as e^{β} , where β is the coefficient of the communication variable (whether the respondent has communicated with professional information provider). In this case, $e^{0.166} = 1.1805$.

CHAPTER 5

DISCUSSION

In this section, results are discussed in light of significance of the explanatory variables. First, we found a positive impact of education level on the adoption of financial innovation, which is consistent with Rogers's proposition. However, more interestingly, we found a non-linear relationship between education and adoption of electronic banking technologies in general, which has not been acknowledged before. Specifically, high school graduates and those with less than a high school education do not show any statistically significant differences with regard to the likelihood of adopting debit cards. The likelihood of adopting direct payment is found to differ between high school graduates and those with bachelor's degree or more education. However, no difference in adoption was found between high school graduates and those with less than a high school education or those with some college education.

Communication with professional information providers was found to increase a consumer's likelihood of adopting all four financial innovations, although its impact is marginally significant on the adoption of direct deposit. Thus, consumers who read magazines, newspapers, and other literature and/or consult with financial planners, bankers, and other professionals are more likely to adopt ATMs, debit cards, direct deposit, and direct payments than those who are not exposed to various professional information sources. On the other hand, the degree to which consumers rely on interpersonal communication does not differ for adopters and non-adopters.

While age negatively influences the likelihood of adopting ATM, debit card, and direct payment, it positively influences the likelihood of adopting direct deposit. This result is consistent with the empirical findings by Zeithaml and Gilly (1987) that elderly consumers are more receptive to EFT, but are less likely to adopt ATMs. One possible explanation to these findings is the degree of involvement on consumers' side. While consumers needed to sign up only once to adopt direct deposit and direct payment, all the other technology requires consumer involvement for every transaction. Another reason for the positive relationship is that both federal and state governments encourage direct deposit for Social Security and other benefits.

Income was found to influence only the likelihood of adopting direct payment: the more affluent households are, the more likely they are to adopt direct payment. However, income is not associated with the likelihood of adopting ATMs, debit card, or direct deposit.

Race/ethnicity was found to be an important determinant of the likelihood of adopting debit cards and direct payment. Compared to non-Hispanic whites, Hispanics are more likely to adopt debit cards but less likely to adopt direct payment. Compared to non-Hispanic whites, Blacks are 48%^c less likely to adopt direct payment. No racial/ethnic impact was found with regard to consumers' likelihood of adopting ATMs and direct deposit.

The impact of marital status also varies across different types of financial innovations. Specifically, married households are more likely to adopt ATM and direct payment than divorced or separated households. On the other hand, marital status is not found to be associated with consumers' likelihood of adopting direct deposit and debit cards. Although the presence of an older adult, such as grandparent, is suspected

to influence a household's likelihood of adopting direct deposit, we could not include the presence of an adult as an independent variable due to a multicollinearity problem.

CHAPTER 6

CONCLUSIONS AND IMPLICATIONS

Using the 1995 Survey of Consumer Finances commissioned by the Federal Reserve Board, we found that a significant number of consumers haven't adopted financial innovations. We found that one-third of consumers who have at least one account with a financial institution still have not adopted ATMs, a technology that is believed to have reached its maturity stage and is relatively easy to use. Consumers' adoption of other electronic banking technologies varies: while more than half of consumers had adopted direct deposit, only one-fourth of consumers had adopted direct payment, and only one-fifth had adopted debit cards. Considering that 9% of these consumers did not have a financial affiliation, it is likely that the diffusion of all of these electronic financial innovations is even less widespread in the total population.

Furthermore, the demographic profiles of the adopters and the non-adopters of financial innovation showed that there are differences in adopter profiles across the types of financial innovations. Therefore, generalizing previous patterns of financial innovation and applying them to a new medium may not be appropriate. In particular, age has an opposite impact on the adoption of direct deposit versus the adoption of ATMs, debit cards, and direct payment. The older a consumer is, the more likely he or she is to adopt direct deposit, while age is negatively associated with the likelihood of adopting all the other electronic financial innovations. In addition, education has a non-linear effect, suggesting that completing high school education may enhance a

consumer's likelihood of adopting debit cards, while completing college enhances a consumer's likelihood of adopting direct payment.

Identifying differential effects of age, education, income, race/ethnicity, and marital status allow public policy makers and financial educators to develop a profile of adopters of a specific financial innovation and thus to create a more targeted diffusion strategy. For example, among the direct deposit users, there are Social Security recipients. Our results suggest that consumers with less than high school education have some difficulty in adopting direct deposit. Therefore, special efforts are needed to reach these low educated consumers to facilitate their adoption of EFT. On the other hand, highly educated and high-income, young consumers are likely to adopt direct payments. As they are found to be susceptible to communication with professional information providers, Financial institutions can target this segment of consumers and communicate the benefits of electronic banking technologies in promoting new financial services involving direct payment, such as Internet banking.

Also, the findings indicate that, in general, non-adopters of electronic innovations are less likely to engage in communication with professional information providers than are adopters. However, the extent of non-adopters' use of interpersonal communication was not significantly different from the extent of adopters' use of interpersonal communication. These findings suggest that professional information delivered through a third party or literature might not be the best way to reach non-adopters. Using the interpersonal communication channel will be a more effective way to reach non-adopters of electronic financial innovations. On the other hand, if public policy makers want to introduce a smart card to more innovative consumers, disseminating the information

about this new technology through professional information channels will be an effective channel.

In conclusion, this paper furnishes some guidance to financial educators as to the current status of consumer acceptance of electronic banking technologies. An accurate description of the characteristics of adopters and non-adopters of various electronic banking technologies will help the financial institutions in achieving profitable positions by identifying differential customer responses to the new technology-based service options. Such knowledge can also assist the government agents in implementing effective electronic funds/benefits transfer plans through development of targeted education and communication programs for the non-adopters.

REFERENCES

- Amel, D. F. (1986, April). Consumer use of Automated Teller Machines. *Working Papers in Banking, Finance, and Microeconomics*, No. 86-5, Financial Structure Section, Division of Research and Statistics, Board of Governors of the Federal Reserve System.
- Bank for International Settlements (1995), *Statistics on Payment Systems in The Group Of Ten Countries*, December, Basle, Switzerland.
- Bass, Frank M. (1969), "A New Product Growth Model for Consumer Durables. *Management Science*, 15 (January), 215-227.
- Clinton, William J. and Al Gore Jr. (1998). *A Framework for Global Electronic Commerce*. Washington, D.C. [WWW document]. URL <http://www.whitehouse.gov/WH/New/> [viewed December 1998].
- Congressional Budget Office (1996, June). *Emerging Electronic Methods for Making Payments*. Government Printing Office, Washington, D.C.
- Devlin, J. F. (1995), "Technology and Innovation in Retail Banking Distribution," *International Journal of Bank Marketing*, 13 (4), 19-25.
- Dickerson, M. D. and J. W. Gentry (1983), "Characteristics of Adopters and Non-adopters of Home Computers. *Journal of Consumer Research*, 10 (September), 225-235.
- El-Haddan, A. and M. Almahmeed (1992), "ATM Banking Behavior in Kuwait: A Consumer Survey. *International Journal of Bank Marketing*, 10 (3), 250-232.
- Federal Reserve Board (1997, March), *Report to the congress on the application of the electronic funds transfer act to electronic stored-value products*, Submitted to the Congress pursuant to section 2601 of the Economic Growth and Regulatory Paperwork Reduction Act of 1996, Washington, D.C.: The Federal Reserve Board.
- Gatignon, Humerto and Thomas S. Robertson (1985), "A Propositional Inventory for New Diffusion Research," *Journal of Consumer Research*, 11 (March), 849-867.
- General Accounting Office (1998, January 15). *Electronic Banking Experiences Reported by Banks in Implementing On-line Banking*, GAO/GGD-98-34.
- Gilly, Mary C. and Zeithaml, Valerie (1985), "The Elderly Consumer and Adoption of Technologies," *Journal of Consumer Research*, 12 (December), 353-357.
- Group of Ten (1997, April), "*Electronic Money: Consumer protection, Law Enforcement, Supervisory and Cross Border Issues*," Report of the Working Party on

- Electronic Money [WWW Document]. URL <http://www.bis.org> [viewed April, 1997].
- Herbig, P. A. and H. Kramer (1994), "The Effect of Information Overload on the Innovation Choice Process," *Journal of Consumer Marketing*, 11 (2), 45-54.
- Hirschman, Elizabeth (1987), "Adoption of an Incredibly Complex Innovation: Propositions from a Humanistic Viewpoint, in Wallendorf, W. and Anderson, P. (Eds.). *Advances in Consumer Research*, 14, 376-377, Association for Consumer Research, Provo, Utah.
- Horovitz, P. M. and L. J. White (1996, June 29), "*The Challenges of the New Electronic Technologies in Banking: Private Strategies and Public Policies*." Paper presented at the Western Economic Association International Session on The New Electronic Technology in Banking: Competitive, Monetary, and Related Implications.
- Kennedy, A. (1983). "Development, Adoption and Diffusion of New Industrial Products," *European Journal of Marketing*, 17 (3), 31-87.
- Kennickell, A. B., D. A. McManus, and R. Woodburn (1996), "*Weighting Design for the 1992 Survey of Consumer Finance*," Working Paper on Survey Methodology of Survey of Consumer Finances, Federal Reserve Board, Washington, D.C.
- Kennickell, A. B. and R. Woodburn, (1997), "*Consistent Weight Design for the 1989 1992 and 1995 SCFs, and the Distribution of Wealth*," Working Paper on survey methodology of Survey of Consumer Finances, Federal Reserve Board.
- Mahajan, Vijay, Eitan Muller, and Frank M. Bass (1990), "New Product Diffusion Models in Marketing: A Review and Directions for Research," *Journal of Marketing*, 54 (January), 1-26.
- Marshall, J., and L. Heslop (1988), "Technology Acceptance in Canadian Retail Banking," *International Journal of Bank Marketing*, 6 (4), 31-41.
- Midgley, D. F. and G. R. Dowling (1978), "Innovativeness: The Concept and Its Measurement," *Journal of Consumer Research*, 4 (March), 229-242.
- Montalto, C. P. and J. Sung (1996), "Multiple Imputation in the 1992 Survey of Consumer Finances," *Journal of Financial Counseling and Planning*, 7, 133-146.
- Olshavsky, R. W. (1980), "Time and the Rate of Adoption of Innovations," *Journal of Consumer Research*, 6 (March), 425-428.
- Pitofsky, R. (1996, September 19), "*Competition and Consumer Protection Concerns in the Brave New world of Electronic Money*," United States Department of the Treasury Conference, Toward Electronic Money and Banking: The Role of Government, Washington, D.C. [WWW document] URL <http://www.ftc.gov/speeches/pitofsky/banking.htm> [viewed October, 1996].

- Ram, S. and J. N. Sheth (1989), "Consumer Resistance to Innovations: The Marketing Problem and Its Solutions. *Journal of Consumer Marketing*, 6 (2), 5-14.
- Ram, S. and H. Jung (1991), "Forced Adoption of Innovation in Organizations: Consequences and Implications," *Journal of Product Innovation Management*, 8 (2), 117-26.
- Rogers, Everett M (1995), *Diffusion of Innovations*, 4th ed., The Free Press, New York.
- Rubin, D. B. (1987). *Multiple Imputation for Nonresponses in Surveys*. John Wiley Sons, New York.
- Swinyard, W.R. and L. Ghee (1987), "Adoption Patterns of New Banking Technology in Southeast Asia," *International Journal of Bank Marketing*, 5 (4), 35-48.
- Taube, P.M. (1988), "The Influence of Selected Factors on The Frequency of ATM Usage," *Journal of Retail Banking*, 10 (1), 47-52.
- U.S. Department of Treasury (1999, March 4), "Federal Acquisition Regulation: Electronic Funds Transfer," [WWW Document] URL <http://www.fms.treas.gov/ef/regs/fareft.txt> [viewed July 8, 2000].
- U.S. Department of Treasury (1999, October 19), "Electronic Benefits Transfer," [WWW Document] URL <http://www.fms.treas.gov/ebt/index.html> [viewed July 2, 2000].
- U.S. Department of Treasury (2000, May 19), "Paper Check Conversion Project," [WWW Document] URL <http://www.fms.treas.gov/emoney/papercheckconv.html> [viewed July 2, 2000].
- White, L. J. (1996), "Technological Change, Financial Innovation, and Financial Regulation in the U.S.: The Challenges for Public Policy" Working Paper, Stern School of Business, New York University.
- Zeithaml, Valerie and Mary C. Gilly (1987), "Characteristics Affecting the Acceptance of Retailing Technologies: A Comparison of Elderly and Non-Elderly Consumers," *Journal of Retailing*, 63 (1), 49-68.

APPENDIX

TABLES AND FIGURES

Table II-1. Description of Variables

Variables	Description
Adoption of Innovation ATM Debit card Direct deposit Direct payment Smart card Any of the above	= 1 adopted ATM, 0 otherwise = 1 adopted debit card, 0 otherwise = 1 adopted direct deposit, 0 otherwise = 1 adopted direct payment, 0 otherwise = 1 adopted smart card, 0 otherwise = 1 adopted ATM, debit card, direct deposit, direct payment, or smart card, 0 otherwise
Education Less than high school High school/GED Some college Bachelor's degree Graduate degree	=1 if years of education < 12 and no GED, 0 otherwise =1 if respondents report a high school diploma or pass GED, 0 otherwise; omitted category =1 if years of education > 12 and ≤ 16 but no BS, 0 otherwise =1 if a college degree is earned, 0 otherwise =1 if years of education > 16, 0 otherwise
Income	log of annual total household income
Age	age of reference person
Communication with professional information provider	= 1 if read books/magazines or consulted with financial planners, bankers, accountants or other experts, 0 otherwise
Communication with personal information provider	= 1 if talked with family or friends, 0 otherwise
Demographics Female headed household Race-ethnicity Hispanic Black Other non-white Non-Hispanic white Martial Status Divorced/separated Widowed Never married Married	=1 if female head, 0 otherwise =1 if Hispanic, 0 otherwise =1 if African American, 0 otherwise =1 if other non-white, 0 otherwise =1 if non-Hispanic white, 0 otherwise; omitted category =1 if divorced or separated, 0 otherwise =1 if widowed, 0 otherwise =1 if single, never married, 0 otherwise =1 if married or living with partner, 0 otherwise; omitted category

Table II-2. Adopters and Non-Adopters of Electronic Banking Technologies

	Adopters	Non-adopters
ATM	66.6% ^a	33.4%
Direct Deposit	50.8%	49.2%
Direct Payment	23.7%	76.3%
Debit Card	19.2%	80.8%
Smart Card	1.2%	98.8%
Any of the Above	83.0%	17.0% ^b

^a Our result on the extent of ATM diffusion differs from Kennickell and Kwast's (1997) report that states that 34.5% of households are using ATMs. It should be noted that our analysis considered only those who are affiliated with financial institutions in calculating the percentage of ATM diffusion. Considering that those who are not affiliated with financial institutions are denied accessibility to ATMs, it is logical to assume that they did not make any adoption decisions about these electronic banking technologies.

^b This 17.0% population is those who use none of the five banking technology services. Note that the total is not simply the sum of the column. By the same token, user population of 83.0% is those who use any of these five services.

Table II-3. Adoption Rate of Five Electronic Banking Technologies Across Demographic Characteristics

Explanatory Variables (Adoption Rate)	ATM %	Debit %	Direct Deposit %	Direct Payment %	Smart Card %	Any Tech- nology %
Education						
Less than high school	41.68 ^a	10.45 ^a	40.98 ^a	14.11 ^{ab}	0.57 ^{ab}	73.45 ^a
High school or equivalent	60.63 ^a	14.68 ^a	45.12 ^a	20.99 ^{ab}	0.64 ^a	80.13 ^a
Some college	72.86 ^b	23.18 ^{ac}	50.09 ^b	24.90 ^{ab}	1.45 ^{ab}	89.24 ^b
Bachelor's degree	79.38 ^b	24.02 ^{bc}	56.95 ^b	28.90 ^a	2.59 ^b	90.86 ^b
Graduate degree	82.78 ^c	27.69 ^b	69.21 ^c	32.93 ^b	1.24 ^{ab}	94.85 ^c
Mantel-Haenszel	221.240	52.665	77.132	67.128	12.654	127.358
Chi-square Statistics	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)
Communication with professional information provider						
Yes	72.54	22.42	54.64	27.18	1.64	87.59
No	58.65	15.42	45.78	19.21	0.73	80.45
Chi-square Statistics	63.692	16.049	19.432	21.506	4.413	37.734
	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(0.036)	(<0.001)
Communication with personal source						
Yes	70.76	20.60	50.52	24.64	1.59	86.46
No	64.71	18.55	50.96	23.35	1.07	83.45
Chi-square Statistics	7.278	0.108	0.022	0.092	0.010	1.974
	(0.007)	(0.743)	(0.882)	(0.762)	(0.916)	(0.160)
Household Income						
Less than \$30,000	55.55 ^a	13.73	44.51 ^a	16.00	0.81	79.86 ^a
\$30,000-\$44,999	72.53 ^{ab}	20.61	50.73 ^{bc}	26.02	1.19	86.34 ^b
\$45,000-\$69,999	76.35 ^b	25.19	55.21 ^b	30.93	1.94	88.59 ^b
More than \$70,000	80.10 ^b	26.73	64.95 ^{ac}	35.69	1.98	92.65 ^b
Mean (Adopters)	51656.77	55763.48	50751.3	59627.99	65926.81	49395.11
Mean (Non-adopters)	36008.31	44191.44	41925.14	42294.74	43346.16	31783.57
Median (Adopters)	36000	39000	36000	41000	39000	34000
Median (Non-adopters)	21000	30000	28000	29000	30000	20000
F-value	391.54	77.68	148.41	350.36	30.63	3361.06
p-value	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)

Table II-2 continues

Age						
18-29	83.41 ^a	29.02 ^a	34.67 ^a	19.00 ^a	1.62	89.44 ^a
30-44	75.03 ^b	25.96 ^b	46.92 ^a	25.96 ^b	1.19	85.65 ^b
45-54	72.21 ^c	18.74 ^b	47.31 ^a	27.80 ^b	1.72	85.35 ^b
55 or older	48.63 ^d	10.82 ^c	62.92 ^b	20.18 ^a	0.86	80.31 ^c
Mean (Adopters)	45.35	42.73	52.48	47.50	43.46	48.45
Mean (Non-adopters)	56.15	50.44	45.33	49.42	48.52	51.42
Median (Adopters)	43	40	49	45	44	45
Median (Non-adopters)	57	47	43	46	45	50
F-value	889.33	441.33	479.11	6.48	0.00	38.71
p-value	(<0.001)	(<0.001)	(<0.001)	(0.011)	(0.981)	(<0.001)
Marital Status						
Married/living with partner	68.73	20.16	49.39 ^{ab}	25.50	1.52	84.19
	78.14	20.42	56.79 ^{ab}	30.02	0.70	90.20
Separated/divorced	41.29	7.39	66.39 ^a	17.10	0.75	80.43
Widowed	69.74	23.05	40.05 ^b	18.25	1.28	83.05
Never married						
Chi-square Statistics	103.098 (<0.001)	23.660 (<0.001)	51.616 (<0.001)	25.260 (<0.001)	1.962 (0.580)	6.906 (0.075)
Race						
Non-Hispanic whites	66.55	19.24 ^a	52.65	25.56 ^a	1.38	84.62
Blacks	64.80	16.71 ^{ac}	45.62	14.67 ^b	0.81	83.71
Hispanics	66.36	28.87 ^b	33.54	13.36 ^{ab}	0.53	80.31
Others	71.73	12.65 ^{bc}	48.07	23.23 ^{ab}	0.74	87.53
Chi-square Statistics	0.765 (0.858)	14.571 (0.002)	15.658 (0.001)	32.368 (<0.001)	3.603 (0.308)	3.187 (0.364)
Female Headed Household						
Yes	58.52	15.95	55.67	20.44	0.89	84.56
No	69.47	20.35	49.07	24.94	1.37	84.30
Chi-square Statistics	28.977 (<0.001)	7.022 (0.008)	7.249 (0.007)	12.439 (<0.001)	0.823 (0.364)	0.016 (0.898)

i. For comparison of adopters versus non-adopters, chi-square statistics and F-value are reported for categorical variables and continuous variables, respectively.

ii. ^{a b c d} present the results of pair-wise tests using Bonferroni adjustment with alpha level of 0.05.

Table II-4. RII (Repeated Imputed Inferences) Results of Logistic Regression of Adoption of Electronic Financial Services

Explanatory /Dependent Variables	ATM	Debit Card	Direct Deposit	Direct Payment
Intercept	1.532 (0.0000)	-1.082 (0.000)	-1.318 (0.000)	-1.260 (0.000)
Education (high school graduate or equivalent as base)				
Less than high school	-0.281 (0.025)	-0.122 (0.520)	-0.393 (0.002)	-0.245 (0.124)
Some college	0.440 (0.000)	0.439 (0.001)	0.205 (0.042)	0.163 (0.166)
Bachelor's degree	0.723 (0.000)	0.525 (0.000)	0.432 (0.000)	0.295 (0.005)
Graduate degree	1.019 (0.000)	0.678 (0.000)	0.658 (0.000)	0.484 (0.000)
Communication with professional information provider	0.334 (0.000)	0.246 (0.009)	0.118 (0.100)	0.166 (0.044)
Communication with personal source	0.231 (0.101)	-0.047 (0.755)	0.201 (0.089)	0.129 (0.315)
Age	-0.034 (0.000)	-0.026 (0.000)	0.023 (0.000)	-0.011 (0.000)
Income	0.036 (0.109)	0.036 (0.202)	-0.025 (0.218)	0.049 (0.045)
Race (White as base)				
Hispanic	-0.036 (0.858)	0.570 (0.005)	-0.212 (0.270)	-0.621 (0.011)
Black	0.166 (0.259)	-0.023 (0.892)	0.071 (0.588)	-0.651 (0.000)
Marital Status (Married or living with partner as base)				
Never been married	-0.083 (0.447)	-0.096 (0.465)	0.179 (0.076)	-0.010 (0.932)
Widowed	-0.179 (0.238)	-0.083 (0.711)	-0.282 (0.056)	-0.108 (0.541)
Divorced/Separated	-0.395 (0.003)	-0.014 (0.924)	-0.232 (0.057)	-0.407 (0.005)
Female-headed Household	0.054 (0.519)	-0.124 (0.183)	0.107(0.149)	-0.008 (0.925)
-2 log Likelihood	4567.30 (<.0001)	3713.20 (<.0001)	5350.90 (<.0001)	4477.30 (<.0001)
Degree of Freedom	14	14	14	14

PART III

A CENSORED PROBIT MODEL OF

CONSUMER ADOPTION OF INNOVATION:

A CASE OF ELECTRONIC BANKING TECHNOLOGIES

CHAPTER 1

INTRODUCTION

The diffusion of innovations is the process that precipitates fundamental technological changes in consumer markets (Mahajan, Muller, and Bass 1990; Gatignnon and Robertson 1985; Rogers 1995). Recent advances in information technology have introduced technology-based financial service deliveries to consumers (White 1998). Analysts and banking executives expect that electronic banking will grow rapidly in the new millennium (ABA Banking Journal 1999).

As the new technologies became available, consumers could choose to conduct their financial businesses electronically using computer banking and automated teller machines (ATM) instead of using paper-checks and human tellers. However, consumer adoption of electronic banking has been slower than expected, suggesting the existence of consumer resistance to the high-tech alternatives as replacements for more familiar banking practices (Fain and Roberts 1997). Gatignnon and Robertson (1985) and Hirschman (1980) note that technological innovations, such as electronic banking, have unique characteristics compared to other consumer durable goods. Adopting technology-based service innovations is rather discontinuous from consumers' past practices (Strutton, Lumpkin, and Vitell 1994) and involve a high amount of learning on the part of consumers (Dickerson and Gentry 1983; Hirschman 1990). Consequently, an individual's adoption of more efficient banking services is not guaranteed.

Although diffusion research is at a relatively mature stage (Sultan, Farley, and Lehmann 1990), a review of pertinent literature reveals that most adoption studies focus on organizational adoption (Frambach et al. 1998; Gauvin and Sinha 1993). Few

studies have empirically examined consumer adoption of the technology-based service innovations. Furthermore, even fewer studies recognized that a consumer's decision to adopt electronic banking technologies is restricted by accessibility to the technology. In fact, non-adoption of electronic banking technologies can stem from not only unwillingness to adopt but also from lack of access to the technology. Samples used to estimate adoption are censored (Meng and Schmidt 1985), since adoption is observed only when consumers have access to electronic banking technologies. Furthermore, there can be differences in consumer characteristics between those who have accessibility to these electronic services and those who do not, and adoption becomes a choice for only those consumers who have accessibility. Heckman (1979) notes that this selectivity problem can lead to biased estimates. In order to estimate adoption correctly, it is necessary to consider a censored probit model that corrects sample selection bias with a two-step estimation approach (Boyes, Hoffman, and Low 1989; Meng and Schmidt 1985).

Studies of consumer adoption of financial innovations have focused on isolating factors that predict individual adoption (Sinha and Chandeashekar 1992). Researchers (Kennickell and Kwast 1997; Lee and Lee 2000) have found that adopters of innovative financial services have certain demographic characteristics, distinct from the non-adopters. Consumers' perceptions of characteristics of innovation, such as complexity, trialability, and observability (Rogers 1995; Strutton, Lumpkin, and Vitell 1994), perceived usefulness (Davis 1989), reliability (Parasuraman, Berry, and Zeithaml 1988), and security (Swaminathan, Lepkowska-White and Rao 1999) have been proposed in the literature as potential antecedents to a consumer's decision to adopt and use innovative technology. However, limited research about how characteristics of

innovation itself or consumer's perceived innovation characteristics affect consumer adoption of electronic banking technologies has been published.

Therefore, this paper presents a study that investigates the effects of consumers' perceived innovation characteristics on consumers' adoption of the electronic banking technologies using a censored probit model that corrects for sample selection bias. This paper is organized as follows. First, a conceptual model of consumer adoption of electronic banking technologies is proposed. From the conceptual model, research hypotheses regarding the effect of the isolating factors, including perceived innovation characteristics and individual characteristics on the probability of consumer adoption of the electronic banking technologies, are generated. Next, an empirical model to test the effects of these antecedents on consumer adoption of two types of electronic banking technologies is presented. They are the uses of personal computers (PC) to conduct financial transactions and ATMs. These two technologies represent innovations at different stages of diffusion according to Rogers' adopter categories (1995).

This study can provide interesting theoretical and managerial implications. For marketing researchers, this two-step estimation approach can generate unbiased estimates for consumer adoption of innovations, by systematically partitioning the variance associated with sample selection. Managerially, the unbiased estimation of consumer adoption allows an accurate demand forecasting.

CHAPTER 2

CONCEPTUAL MODEL

Access to Electronic Banking Technologies

The adoption of electronic banking technologies depends on a number of factors. One is whether the financial institutions at which consumers have accounts offer such innovative services. Zeithaml and Gilly (1987) found that the major reason for consumers not to adopt ATMs was the lack of access, rather than their avoidance of the technology at its introductory stage.

Generally, having access to electronic banking technologies is related to whether the consumer is affiliated with a bank that offers a variety of service options including computer banking and ATM. In practice, financial institutions use segmentation strategies for services that are based on customers' income (Burnett 1990; Hefter 1987; McCormick and Sanford 1994; Raddon 1996), education (Hefter 1987), and age (Murphy and Rogers 1986; Raddon 1996; Stanley, Ford, and Richards 1985). Therefore, it is hypothesized that one's likelihood to have access to electronic banking is related to these variables.

$$\text{ACCESS} = f_{\text{ACCESS}}(\text{income, education, age}).$$

Adoption of Electronic Banking Technologies

Perceptions of innovation characteristics and socioeconomic characteristics have been proposed to influence consumers' adoption of technological innovations (Gatignon and Robertson 1985). Ostlund (1974) and Labby and Kinnear (1981) suggest that

perceived innovation characteristics can be very effective predictors of adoption and that the predictive power of these variables is stronger than socioeconomic characteristics. Given that electronic banking is available, consumers' adoption of electronic banking is assumed to be determined by their perceptions of innovation characteristics and personal characteristics (see Figure II-1).

Perception of innovation characteristics includes perceived usefulness (Davis 1989), reliability (Dabholkar 1996; Parasuraman et al. 1988), security (Swaminathan, Lepkowska-White and Rao 1999), complexity (Davis 1989; Rogers 1995), need for human interaction (Cowles and Crosby 1990), trialability (Rogers 1995), and observability (Rogers 1995). Selected individual characteristics, such as age, education, income (Rogers 1995), and PC access at home also have potential impacts on consumers' adoption of the new technologies. The proposed conceptual model of consumer adoption of electronic banking is summarized in Figure II-1. Specifically, consumer adoption of electronic banking technologies can be modeled as the following:

$$\text{ADOPTION} = f_{\text{ADOPTION}} [\text{perceived usefulness, reliability, security, complexity, trialability, observability, age, education, income, PC access at home} \mid \text{ACCESS}]$$

Perceived Innovation Characteristics

Davis (1989) asserts that the decision to use a new technology is determined by the extent to which a person believes that it is cost effective in providing goods or services compared to the current method. Perceived usefulness is conceptually similar to Rogers' relative advantage because Rogers (1995) defines relative advantage as "the degree to which an innovation is perceived better than the idea it supercedes" (p. 212). Relative advantage was found to have a significant effect on adoption (Tornatzky and

Klein 1982). Convenience and effective management of personal finances are two advantages in using electronic banking. Zeithaml and Gilly (1987) found that consumers who used ATMs and electronic funds transfer (EFT) gave convenience as the reason for their adoption decision. Electronic banking also provides consumers with more flexibility in managing their finances and control over their accounts (US Banker 1997). For example, computer banking allows customers to know their exact daily balances and to pay or delay paying other bills accordingly. Therefore, if the consumer perceives electronic banking is convenient and helps him/her to manage personal finance effectively, then the consumer is more likely to adopt electronic banking technologies.

Hypothesis 1: Perceived usefulness has a positive impact of consumer adoption of electronic banking technologies.

Reliability refers to the degree to which consumers believe a new technology will perform a job consistently and accurately. Reliability has been reported as critical when deciding whether or not to adopt technologies, such as information and data exchange technology (Health Care Strategic Management 1997; Mohamed 1992; Simms 1999; Smith 1996; Takac and Singh 1992). Lewis (1989) applied the SERVQUAL scale to the bank-marketing context and confirmed that reliability cannot be ignored in assessing quality of banking services. If the potential adopter of electronic banking perceives the new technology is not reliable and believes that mistakes are likely to occur, s/he is not likely to adopt (Dabholkar 1996). Therefore, reliability is expected to have a positive influence on adoption of electronic banking technologies.

Hypothesis 2: Perceived reliability has a positive impact on consumer adoption of electronic banking technologies.

Perceived security risk is a major reservation consumers have about electronic banking. Concerns about transaction security, such as potential cyber crime and errors in transactions, can limit adoption of electronic technologies (Gingrade 1998; Simms 1999). Often, people are hesitant to sign up for services that involve giving financial information electronically due to their concerns about security of transactions (O'Connell 1999; Swaminathan, Lepkowska-White and Rao 1999). Therefore, it is hypothesized that the perception of security in electronic banking is positively related to the adoption.

Hypothesis 3: Perceived security has a positive impact on consumer adoption of electronic banking technologies.

Complexity is the degree to which a consumer perceives an innovation as difficult to use. Complexity can create barriers to adoption of the innovation, especially when the initial use requires a great deal of consumer learning, as is the case of electronic banking (Fain and Roberts 1997). To some consumers who have the learning capability, electronic banking technologies are clear and easy to understand, whereas to others the technologies can be difficult and frustrating to use. Rogers (1995, p. 242) suggested that the complexity of an innovation, as perceived by potential adopters, is negatively related to the speed of diffusion of that innovation. It was also found that ease of use, which is opposite of Rogers' complexity, was positively correlated with use of consumer technologies, such as computer software (Davis 1989; Venkatesh and Davis 1996). That is, the more the consumer perceives electronic banking technologies as difficult to use, the less s/he is likely to adopt the technology.

Hypothesis 4: Complexity has a negative effect on consumer adoption of electronic banking technologies.

Trialability refers to how easily a consumer can try an innovation before actual adoption (Rogers 1995, p. 243). An innovation that can be tested under the consumer's own conditions is more likely to be adopted than an innovation that cannot be tried on a personal basis (Rogers 1995). Consumers who have opportunities to try various electronic banking transactions are, therefore, expected to be more open to adoption of electronic banking technologies.

Hypothesis 5: Trialability has a positive effect on consumer adoption of electronic banking technologies.

Observability is the degree to which an innovation is visible to others (Rogers 1995, p. 244). Innovations that are easily observed and communicated by others generate greater exposures to potential adopters. Rogers (1995, p. 244) suggested that the observability of an innovation is positively associated with adoption. If consumers can actually see how others use the electronic banking technologies and observe that using technology produces a good outcome, that will encourage consumer adoption. Therefore, it is hypothesized that observability has a positive effect on the adoption of electronic banking technologies.

Hypothesis 6: Observability has a positive effect on consumer adoption of electronic banking technologies.

Many electronic banking technologies replace the interactions with human tellers with the interaction with machines. Dabholkar (1996) notes that the need for human interaction is a very relevant factor in understanding perception of service quality. In addition, consumer intention to use a service technology, including electronic banking, is often reduced by the need for interacting with human tellers (Prendergast and Marr 1994). Cowles and Crosby (1990) showed that consumers have different tolerance

levels for automated services. For some consumers, the preference for personal interaction is strong, and as a result, the loss of human contact outweighs the increased benefits of electronic banking, such as convenience and timesaving (Ledinghan 1984). Therefore, preference for human interaction negatively influences consumer adoption of electronic banking technologies.

Hypothesis 7: Preference for human interaction has a negative effect on consumer adoption of electronic banking technologies.

Individual Characteristics

Demographic differences have been found between adopters and non-adopters of various innovations (Gatignon and Robertson 1985; Kennedy 1983; Midgley and Dowling 1978; Robertson and Kennedy 1969; Robertson, Zielinsky, and Ward 1984; Rogers 1995; Zeithaml and Gilly 1985). In general, adopters of innovations were found to be younger, be more highly educated, and have higher incomes than the non-adopters (Rogers 1995, p. 269).

Adopters of ATMs are more likely to be young, and have above average incomes, and at least high school education (El-Haddad and Almahmeed 1992; Marshall and Heslop 1991; Stanley, Ford, and Richards 1985; Swinyard and Ghee 1984; Taube 1988). Gilly and Zeithaml (1985) found that age can influence consumers' likelihood of adopting ATM versus EFT differently. Elderly consumers are somewhat less likely to adopt ATMs than younger consumers, but more likely to adopt EFT (Gilly and Zeithaml 1985). More recently Kennickell and Kwast (1997) show that household heads under the age of 35 are more likely to use computerized banking and ATMs than their older counterparts. Kennickell and Kwast (1997) and Lee and Lee (2000) found that the

effects of education and income on adoption of various electronic banking technologies are significant. In particular, Lee and Lee (2000) found that some college or higher education has a positive effect on the adoption of ATMs. Based on these studies, it is hypothesized that age has a negative effect on the adoption of electronic banking technologies, whereas education and income have positive impacts.

Hypothesis 8: Age has a negative effect on adoption of electronic banking.

Hypothesis 9: Education has a positive effect on adoption of electronic banking.

Hypothesis 10: Income has a positive effect on electronic banking.

Since PC banking requires access to a computer, it is prerequisite to the adoption of computer banking. Therefore, consumers who have access to PCs at home are more likely to adopt computer banking than those who do not have access to PCs at home.

Hypothesis 11: Having a PC at home has a positive effect on the adoption of computer banking.

CHAPTER 3

EMPIRICAL MODEL:

SAMPLE SELECTION AND TWO STEP ESTIMATION

Access and adoption are sequentially related. In order for a consumer to adopt electronic banking, he or she must first have an access to the innovative service. Let zero denote no access or adoption and one represent access or adoption. No-access consumers would have all zero observations for adoption and adopter consumers would have all nonzero observations for access. Heckman (1979) noted a bias could be caused by using a pre-selected sample to estimate behavioral relationships between two related constructs, especially when certain common unobserved variables influence both the selection variable and the response variable. This is a selectivity problem from a censored distribution because adoption is observed only when the consumer has access to electronic banking (Meng and Schmidt 1985). If only the access group is used in estimation for adoption, not only are estimates biased, they are also inconsistent (Nayga 1996).

A two step estimation model is constructed that adjusts for the selection bias. Heckman (1979) first introduced two-step estimation. In principle, a two-step estimation replaces the unobserved components with the estimated values from an additional model (Murphy and Topel 1985). Because adoption is measured as a binary (yes/no) dependent variable, the standard Heckman procedure must be modified. More precisely, the access and the adoption models together constitute a censored probit framework (Boyes, Hoffman, and Low 1989; Meng and Schmidt 1985).

The first stage involves estimating a probit model that predicts access for consumer i :

$ACCESS_i = 1$ if access was offered,

$= 0$ if not.

$ACCESS_i^* =$ marginal benefit of having access to electronic banking,

$$ACCESS_i^* = \gamma' \omega_i + \varepsilon_{i1}, \quad (1)$$

where $\gamma' =$ a $1 \times K$ vector of parameters,

$\omega_i =$ a $K \times 1$ vector of independent variables that determine access.

$K =$ number of estimated coefficients,

$\varepsilon_{i1} =$ random error.

$ACCESS_i = 1$ if $ACCESS_i^* > 0$,

$= 0$ otherwise.

$\phi_1(\gamma' \omega) =$ standard normal probability density for $ACCESS_i^* > 0$, and

$\Phi_1 =$ cumulative standard normal for $ACCESS_i^* > 0$.

The second step estimates consumer adoption as follows:

$ADOPT_i = 1$ if adopted,

$= 0$ if not.

$ADOPT_i^* =$ marginal benefit of using electronic banking given it is available

$$ADOPT_i^* = \beta' x_i + \varepsilon_{i2}, \quad (2)$$

where $\beta' =$ a $1 \times K^*$ vector of parameters,

$x_i =$ a $K^* \times 1$ vector of independent variables that determine adoption,

$K^* =$ number of estimated coefficients,

$\varepsilon_{i2} =$ random error.

$\phi_2(\gamma'\omega, \beta'x, \rho)$ = standard normal probability density for $ADOPT_i$ given

$ACCESS=1$, and

Φ_2 = cumulative standard normal for $ADOPT_i$ given $ACCESS_i=1$.

The errors have the standard bivariate normal distribution,

$$\varepsilon_1, \varepsilon_2 \sim \text{BVN}(0, 0, 1, 1, \rho),$$

where ρ is the correlation between access and adoption.

Here, sample selection bias is introduced because adoption of computer banking can occur only when the consumer has access to the technology. In other words, adoption is observed in this censored probit model only if $access=1$ (Boyes, Hoffman, and Low 1989, p.6). The log likelihood function for the i^{th} observation in a sample, as specified in Greene (1997 p. 912; 1998, p.492) and Meng and Schmidt (1985 p. 6), is based on three types of observations in the sample with associated probabilities

$$\text{Access}=0: \quad \text{Prob}(\text{access}=1) = 1 - \Phi_1(\gamma'\omega),$$

$$\text{Adoption}=0, \text{Access}=1: \quad \text{Prob}(\text{adoption}=0, \text{access}=1) = \Phi_2(-\beta'x, \gamma'\omega, -\rho), \text{ and}$$

$$\text{Adoption}=1, \text{Access}=1: \quad \text{Prob}(\text{adoption}=1, \text{access}=1) = \Phi_2(\beta'x, \gamma'\omega, \rho).$$

Therefore, the log likelihood function can be written as follows.

$$\begin{aligned} \ln L = & \sum_{\text{access}=1, \text{adoption}=1} \log \Phi_2[\beta'x, \gamma'\omega, \rho] + \sum_{\text{access}=1, \text{adoption}=0} \log \Phi_2[-\beta'x, \gamma'\omega, -\rho] \\ & - \sum_{\text{access}=0} \log \Phi_1[-\gamma'\omega]. \end{aligned} \quad (3)$$

Data and Sample Characteristics

The dataset used for this study was the 1999 Survey of Consumers commissioned by University of Michigan Institute of Social Research Survey Research Center. Surveys of Consumers were initiated in the late 1940s by the Survey Research Center at the University of Michigan. They are designed to measure changes in consumer attitudes and expectations, to explain why such changes occur, and to evaluate how these changes relate to consumer decisions to save, borrow, or make discretionary purchases. In September and October of 1999, the Federal Reserve Board commissioned additional questions on the Surveys of Consumers, including specific questions on consumers' adoption of electronic banking and the factors underlying adoption. The survey was a national sample of telephone survey of 1,000 adults. Among the 1,000 respondents, 890 people who had accounts with a bank, thrift, or credit union over the past twelve months comprised the sub-sample used in the estimation.

Measures

Two electronic banking technologies were examined in this study: computer banking and ATM. Access and adoption were measured as responses to four questions which are shown in Table III-1. Consumer perceptions of innovation characteristics and individual socioeconomic variables comprise the explanatory variables. Consumer perceptions of innovation characteristics include perceived usefulness, reliability, security, complexity, trialability, observability, and need for human interaction. Multiple item measures were included for each construct, however, after a pilot test, several

items were dropped in order to reduce burdens on the respondents due to the lengthy telephone survey.

The responses were recorded on a 5-point Likert scale (1=strongly disagree, 2=disagree, 3=neutral, 4=agree, 5=strongly agree). The specific statements employed to identify each of the above perceived innovation characteristics are presented in Table III-3a. For socioeconomic characteristics, the respondent's income, education, age, and PC access at home were also included in the analysis, and the corresponding measures are presented in Table III-2.

Analysis

First, descriptive statistics were used to examine demographic profiles of consumers who have access to computer banking, adopted computer banking or ATMs. Next, factor analysis was used to identify the underlying factors of consumers' perceived characteristics of electronic banking technologies since some of the constructs were measured with multiple items. Factor scores were generated from the factor analysis and used as explanatory variables in the subsequent probit analysis. Factor scores produced with orthogonal estimation such as varimax rotation can avoid multicollinearity. In addition, by employing factor scores, the subsequent probit models can use only the common variances that are generated from the underlying factors and not from the disturbances.

Since 94 percent of bank customers (N=890) in the sample had access to ATMs, access is not a barrier to consumer adoption of ATMs. Therefore, the sample selection bias is negligible in estimating consumer adoption of ATMs, so this equation could be estimated without the first step. On the other hand, computer banking is a recent

technology within the category of electronic banking, and computer banking is found not to be widely available to consumers. Table III-2 indicates that about 60 percent of bank customers had access to computer banking.

A bivariate probit model with the "select" option in LIMDEP version 7.0 was used employing the Davidon-Fletcher-Powell algorithm (Greene 1998). Results of the first step probit analysis, which estimates the probability of having access, are used to correct sample selectivity problem for the respondents who did not receive access to computer banking.

For consumers, trialability and access can be highly correlated. Those who have access to computer banking are more likely to be able to try the technology, while those who do not have access are unable to try. Therefore, including trialability introduces multicollinearity problem in estimating the model of adoption of computer banking. On the other hand, for ATM adoption including trialability can be meaningful because non-access was less frequent in the sample. Therefore, two factor analyses were conducted to produce factor scores for subsequent probit analyses: a five factor model and a six factor model based on inclusion of trialability for modeling computer adoption and ATM adoption, respectively.

Significant correlations were observed between income and several other variables, such as PC access (Spearman's $\rho=0.405$), education, and age. Due to the relationship among income, education, and use of PCs and the lifecycle of earnings, a linear combination was not unexpected. Consequently, income was not included, and estimated coefficients of age, education, and PC access also contain the effect of income.

CHAPTER 4

RESULTS

Descriptive Analysis

Table III-1 presents frequencies of access and adoption for computer banking and ATM. The two technologies appear to be at different stages of their adoption (diffusion) processes. ATMs have been in use for a much longer period than computer banking. For the survey of consumers, almost (94 percent) everyone who had affiliation with financial institution had access to ATMs, whereas just under 60 percent had access to computer banking. Within the access subgroup nearly two-thirds used the ATM technology, while only 21 percent of those who had access to computer banking used it. Computer banking appears to be at an earlier stage of diffusion than ATM.

Table III-2 shows demographic characteristics of computer banking adopters and ATM adopters. Demographic information about consumers who have access to computer banking is also presented. Overall, an average computer banking user appears to be younger (age 40), better educated, and have higher income, compared to an average ATM adopter. Consumers who already use computer banking are likely to have PCs at home. About 88 percent of computer banking adopters have PCs at home, whereas 70 percent of consumers who have access to computer banking have PCs at home.

Factor Analysis

For the computer banking adoption model, five factors emerged: perceived usefulness, reliability, security, complexity, and observability, which later were used as explanatory variables for the computer banking adoption model. Table III-3a presents the results of the first factor analysis. Although these five factors reflect each construct adequately, it should be noted that preference for human tellers loaded on the reliability factor instead of standing alone. Preference for human tellers may be highly negatively correlated with perceived reliability of electronic banking technologies. The bold face indicates large factor loading scores. These five factors explained about 75.7 percent of total variance, and the eigenvalues ranged from 2.12 to 1.01.

Table III-3b shows that the six factors (the five from Table III-3a and trialability) explained about 78.3 percent of total variance in ATM adoption. Factor loading patterns appear to be adequate, and eigenvalues for each factor ranged from 1.99 to 1.02.

Probit Analysis

Table III-4 presents the estimated equations. The first step computer banking model was significant (Chi square =92.183, df=3, p=0.000). Table III-5a shows that the estimated model predicts 64 percent of the observation correctly. The second-step computer banking model was highly significant (Chi square =113.368, df=9, p=0.000). McFadden's R^2 was not high (0.062), however, the model predicts 412 of 531, or 78 percent, of the observation correctly suggesting a good overall fit (see Table III-5b). The first step probit model, accounting for access to computer banking, has significant age,

income, and education coefficients. The second step probit model for computer banking adoption shows perceived usefulness, reliability, security, and complexity have significant effects.

For ATM adoption, the model was estimated twice. The first probit analysis included the total sample (N=890), and the second analysis excluded the consumer segment without access to ATM (N=837). The estimated models had good overall fits; McFadden's R^2 were 0.361, and 0.241, for the N=890 model and the N=837 model, respectively. In addition, these two models produced the same pattern of direction and significance of parameter estimates. Both models were highly significant (Chi square (N=890) = 496.555, df=9, p=0.000; Chi square (N=837) = 259.116, df=9, p=0.000). The convergence of actual and predicted outcomes of the ATM adoption model indicates that the models had a good predictive power with 77 percent accuracy in prediction (See Table III-5c). The effects of the all predictor variables on ATM adoption except observability were found to be significant.

CHAPTER 5

DISCUSSION

The hypotheses were tested with regard to the significance ($\alpha=0.05$) and direction of parameter estimates generated from the probit analyses. Positive (negative) coefficients are associated with higher (lower) likelihoods of adopting or having access to electronic banking technologies. The hypothesis tests are summarized in Table III-6.

Socioeconomic variables were highly significant predictors of having access to computer banking. The younger, the more highly educated, and the higher the income, the more likely a consumer is to have access to computer banking. In addition, perceived characteristics of electronic banking technologies were found to be significant predictors of consumer adoption of computer banking and ATM. First of all, perceived usefulness was found to be a significant predictor of both computer banking adoption ($\beta = 0.477$, $p=0.000$) and ATM adoption ($\beta=0.273$, $p=0.000$) (H1 supported). The more one perceives the advantages of electronic banking, convenience and effective management of personal finances, the more likely the consumer is to adopt computer banking and ATM.

The effects of reliability on adoption of computer banking ($\beta = -0.294$, $p=0.000$) and ATM ($\beta= -0.266$, $p=0.000$) were also found to be significant (H2 supported). If the consumer perceives that mistakes are more likely with electronic banking and that mistakes with electronic banking are more difficult to get corrected than regular banking, then the consumer is less likely to adopt either computer banking or ATM. Interestingly, it was found in the factor analysis that consumers' preference for human tellers is

associated with their perception that electronic banking without human presence is not as reliable as banking with human tellers (see factor loadings in Table III-4).

Security was found to be significantly related to adoption of electronic banking technologies (H3 supported). Consumers who perceive electronic banking as safe and feel comfortable about providing personal information through electronic banking systems are more likely to adopt computer banking ($\beta=0.178$, $p=0.007$) and ATM ($\beta=0.119$, $p=0.019$).

Complexity was found to be negatively associated with adoption of electronic banking (H4 supported). Consumers who perceive electronic banking as difficult to use are less likely to adopt computer banking ($\beta=-0.189$, $p=0.017$) and ATM ($\beta=-0.178$, $p=0.000$).

The impact of observability was found to be insignificant on consumer adoption of computer banking ($p=0.351$) (H6 not supported) and was only marginally significant for consumer adoption of ATMs ($\beta=0.093$, $p=0.062$). In fact, observability is the only insignificant predictor in our model. This non-significance may well relate to the fact that electronic banking is not as highly observable as other visible consumption like fashion or cars (Fain and Roberts, 1997)

Regarding demographic impacts, age was found to be negatively related to the propensity to adopt ATM ($\beta=-0.027$, $p=0.000$), but no significant relationship between age and computer banking was found ($\beta=-0.003$, $p=0.545$) (H8 partially supported). Education was positively associated with consumer adoption of electronic banking technologies. Adopting ATM was found to be more likely among people with at least some college education ($\beta=0.274$, $p=0.001$). However, the effect of having bachelor's degree on adoption of computer banking was found not to be significant ($\beta=-0.279$,

$p=0.081$) (H9 partially supported). The effect of having access to PC was found to be marginally significant ($\beta=0.405$, $p=0.066$) (H11 not supported). Finally, the effect of income on adoption of ATM was found to be significant ($\beta=0.051$, $p=0.001$) (H10 supported).²

The estimate of ρ that maximizes the bivariate probit likelihood is -0.646 . This indicates that unexplained tendencies of not having access are actually associated positively with adopting computer banking in our sample (Boyes, Hoffman, and Low 1986, 1989). The significant ρ ($p=0.015$) suggests that there exists significant sample selection bias with regard to access when estimating consumer adoption of computer banking. This is the evidence that two-step estimation is, in fact, appropriate.

CHAPTER 6

CONCLUSIONS AND IMPLICATIONS

Consumer adoption of two kinds of technological innovations in banking, computer banking and ATM, was examined in this study. The former is in an early stage of diffusion and access is available only to subset portion of the population. Consequently, a two-step estimation is employed to estimate access and adoption given access. Since nearly everyone had access to ATMs, only the adoption equation needed to be estimated in the latter.

Individual socioeconomic variables were found to be highly significant predictors of having access to computer banking. It appears that financial institutions selectively offer computer-banking options to young, highly educated, and high-income consumer segments. Perceived innovation characteristics have significant impacts on the likelihood of adoption. The effects of perceived innovation characteristics were more significant than the effects of socioeconomic variables in predicting for consumer adoption of the electronic banking technologies, after correcting the sample selection bias associated with accessibility. Consumers' perceptions of the electronic banking technologies as useful, reliable, secure, and easy way to bank increase the probability to adopt computer banking and ATMs. Giving customers various opportunities to try out the technologies also can facilitate their adoption. Observability, however, did not significantly enhance the probability to adopt.

Younger, higher income and better-educated consumers are more likely to adopt ATMs. However, the effects of individual socioeconomic characteristics on consumers'

adoption of computer banking were not significant. Having a PC at home is significant at the 0.10 level in affecting consumer adoption of computer banking.

The results provide insights for diffusion agents, such as marketing managers and public policy makers, who are interested in the dissemination of electronic banking technologies. Diffusion agents should build effective communication strategies that emphasize convenience, and other relative advantages, reliability, security, and ease of using electronic banking. For example, communicating improved reliable performance can invite consumers to use electronic banking technologies. Similarly, addressing security concerns can increase the likelihood that customers will use electronic banking. With respect to marketing consumer segments, increased use of ATMs is most likely to occur among younger, more highly educated, and above average income customers. These same customers are more likely to have access to computer banking, but their adoption is determined mainly by the perceived attributes of the technology and marginally by available resources such as having PC at home.

In conclusion, this study provides an understanding of the impacts of innovative characteristics affecting consumer adoption of electronic banking technologies to help practitioners to develop effective diffusion strategies. This study employed a two step censored probit model to predict consumer adoption of new technologies with limited accessibility. This new modeling method is useful because it produces unbiased estimation. However, supply-side factors such as effects of marketing communication efforts are not included in this study. Understanding supply-side variables would be of interest to managers, as they can control them to a great extent to influence adoption of innovations. Therefore, future research can be directed to investigate supply-side factors. Finally, this study made an assumption that access is required for adoption and

did not account for the fact that a consumer can choose a financial institution because it provides access to the innovative services. Limitation of this study also includes measurement issues. The nature of the data did not allow multiple-item measures for some constructs. For example, trialability was measured with one item that was not clearly distinguished from accessibility in the empirical model. Future research is needed to find a better way to measure trialability to represent its unique conceptual dimensions.

REFERENCES

- ABA Banking Journal (1999), "At last, Internet Banking Takes Off," 91 (7), 36.
- Barczak, Gloria, Pam Scholder Ellen, and Bruce K. Pilling (1997), "Developing Typologies of Consumer Motives for Use of Technologically Based Banking Services," *Journal of Business Research*, 38, 131-139.
- Boyes, W. J., Dennis Hoffman, and Stuart Low (1986), Lender Reactions to Information Restrictions: The Case of Banks and ECOA," *Journal of Money, Credit, and Banking*, 18(2), 211-19.
- Boyes, W. J., Dennis Hoffman, and Stuart Low (1989), " An Econometric Analysis of the Bank Credit Scoring Problem," *Journal of Econometrics*, 40(1), 3-14.
- Burnett, John J. (1990), "Adult Singles: An Untapped Market," *International Journal of Bank Marketing*, 8 (4), 10-16.
- Dabholkar, Pratibha (1996), "Consumer Evaluations of New-Technology-Based Self Service Options: An Investigation of Alternative Models of Service Quality," *International Journal of Research in Marketing*, 13, 29-51.
- Davis, Fred D. (1989), "Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology," *MIS Quarterly*, (September), 319-339.
- Dickerson, Mary Dee and James W. Gentry (1983), "Characteristics of Adopters and Non-Adopters of Home Computers," *Journal of Consumer Research*, 83 (10), 225-235.
- El-Haddan, A., and Almahmeed, M.(1992), "ATM Banking Behavior in Kuwait: A Consumer Survey," *International Journal of Bank Marketing*, 10(3), 250-232.
- Frambach, Rund T., Barkema, Harry G., Nooteboom, Bart, and Michel Wedel (1998), "Adoption of Service Innovation in the Business Market: An Empirical Test of Supply-Side Variables," *Journal of Business Research*, 41 (2), 161-174.
- Fain, Deborah and Mary Lou Roberts (1997), "Technology vs. Consumer Behavior: The Battle for the Financial Services Customer," *Journal of Direct Marketing*, 11 (Winter),
- Gatignon, Hubert and Robertson, Thomas, R. (1985), " A Propositional Inventory for New Diffusion Research," *Journal of Consumer Research*, 11 (March), 849-867.
- Gauvin, Stephanie and Rajiv K. Sinha (1993), "Innovativeness of Industrial Organizations: A Two-Stage Model of Adoption," *International Journal of Research in Marketing*, 10 (2), 165-184.

- Gingrade, Arthur (1998), "Reshaping the InfoTech Landscape of Insurance," *Inform*, 12 (5 May), 42-46.
- Greene, William H. (1981), "Sample Selection Bias as a Specification Error," *Econometrica*, 47 (1), 153-161.
- Greene, William H. (1993), *Econometric Analysis*. Prentice-Hall: New Jersey.
- Greene, William H. (1998), *LIMDEP Version 7.0 User's Manual*, Econometric Software, Inc. New York.
- Health Care Strategic Management (1997), "Health Care Lags Other Industries in Internet Use Because of Security Concerns," *Health Care Strategic Management*, 15 (4), p. 7.
- Heckman, James J. (1976), "The Common Structure of Statistical Models of Truncation, Sample Selection, and Limited Dependent Variables and a Simple Estimator for Such Models," *Annals of Economic and Social Measurement*, 5/4, 475-492.
- Heckman, James J. (1979), "Sample Selection Bias as a Specification Error," *Econometrica*, 47 (1), 153-160.
- Hefter, Tom J. (1987), "Go with Those You Know: Sell to Existing Customers," *Bottomline*, 4 (11 November), 15-20.
- Hirschman, Elizabeth, C. (1980), "Innovativeness, Novelty Seeking, and Consumer Creativity," *Journal of Consumer Research*, 7 (December), 289-295.
- Kalbfleisch, J. D. and Lawless, J. F. (1992), "Some Useful Statistical Methods for Truncated Data," *Journal of Quality Technology*, 24 (3), 145-152.
- Kennickell, Arthur B. and Myron L. Kwast (1997), "Who Uses Electronic Banking? Results from the 1995 Survey of Consumer Finances," presented at the Annual Meeting of the Western Economic Association, (July), Seattle, Washington.
- Labby, Duncan G. and Thomas C. Kinnear (1985), "Exploring the Consumer Adoption Process in the Adoption of Solar Energy Systems," *Journal of Consumer Research*, 8 (December), 271-278.
- Ledingham, J. A. (1984), "Are Consumers Ready for the Information Age?" *Journal of Advertising Research*, 24 (4), 31-37.
- Lee, Eun-Ju and Jinkook Lee (2000), "Haven't Adopted Electronic Financial Services Yet? The Acceptance and Diffusion of Electronic banking technologies," *Journal of Financial Counseling and Planning*, in press.
- Lewis, Barbara R. (1989), "Quality in the Service Sector: A Review," *International Journal of Bank Marketing*, 7 (5), 4-12.

- Maddala, G. S. (1983), *Limited Dependent and Qualitative Variables in Econometrics*, Cambridge University Press, New York.
- Mahajan, Vijay, Eitan Muller, and Frank M. Bass (1990), "New Product Diffusion Models in Marketing: A Review and Directions for Research," *Journal of Marketing*, 54 (January), 1-26.
- Mark, Arend (1991), "Are Your Bank's ATM Earning Their Keep?" *ABA Banking Journal*, 83 (11), 37-42.
- Marr, Norman E., and Gerard Prendergast (19), "Human Tellers: Who Need Them?" *International Journal of Bank Marketing*, 8 (2), 32-39.
- Marshall, J., and L. Heslop (1988), "Technology Acceptance in Canadian Retail Banking," *International Journal of Bank Marketing*, 6(4), 31-41.
- Meng, C. L. and P. Schmidt (1985), "On the Cost of Partial Observability in the Bivariate Probit Model," *International Journal of Economic Review*, 26, 71-85.
- Mohamed, Zairi (1992), "Measuring Success in AMT Implementation Using Customer-Supplied Interaction Criteria," *International Journal of Operations and Production Management*, 12 (10), 34-55.
- Murphy, Kevin M., and Topel, Robert H. (1985), "Estimation and Inference in Two-Step Econometric Models," *Journal of Business and Economic Statistics*, 3 (4), 370-379.
- Murphy, Neil B., and Ronald C. Rogers (1986), "Life Cycle and the Adoption of Consumer Financial Innovation: An Empirical Analysis of the Adoption Process," *Journal of Bank Marketing*, 17 (1), 3-8.
- Nayga, Jr., Rodolfo M. (1996), "Wife's Labor Force Participation and Family Expenditures for Prepared Food, Food Prepared at Home, and Food Away from Home," *Journal of Agricultural Resource Economic Review*,
- O'Connell, Brian (1999), "Microsoft's Smart Card Play," *Bank Technology News*, January 20.
- Ostlund, Lyman E. (1974), "Perceived Innovation Attributes as Predictors of Innovativeness," *Journal of Consumer Research*, 1 (June), 23-29.
- Owen, Kenneth (1986), "Computer Security: IFIP Addresses the Practical Issues," *Information Age*, 8 (2), 81-84.
- Parasuraman, A. Zeithaml, Valarie A., Berry, Leonard L. (1988), "SERVQUAL: A Multiple-Item Scale for Measuring Consumer Perceptions of Service Quality," *Journal of Retailing*, 64 (1), 12-40.

- Prendergast, Gerard and Norman Marr (1994), "Challenging Human Interaction in the Delivery of Banking Services: New Zealand as a Microcosm of European Banking in the Futures," *Journal of Retail Banking Services*, 18 (4), Winter, 33-40.
- Raddon, Gary (1996), "A Profit-Driven Scheme," *Credit Union Management*, 19 (6 June), 38-39.
- Rogers, Everett E. (1995), *Diffusion of Innovations*, The Free Press, New York.
- Simms, Monica (1999), "New on the Web: Market Data Vendors Roll Out Red Carpet on Web Offerings," *Wall Street and Technology*, Third Quarter, 10-12.
- Sinha, Rajiv K., and Murali Chandrashekar (1992), "A Split Hazard Model for Analyzing the Diffusion of Innovations," *Journal of Marketing Research*, 29 (February), 116-127.
- Smith, Bers J. (1996), "Driving into Internet EDI," *Bank Systems and Technology*, 33 (3), 38-40.
- Stanley, Thomas, O., John K. Ford, and Sande K. Richards (1985), "Segmentation of Bank Customers by Age," *International Journal of Bank Marketing*, 3 (3), 56-63.
- Sultan, Fareena, John U. Farley, and Donald R. Lehmann (1990), "A Meta-Analysis of Applications of Diffusion Models," *Journal of Marketing Research*, 27 (February), 70-77.
- Swaminthan, Vanitha, Elzbieta Lepkowska-White and Bharat Rao (1999), "Browsers or Buyers in Cyberspace? An Investigation of Factors Influencing Electronic Exchange." *Journal of Computer-Mediated Communication* 5 (2). [WWW Document] URL <http://www.ascusc.org/jcmc/vol5/issue2/swaminathan.htm>.
- Takac, Paul F. and C. F. Sing (1992), "Banking Technology: Improving Its Potential Through Better Management," *Management Decision*, 30 (5), 17-20.
- Talmor, S. (1995), "New Life for Dinosaur. *The Banker*," 145 (September), 77.
- Taube, P.M. (1988), "The Influence of Selected Factors on the Frequency of ATM Usage," *Journal of Retail Banking*, 10 (1), 47-52.
- Tornatzky, L. K., and K. J. Klein (1982), "Innovation Characteristics and Innovation Adoption-Implementation: A Meta Analysis of Findings," *IEEE Transactions on Engineering Management*, 29, 28-45.
- US Banker (1997), "Luring Customers with Bill Pay," 107 (11), S16-S20.
- Venkatesh, Viswanath, and Fred D. Davis (1996), "A Model of the Antecedents of Perceived Ease of Use: Development and Test," *Decision Sciences*, 27 (3), 451-481.

- Strutton, H. David, James R. Lumpkin, and Scott J. Vitell (1994), "An Applied Investigation of Rogers and Shoemaker's Perceived Innovation Attribute Typology When Marketing to Elderly Consumers," *Journal of Applied Business Research*, 10 (1), 118-131.
- White, Lawrence J. (1998). *Technological Change, Financial Innovation, and Financial Regulation in the U.S.: The Challenges For Public policy*. Working Paper, Stern School of Business, New York University.

APPENDIX

TABLES AND FIGURES

Table III-1. Frequencies of Access and Adoption (N=890)

Access and Adoption	Computer Banking	ATM
	Do any of the financial institutions at which you have checking, money market, or savings accounts offer computer banking? = 1 have access to computer banking, 0 otherwise	Do any of the financial institutions at which you have checking, money market, or savings accounts offer their customers access to ATMs? = 1 have access to ATM, 0 otherwise
Have Access	531 59.66%	837 94.04%
No Access	359 40.34%	53 5.96% ^a
	890 100.00%	890 100.00%
Among the consumers who have access		
	Computer banking uses a personal computer to review account information or to transfer funds. During the past twelve months, did you use computer banking? = 1 adopted computer banking, 0 otherwise	Some people use automated teller machines, or ATMs, to deposit money in, or withdraw money from, their bank accounts. Over the past twelve months, have you used an ATM? = 1 adopted ATM, 0 otherwise
Adopters	111 20.90%	551 65.83%
Non-Adopters	420 79.10%	286 34.17%
	531 100.00%	837 100.00%

Table III-2. Descriptive Statistics

Variables	Consumers with Access to Computer Banking (N=531) (% of sample)	Computer Banking Adopters (N=111) (% of sample)	ATM Adopters (N=551) (% of sample)
Education^a			
Some college or more χ^2	71.00% 66.3082 (<0.0001)	80.18% 22.9540 (<0.0001)	72.78% 96.9646 (<0.0001)
Bachelor's degree or more χ^2	46.33 37.6447 (<0.0001)	54.95% 16.2311 (<0.0001)	47.45% 52.8833 (<0.0001)
Income			
< \$10,000 (=1)	1.32%	0%	0.18%
\$10,000-\$14,999 (=2)	3.95%	0.90%	3.45%
\$15,000-\$19,999 (=3)	3.20%	0.90%	3.81%
\$20,000-\$24,999 (=4)	5.65%	3.60%	4.17%
\$25,000-\$29,999 (=5)	4.33%	3.60%	4.72%
\$30,000-\$34,999 (=6)	3.95%	2.70%	4.72%
\$35,000-\$39,999 (=7)	5.65%	6.31%	6.17%
\$40,000-\$44,999 (=8)	6.59%	8.11%	5.81%
\$45,000-\$49,999 (=9)	10.92%	9.01%	11.62%
\$50,000-\$59,999 (=10)	12.81%	8.11%	12.16%
\$60,000-\$74,999 (=11)	12.05%	14.41%	12.34%
\$75,000-\$99,999 (=12)	12.05%	15.32%	14.70%
\$100,000-\$124,999 (=13)	8.47%	11.71%	7.62%
\$125,000 or more (=14)	9.04%	15.32%	8.53%
Mean χ^2 (Cochran-Mantel-Haenszel statistic)	9.19 73.0583 (<0.0001)	10.33 39.2434 (<0.0001)	9.33 104.76 (<0.0001)
Age			
18-24 years old	7.91%	8.11%	10.89%
25-34 years old	21.66%	30.63%	24.14%
35-44 years old	26.74%	30.63%	29.04%
45-54 years old	18.83%	17.12%	18.87%
55-64 years old	12.62%	9.91%	11.80%
over 65	12.24%	3.60%	5.26%
Mean χ^2 (Cochran-Mantel-Haenszel)	44.06 11.6071 (0.0007)	39.77 17.8071 (<0.0001)	40.99 110.6474 (<0.0001)
PC Access			
=1 have access at home χ^2	70.06% 62.283 (0.081)	88.29% 45.636 (<0.0001)	72.41% 97.857 (<0.0001)

Table III-2 continues

^a The likelihood of having a computer and the likelihood of using it for computer banking are greater the higher the level of educational attainment because familiarity with personal computer through the educational and job related situations increase with education. Consequently, an average computer- banking user is expected to have higher education levels than an average ATM user. Two binary variables reflecting whether the respondent had a bachelor's or higher degree or whether the respondent had some college or more education were created for computer banking and ATM, respectively.

Table III-3a. Results of Factor Analysis with Varimax Rotation: Factor Scores Used For Computer Banking Adoption

	Factor 1 Perceived Usefulness	Factor 2 Reliability	Factor 3 Security	Factor 4 Complexity	Factor 5 Observability	Communality
Electronic banking is convenient	0.7399	-0.1752	0.1550	-0.1938	0.2170	0.6405
Electronic banking helps me to better manage my personal finances	0.7782	-0.2956	0.1295	-0.0232	0.0615	0.6847
There are enough advantage of electronic banking for me to consider using it	0.7505	-0.1650	0.2638	-0.1055	0.0520	0.7045
Mistakes with electronic banking are more difficult to get corrected than with regular banking	-0.1142	0.8548	-0.1498	0.0235	0.0206	0.7750
Mistakes are more likely to occur with electronic banking than with regular banking	-0.1870	0.7634	0.0436	0.1686	-0.1009	0.6786
It bothers me to use a machine for banking transactions when I could talk with a person instead	-0.3952	0.5759	-0.2286	0.2812	0.0200	0.6367
When I use electronic banking, my money is as safe as when I use other banking services	0.1377	-0.1492	0.8968	-0.0650	0.0441	0.8588
I feel comfortable providing my personal information through electronic banking systems	0.3552	0.3510	0.6577	-0.0532	-0.0338	0.6858
Electronic banking is difficult to use	-0.1566	0.1990	-0.0729	0.9413	-0.0649	0.9596
I have seen how others use electronic banking	0.1935	-0.0038	-0.0256	-0.0560	0.9616	0.9696
Eigenvalue	2.1202	1.9536	1.4369	1.0535	1.0061	7.5704
Explained Variance (%)	21.2%	19.5%	14.7%	10.5%	10.1%	75.7%

Table III-3b. Results of Factor Analysis with Varimax Rotation: Factor Scores Used for ATM Adoption

	Factor 1 Perceived Usefulness	Factor 2 Reliability	Factor 3 Security	Factor 4 Complexity	Factor 5 Triability	Factor 6 Observability	Communality
Electronic banking is convenient	0.7788	-0.0851	0.0574	-0.1895	0.0031	0.2056	0.7290
Electronic banking helps me to better manage my personal finances	0.7508	-0.2971	0.1933	0.0115	-0.0654	0.0886	0.6969
There are enough advantage of electronic banking for me to consider using it	0.7016	-0.1777	0.2686	-0.1058	0.3276	-0.0038	0.7153
Mistakes with electronic banking are more difficult to get corrected than with regular banking	-0.1160	0.8579	-0.1398	0.0229	-0.0062	0.1781	0.7815
Mistakes are more likely to occur with electronic banking than with regular banking	-0.1926	0.7686	-0.1690	0.1662	0.0104	0.0463	0.6843
It bothers me to use a machine for banking transactions when I could talk with a person instead	-0.3224	0.5725	-0.2288	0.2843	-0.2538	0.1067	0.6455
When I use electronic banking, my money is as safe as when I use other banking services	0.1533	-0.1564	0.8874	-0.0641	-0.0654	0.0220	0.8661
I feel comfortable providing my personal information through electronic banking systems	0.2831	0.3478	0.6743	-0.0570	0.2295	0.1609	0.7226
Electronic banking is difficult to use	-0.1443	0.1988	-0.0741	0.9428	-0.0588	-0.0680	0.9623
I have the opportunity to try various electronic services	0.1598	-0.0333	0.0317	-0.0562	0.9043	-0.0071	0.9024
I have seen how others use electronic banking	0.1693	-0.0326	0.0698	-0.0515	0.2157	0.9047	0.9022
Eigenvalue	1.9957	1.9687	1.4668	1.1023	1.0583	1.01623	8.6081
Explained Variance (%)	18.1%	17.9%	13.3%	10.0%	9.6%	9.2%	78.3%

Table III-4. Results of Probit Analyses: Computer Banking and ATM

	Computer Banking		ATM (N=890)		ATM (N=837)	
<i>Access First Step Estimation</i>	Parameter Estimate	p-value	Parameter Estimate	p-value	Parameter Estimate	p-value
Intercept	-0.416	0.983				
Age	-0.006**	0.002				
Education	0.284**	0.000				
Income	0.081**	0.000				
Chi-square (-2 Δ log L) df	92.183**	0.000 3				
<i>Adoption Second Step Estimation</i>						
Intercept	-0.584	0.194	0.859	0.000	1.125	0.000
Perceived usefulness	0.477**	0.000	0.248**	0.000	0.273**	0.000
Reliability	-0.294**	0.000	-0.232**	0.000	-0.266**	0.000
Security	0.178**	0.007	0.126*	0.011	0.119*	0.019
Complexity	-0.189*	0.017	-0.191**	0.000	-0.178**	0.000
Trialability ^a			0.243**	0.000	0.254**	0.000
Observability	-0.056	0.351	0.093	0.056	0.093	0.062
Age	-0.003	0.545	-0.028**	0.000	-0.027**	0.000
Education	-0.279	0.081	0.384**	0.000	0.274*	0.012
Income ^b			0.065**	0.000	0.051**	0.001
PC Access	0.405	0.066				
rho (adoption, access)	-0.646*	0.015				
Chi-square (-2 Δ log L) df	113.368**	0.000 9	496.555**	0.000 9	259.116**	0.000 9

* p<0.05

** p<0.01

^a Trialability was not included in the computer banking model, since trialability is closely tied with access.

^b This variable was eliminated in the analysis due to its significant correlations with between PC access, education, and age.

**Table III-5a. Frequencies of Actual and Predicted Outcomes:
Computer Banking Access**

		Predicted		Total
		0	1	
Actual	0	258	211	469
	1	150	381	431
Total		408	592	1000

**Table III-5b. Frequencies of Actual and Predicted Outcomes:
Computer Banking Adoption (Based on N=531)**

		Predicted		Total
		0	1	
Actual	0	367	53	420
	1	66	45	111
Total		433	98	531

**Table III-5c. Frequencies of Actual and Predicted Outcomes:
ATM Adoption**

		Predicted		Total
		0	1	
Actual	0	155 (205) ^a	131 (134)	286 (339)
	1	64 (74)	487 (477)	551 (551)
Total		279 (219)	618 (611)	837 (890)

a The model was fit twice for N=837, and N=890. The frequencies for the model (N=890) are in parenthesis.

Table III-6. Summary of Hypotheses Testing

Hypothesis	Computer Banking		ATM
	Adoption	Access	Adoption
Perceived Usefulness	Supported	Not Included ^a	Supported
Reliability	Supported	Not Included ^a	Supported
Security	Supported	Not Included ^a	Supported
Complexity	Supported	Not Included ^a	Supported
Trialability	Not Included ^a	Not Included ^a	Supported
Observability	Not supported	Not Included ^a	Not supported
Preference for Human Tellers	N/A ^b	Not Included ^a	N/A ^b
Age	Not Supported	Supported	Supported
Education	Not Supported	Supported	Supported
Income	Not Included ^a	Supported	Supported
PC Access	Marginally Supported	Not Included ^a	Not Included ^a

^a Not applicable because the variable was not included in the model.

^b Since preference for human tellers was loaded on the reliability factor, the effect of this variable could not be tested.

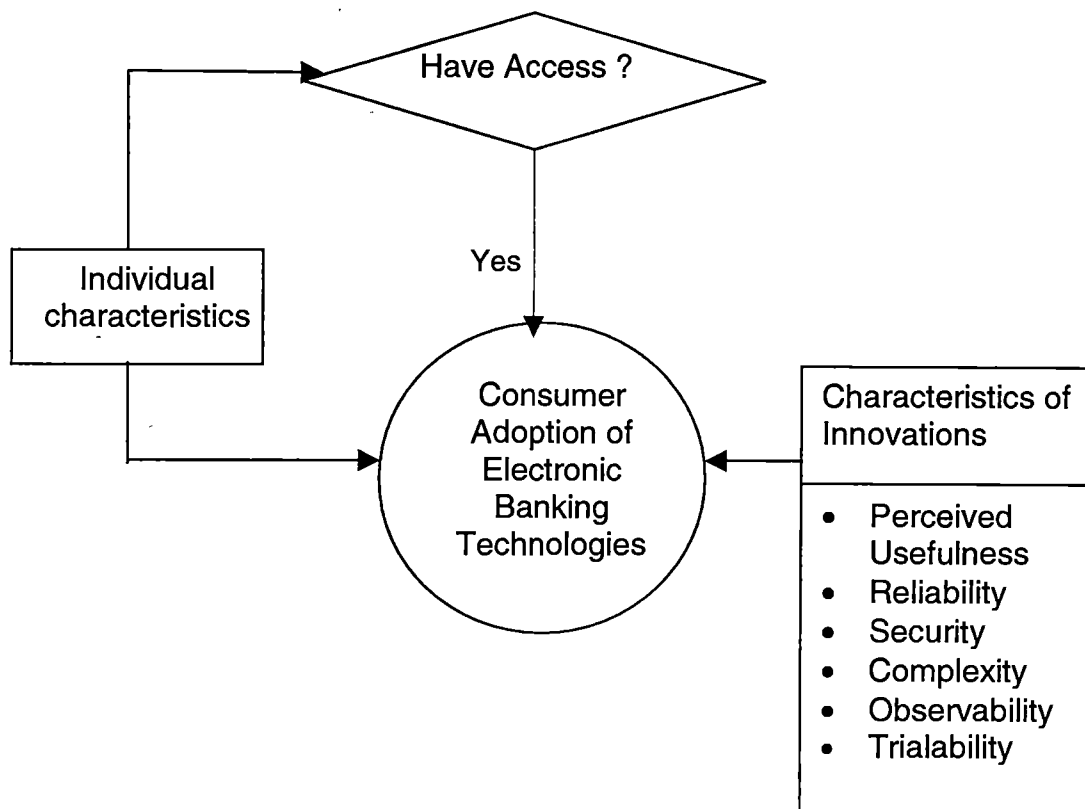


Figure III-1. The Conceptual Model

PART IV

**EFFECTS OF CHANNEL AND COMMUNICATION MODE ON
CONSUMER ADOPTION OF ELECTRONIC BANKING INNOVATIONS**

CHAPTER 1

INTRODUCTION

Recent advancements in information technology have introduced electronic banking as a convenient way to conduct financial business (Mester 2000; White 1998). Electronic banking refers to all the financial activities involving electronic media, such as automated teller machines (ATMs), computer banking, direct deposit or payment, and phone banking. Using these electronic banking innovations, consumers can conduct fast and convenient financial transaction activities and obtain their account information without visiting bank branches (Lee and Lee 2000).

The diffusion of innovation theory is a powerful framework that explains how new technologies spread across members of society (Gatignon and Robertson 1985). As a communication theory, the diffusion of innovation theory focuses on the role of communication in the diffusion process (Mahajan, Muller, and Bass 1990). However, current diffusion studies in consumer research tilt heavily toward either individual predispositions (Hirschman 1980; Midgley and Dowling 1978) or innovation characteristics (Rogers 1995) as precursors of innovation adoption. Few studies consider the fact that individual adoption of innovations can be influenced by various types of communication.

The diffusion of innovations literature suggests that information about new technology can travel through a variety of communication *channels* to members of a social system (Rogers 1995, p.10). Extant literature on consumer information search, although it is coming from a different research stream, helps to identify the types of consumer communication about electronic banking. These communication channels

include marketers, independent third parties, and personal sources (Newman and Staelin 1973; Mazis, Staelin, and Salop 1981).

While information about electronic banking may come from a variety of channels, consumers use the provided information selectively. The preferred information source differs across individual consumers (Beales et al. 1981; Midgley and Dowling 1993; Thorelli 1971). The interaction of information provided by different channels of communication also reinforces the consumer's decision to adopt electronic banking. For example, when positive messages about electronic banking come from multiple sources, the likelihood of consumers' adoption of electronic banking increases.

Another important aspect of communication is the *mode* of communication. The mode of communication refers to the way in which information is delivered; two modes discussed here are written information and conversation. Written communication, such as print media advertisement, and conversational communication, such as discussion with salespeople, can have different impacts on consumers' perceptions. Therefore, it is important to examine how different modes of communication influence consumers' perception of innovations, and thereby, their decisions to adopt new technology.

The purpose of this study is to examine the effects of channels and modes of communication on consumers' adoption of electronic banking innovations. By understanding these effects, diffusion agents can find a persuasive combination of channels and modes of communication to facilitate consumers' adoption of electronic banking. This study will provide such strategic guidance to the diffusion agents to develop effective communication strategies to facilitate consumers' adoption of electronic banking innovations.

CHAPTER 2

BACKGROUND: DIFFUSION OF ELECTRONIC BANKING INNOVATIONS

Technological innovation has played a central role in the evolution of the financial services industry over the years. Many of the new technologies involve electronic transactions and contacts with consumers mediated by electronic technology (Dalton 1999). Consequently, recent technological changes have altered the nature of consumer interactions with the providers of financial services, reducing the importance of physical location and face-to-face interactions (White 1998). There is a clear advantage for financial institutions to use electronic banking instead of paper checks: low cost. For example, the transaction cost of electronic banking is only a fraction of the expense for regular teller banking (Sheth and Sisodia 1999; Talmor 1995).

Because check processing costs approximately \$181 billion per year (Consumers' Research Magazine 1999), low cost is also an attractive incentive for governments to embrace electronic banking. In 1999, Congress finalized the Electronic Fund Transfer Act, which mandated electronic disbursement of social security benefits (Department of Treasury, 1999). However, both the financial industry and government face consumer resistance to electronic banking (Fain and Roberts, 1997; Mester 2000). Many consumers are not well informed about the benefits of electronic banking innovations (Barczac, Scholder, and Pilling 1997) and perceive security risks regarding financial transactions via electronic media (O'Connell 1999). Therefore, communicating the benefits and security of electronic banking with consumers becomes critical in the successful diffusion of electronic banking innovations.

CHAPTER 3

LITERATURE REVIEW

Communication channels regarding electronic banking can be classified into several categories based on the types of channels and the mode of communication. The types of communication channels refer to who provides the information. Possible channels of communication for electronic banking include marketers, independent third parties (government and consumer agencies), and personal sources (family and friends). The mode of communication refers to the way in which information is disseminated, including both written and conversational information.

This taxonomy of consumer communication is summarized in Table IV-1. Marketers and government consumer agencies disseminate electronic banking information via written and conversational channels. Interpersonal communication with family and friends occurs in dialogues and rarely involves written communication. Therefore, market and third-party-initiated communications can appear in written and conversational modes, whereas interpersonal communication is only conversational. In the following subsections, we discuss research propositions regarding consumer communication strategies and their impacts on consumer adoption of electronic banking.

Communication Channels/ Information Sources

Communications involving various types of information exchange among members of a social system comprise the diffusion process. Although a variety of external information sources have been introduced (see Claxton, Fry, and Portis (1974),

Capon and Lutz (1979), Beales et al. (1981), Kiel and Layton (1981), Beatty and Smith (1987), Schmidt and Spreng (1996) for alternative taxonomies), the sources of information, and therefore channels of communication can be classified into marketer-provided, independent third party, and interpersonal (family and friends) (Newman and Staelin 1973; Mazis, Staelin, and Salop 1981).

Communicating with marketers, consulting with third party experts, and discussing with family and friends about electronic banking will provide consumers with more exposure to electronic banking innovations. Exposure to the new technology is likely to raise consumer interests and thus encourage adoption. Therefore, receiving information from financial institutions, government/consumer agencies, and family and friends will positively influence consumer adoption of electronic banking innovations.

Hypothesis 1: Receiving information about electronic banking from financial institutions will be positively associated with consumer adoption of electronic banking innovations.

Hypothesis 2: Receiving information about electronic banking from government/consumer agencies will be positively associated with consumer adoption of electronic banking innovations.

Hypothesis 3: Receiving information about electronic banking from family and friends will be positively associated with consumer adoption of electronic banking innovations.

It was suggested that adopters tend to use information from various sources, such as marketers and independent third parties, beyond close interpersonal networks

(Bayus, Carroll, and Rao 1985; Rogers 1995; Westbrook and Fornell 1979), because they are highly involved in the product category (Bloch, Sherrell, and Ridgway 1986).

Communication Mode: Written Versus Conversational

Suppose one consumer reads about electronic banking from a promotional brochure and another consumer speaks with a salesperson, who eagerly promotes electronic banking. Will these two different ways of disseminating financial information have identical impacts on consumer adoption? The answer to these questions may be no, because consumers may perceive conversation communication more useful than written information (Herr, Kardes, and Kim 1991; Thomas 1992).

Generally, print media is most widely used to promote consumer adoption of electronic banking innovations. Alternatively, information about electronic banking can be delivered through conversations with salespeople, employees at government/consumer agencies, and family and friends. The major difference between written and conversational communication is that written communication is one-way communication from the source to the receiver. Thus, the success of written communication is based on the comprehension of that information by the receiver.

On the other hand, conversation is an interpersonal interaction that allows two speakers to exchange sequentially linked messages, which consequently develops mutual agreement on the issue (Thomas 1992). Conversational information is presented more vividly compared to written information (Herr, Kardes, and Kim 1991), which requires rather elaborate processing. Therefore, conversational information tends to be more persuasive than written information, especially when consumers are not highly motivated to learn (Celsi and Olson, 1988; Petty and Cacioppo 1982; Thomas 1992).

Conversational information is also flexible. For example, a salesperson can customize information about a new product/service for an individual customer to help his/her understanding. The literature demonstrates that the better the consumer understands the technology, the greater the probability of adoption (Davis 1989; Rogers 1985).

Wilton and Myers (1986) suggest that the characteristics of information determine the utility of that information. If the consumer perceives that the information has a desirable characteristic, such as usefulness, then that consumer is more likely to accept the message. A study by Wilkie and Dickson (1985) shows that 41 percent of the purchasers of electrical appliances rated the salesperson as the most useful information source over print ads and *Consumer Reports*. Since technical innovations require high consumer learning for initial adoption compared to other consumer goods and services, understandability becomes important for potential adopters. Therefore, we hypothesize that consumers will perceive conversational information more useful than written information.

Hypothesis 4: The mode of communication will influence consumers' perception of the information. Conversational information will be perceived as more useful than written information.

Adopter Categories and Channel Preferences

Individuals have different propensities for relying on marketer provided information, independent third-party information, and information from personal sources (Bearden et al. 1989; Furse et al. 1984). Bass and his colleagues (1969, 1990) make a distinction between adopter categories based on the source of influence. According to these researchers, imitators make adoption decisions influenced by the opinions of

others and innovators make adoption decisions independently of the opinions of other people. Thus, innovators tend to be heavy users of professional communication channels (Bayus, Carroll, and Rao 1985; Midgley and Dowling 1992; Price, Feick, and Higie 1987). As such, innovators and non-adopters will probably show some differences in their preferences of communication channels. Specifically, innovators are likely use information from professional sources including marketers and independent third parties, as well as interpersonal communication (Bayus, Carroll, and Rao 1985; Rogers 1995; Westbrook and Fornell 1979). Non-adopters are also likely to use close interpersonal communication; however, they are less likely to use professional information sources than innovators (Gatignon and Robertson 1985).

Hypothesis 5: Innovators and non-adopters will show differences in their preferences of communication channels. Innovators will be more likely to use professional information than non-adopters.

Relationships among Communication Channels and Modes

Several researchers assert that the interaction among different channels of communication influences the extent to which an innovation is diffused across individuals (Gatignon and Robertson 1985; Mahajan, Muller, and Bass 1990; Rogers 1995). Similarly, studies in consumer information search have suggested that information search activities might be interdependent (Katona and Mueller 1955; Thorelli 1971), and Lee and Hogarth (2000) reported supporting evidence for this possibility. For example, if a consumer uses a particular source of information, he or she is more or less likely to be exposed to other types of information sources.

Many studies have investigated consumer use of individual information sources; however, little is known about how individuals combine more than one channel of communication in their decision-making (Lee and Hogarth 2000). Acknowledging the gaps in the literature, researchers call for more study of the interrelationships among various communication channels (Beales et al. 1981; Mazis et al. 1981; Price et al. 1987). In addition, less is known about how communication channels and modes interact in influencing consumer adoption. Therefore, it is of interest to investigate the interdependent effects of channels and modes of communication on consumer adoption of electronic banking innovations.

Hypothesis 6: There are interdependencies among channels and modes of communication in affecting consumer adoption of electronic banking innovations.

CHAPTER 4

METHODOLOGY

Data

The dataset used for this study was the 1999 Survey of Consumers commissioned by The University of Michigan Institute of Social Research Survey Research Center. The Surveys of Consumers were initiated in the late 1940s by the Survey Research Center at the University of Michigan. The purpose of these surveys is to measure changes in consumer attitudes and expectations, to explain why such changes occur, and to evaluate how these changes relate to consumer decisions to save, borrow, or make discretionary purchases. In September and October of 1999, the Federal Reserve Board commissioned additional questions on the Surveys of Consumers, including specific questions on consumers' adoption of electronic banking innovations. The authors of this study contributed to the development of specific questions about electronic banking innovations and consumer communication patterns. Using a telephone survey, the researchers queried a national sample of 1,000 adults.

Measures

Table IV-2 presents the questions that were asked to respondents in order to identify consumers' communication patterns and their adoption of electronic banking innovations. Demographic variables comprise another set of explanatory variables and are used as control variables in the analysis.

Channels of Communication. Three different channels of communication regarding electronic banking were included: financial institutions, government/consumer agencies, and family and friends. The consumers who had received information regarding electronic banking from each of the three channels were categorized into receivers on a binary scale (1=received, 0=not received).

Modes of Communication. Two types of communication modes-- written and conversational -- were recorded for information from financial institutions and information from government/consumer agencies, respectively. Therefore, five different combinations of channels and modes of communication were investigated in this study: (1) written information from financial institutions, (2) conversational information from financial institutions, (3) written information from government/consumer agencies, (4) conversational information from government/consumer agencies, and finally, (5) information from family and friends.

Perceived Usefulness. To measure their perception of each of the above five types of communication, respondents were asked the following question: "How useful was this information from _____ in making decisions to use or not to use electronic banking services?" Each response was recorded on 3-point Likert scale ranging from "not at all useful (=1)," "somewhat useful (=2)," to "very useful (=3)."

Adoption of Electronic Banking. Consumer adoption of electronic banking was measured for ATM, computer banking, direct deposit, direct payment, and phone banking, respectively. Adoption was recorded for each technology for the respondents who had used the technology over the past 12 months.

Age. Age was measured according to the following five ordinal categories: 18-24 years, 25-34 years, 35-44 years, 45-54 years, 55-64 years, and over 65. Midpoints were used in multivariate analyses.

Education. The respondent's education level was recorded on five levels: Less than High School (=1), High School (=2), Some College (=3), Bachelor's Degree (=4), and Graduate Degree (=5).

Income. Fourteen income levels were created: \$10,000 or less (=1), \$10,000-\$14,999 (=2), \$15,000-\$19,999 (=3), \$20,000-\$24,999 (=4), \$25,000-\$29,999 (=5), \$30,000-\$34,999 (=6), \$35,000-\$39,999 (=7), \$40,000-\$44,999 (=8), \$45,000-\$49,999 (=9), \$50,000-\$59,999 (=10), \$60,000-\$74,999 (=11), \$75,000-\$99,999 (=12), \$100,000-\$124,999 (=13), and \$125,000 or more (=14).

Race. Three categories of race were included in the survey: white, black, Asian, and Hispanic. Only the binary variable of "black" was used in the multivariate model (1=black, 0=other), because Asian and Hispanic race categories were less than five percent in cell counts.

Marital Status. Each respondent's marital status was recorded into one of the following four categories: married, separated or divorced, widowed, and never married. A binary variable of "married" was created and used in the multivariate analysis (1=married, 0=not married).

Analysis

To identify distinct user groups of electronic banking innovations, cluster analysis was employed using SAS CLUSTER procedure. Cluster analysis was intended to categorize individuals based on their adoption pattern of the five electronic banking

innovations. The cluster analysis employed Ward's minimum variance method. The number of clusters was determined based on cubic clustering criterion, pseudo F, and pseudo t-statistics. The identified clusters were then used as dependent variables in the subsequent multinomial logit analysis to investigate the effects of communication factors and demographic differences on consumer adoption of electronic banking.

Bivariate analyses, including χ^2 tests and F statistics in analysis of variance (ANOVA), were used to examine cluster differences in communication patterns as well as in demographics. Specifically, Hypothesis 4, which is the relationship between communication mode and perceived usefulness, was examined using a contingency table and the associated χ^2 tests. Also, differences in channel preferences among consumers of different adoption stages, which is Hypothesis 5, were investigated by pair-wise tests using the LS (Least Squares) Means option in the SAS GLM (General Linear Model) procedure. In doing so, Bonferroni adjustments were made to reduce the type 1 error.

The SAS CATMOD (Categorical Data Modeling) procedure was then used for a multinomial logit analysis. In a multinomial logit analysis, the likelihood ratio indicates the goodness of fit of the tested model. The channel and the mode of communication and their interactions, as well as individual demographic variables, comprised the explanatory variables to predict consumer adoption/usage of electronic banking innovations. Specifically, the significance and magnitude of relationships provided bases for testing hypotheses 1 through 3. In addition, interdependencies among the channel and the mode of communication, which is Hypothesis 6, were tested by the interaction terms among the independent variables in the multinomial logit analysis.

CHAPTER 5

RESULTS

Cluster Analysis and Descriptive Analyses

Five distinct clusters emerged. The five clusters were labeled Laggards, Bill Collectors, Bill Payers, Phone-Callers, and Innovators according to the adoption pattern of electronic banking innovations. The adoption patterns of five electronic banking innovations and demographic characteristics are presented in Tables IV-3 and IV-4. Profiles of the five clusters are presented below.

The "Laggards" cluster is composed of 210 people (21.0%) who do not use electronic banking innovations in any form. An average Laggard consumer (age 47) is older than the average consumers of Bill Payer (age 47), Phone-Caller (age 40), and Innovator (age 37) clusters. In terms of social attainment, the "Laggards" cluster has significantly lower income and education levels than the other clusters and the highest proportion of non-white population.

The "Bill Collectors" cluster is composed of 191 consumers (19.1 %), and all of them use direct deposit. About one half of the cluster members have used ATMs; however, none of the Bill Collector consumers had used computer banking, direct bill payment, or phone banking. An average Bill Collector consumer is age 54, which is significantly older than that of the other four clusters ($F=28.86$, $p<0.001$). The average income and education level is the second lowest next to Laggards. This cluster may well

include social security recipients who receive their benefits electronically and who may not be the active customers of financial institutions.

The "Bill Payers" cluster (N=233, 23.3%) can be characterized by the use of direct bill payment. All Bill Payers use direct bill payment (100%). Most Bill Payers use direct deposit (73.82%) and slightly less than one half uses phone banking (48.5%). However, none of them use computer banking. The average Bill Payer consumer is age 47, and the average income is about \$45,000, the highest next to the Innovators. This consumer is likely to have more than some college education. About 67 percent of the Bill Payers are married.

The "Phone-Callers" cluster consists of 255 people (25.5%) most of whom use phone banking (72.16%), and ATMs (82.35%). However, none of the Phone-Callers use direct bill payment and computer banking. About one half of the Phone-Callers use direct deposit (48.63%). The average income is between \$40,000-\$45,000. On average, consumers of the Phone-Caller cluster is young (average age=40) and have more than some college education.

Finally, the "Innovators" is composed of users of computer banking (N=111, 11.1%). Every consumer in this cluster uses computer banking. About 90 percent use ATMs, and 76 percent use direct deposit. About one half of Innovator also use direct deposit (51.35%). This Innovator cluster is composed of the young (average age=36.77), significantly wealthy (average income \$50,000 or higher) individuals with the highest level of education among the five consumer clusters. About 70 percent of the Innovators are married.

Communication Pattern

Table IV-5 represents the percentage of respondents who received a particular type of information. Overall, written information from financial institutions is more available to consumers (42.1%) than conversational information (15.5%). Next most available communication is interpersonal communication with family and friends (25.2%). Information from government/consumers agencies reaches about 12% of consumers through written communication and about 6 % of consumers through conversational communication. Table IV-6 represents the perceived usefulness of the different types of communication among consumers who received information. Conversational communication from government/consumer agencies is perceived most useful (mean 2.21), closely followed by conversational information from financial institutions (2.19) and interpersonal communication with family and friends (2.02). On average, written communication from both financial institutions (1.82) and government/consumer agencies (1.81) are perceived somewhere between "not at all useful" and "somewhat useful." A discussion of the communication pattern of each cluster is presented below.

First, the Laggards are getting the least information in all five types of communication. Only eleven percent of the Laggards have received written information from financial institutions, and five percent have discussed the information with employees at financial institutions. Only five percent have received written information from government/consumer agencies, and two percent have personal contacts with employees at government/ consumer agencies. They also appear to be less likely to discuss electronic banking with their family and friends than the Phone-callers and the Innovators.

The Bill Collectors more actively seek information from financial institutions than do the Laggards, but less actively so than the Innovators (written: $\chi^2 = 135.74$, $p < 0.001$; conversational $\chi^2 = 59.83$, $p < 0.001$). Specifically, about 37 percent of the Bill Collectors have received written information from financial institutions, twelve percent have discussed electronic banking with employees at financial institutions, twelve percent have received written information from government/ consumer agencies, five percent have discussed the information with employees at government/ consumer agencies. Eighteen percent have received information from their family and friends.

The Bill Payers are more likely to get written information from government and consumer agencies than the Laggards ($\chi^2 = 16.48$, $p = 0.0024$). About 16 percent have received information from government/ consumer agencies, and seven percent have discussed electronic banking with employees at government/ consumer agencies. As to their communication with financial institutions, almost 50 percent have received written information about electronic banking from financial institutions and 14 percent have discussed the idea with employees at financial institutions. Over one-quarter of the Bill Payers have received information about electronic banking from family and friends.

The Phone-Callers most actively communicate with their family and friends ($\chi^2 = 73.32$, $p < 0.001$). About 40 percent have received information from family and friends, which is almost twice the amount for the Bill Collectors, and five times more than the amount for the Laggards. More than one half of the Phone-Callers (54%) have received written information from financial institutions and about 20 percent have discussed electronic banking with employees at financial institutions. About 13 percent have received written information from government/ consumer agencies, and eight percent have discussed the idea with employees at government/ consumer agencies.

The Innovators are active information seekers who use all five types of communication extensively. About 70 percent of the Innovators have received written information about electronic banking from financial institutions, 36 percent have discussed electronic banking with employees at financial institutions. Twelve percent have received information from government/ consumer agencies, and nine percent have discussed the information with employees at government/ consumer agencies. Slightly less than 40 percent have received information from family and friends. The Innovators perceive most types of communication useful compared to the consumers in the other four clusters.

The *post hoc* comparisons indicate that the Innovators and the Laggards demonstrate the most distinct differences in degrees of exposure to various communications, thereby suggesting Hypothesis 5. Specifically, the Innovators receive written and conversational information from financial institutions to a greater extent than the Laggards. The Innovators also discuss with family and friends more frequently than the Laggards. Although it appears that the Innovators also receive more information from third-party information sources, the differences were not statistically significant.

Perceived usefulness of the five different types of communication by cluster is presented in Table IV-6. The results show that there are significant overall cluster differences in the perceived usefulness of written ($F=4.13$, $p=0.0027$) and conversational information ($F=2.75$, $p=0.0305$) from financial institutions. Specifically, *post-hoc* comparisons show that the Innovators perceive written information from financial institutions more useful than the Bill Collectors, the Phone-Callers, and the Laggards. They also value conversational information more than the Bill Collectors do. However, the Bill Payers, the Phone-Callers, and the Laggards are not significantly different from

the Innovators in their perception of usefulness of conversational information provided by financial institutions.

No significant cluster differences were found in their perceptions of the written ($F=1.06$, $p=0.3811$) and conversational communication ($F=1.07$, $p=0.3806$) initiated by government/consumer agencies and information from family and friends ($F=2.30$, $p=0.06$). Interestingly, although the Innovators and the Laggards differed in their perceptions about the usefulness of written information from financial institutions, no differences were found between the Innovators and the Laggards concerning the value of conversational communications from all three sources.

The mode of communication was found to significantly influence consumer perception of usefulness. When χ^2 tests were conducted on written versus conversational communication, the conversational mode was perceived more useful than the written mode for communications initiated by financial institutions and communications initiated by government/consumer agencies ($p<.001$, and $p=0.002$, respectively.) The effectiveness of conversational information was evident when the two channels were collapsed ($\chi^2=44.5745$, $p<0.0001$), thereby supporting Hypothesis 4 (see Table IV-7). About 85 percent of the respondents who had received conversational information thought that the information was useful in making decisions to use or not to use electronic banking services, whereas only 64 percent of the respondents who had received written information perceived it as useful.

Multinomial Logit Analysis

In order to observe distinct differences between the clusters, (1) the Bill Collectors, (2) the Bill Payers, (3) the Phone-Callers, and (4) the Innovators were

compared to (5) the Laggards. Specifically, four log odds ratios were estimated in the subsequent multinomial logit analysis:

$$\ln (P_1 / P_5), \ln (P_2 / P_5), \ln (P_3 / P_5), \text{ and } \ln (P_4 / P_5),$$

where P_1 / P_5 = probability of an individual being a Bill Collector over a Laggard,

P_2 / P_5 = probability of an individual being a Bill Payer over a Laggard,

P_3 / P_5 = probability of an individual being a Phone-Caller over a Laggard, and

P_4 / P_5 = probability of an individual being an Innovator over a Laggards.

The tested model has a good fit. The likelihood ratio of χ^2 is zero, $p=1.00$, indicating that the clusters based on the adoption patterns are very well explained by the communication factors and the demographic variables included in the model.

The results of the multinomial logit analysis are presented in Table IV-8. These results show that receiving written information about electronic banking from financial institutions is, in fact, positively associated with consumer adoption of electronic banking innovations. All four log odds ratios, $\ln (P_1/P_5)$, $\ln (P_2/P_5)$, $\ln (P_3/P_5)$, and $\ln (P_4/P_5)$ were significantly influenced by written information from financial institutions, thereby supporting Hypothesis 1. Therefore, receiving written information from financial institutions increases the probability using electronic banking innovations and decreases the probability of belonging to the non-user group. On the other hand, receiving conversational information from financial institutions did not significantly influence $\ln (P_1/P_5)$, $\ln (P_2/P_5)$, and $\ln (P_3/P_5)$. However, the conversational information from financial institutions increases the probability of belonging to the Innovators over the Laggards.

Receiving information from government/ consumer agencies did not influence any of the four log odds-ratios, thereby failing to support Hypothesis 2. On the other hand, receiving information from family and friends had a significant influence on $\ln$

(P_3/P_5), but not on the others. Receiving information from interpersonal sources was positively associated with the probability of belonging to the Phone-Callers over the Laggards. Therefore, Hypothesis 3 was partially supported.

The relationships among channels and modes of communication in affecting consumer adoption of electronic banking innovations, as stated in Hypothesis 6, were tested by including interaction terms in the model. Only one interaction term -- the interaction between receiving conversational information from financial institutions and interpersonal communication with family and friends -- was found to be significant. Conversational information from financial institutions and interpersonal communications are not significant predictors of consumer adoption by themselves; however, their combined effects on consumer adoption are highly significant. Figures IV-1 and IV-2 illustrate how the odds ratios increase when the two effects are combined. For example, the probability of being an Innovator over a Laggard is not significantly influenced by receiving information only from family and friends ($\beta=0.3824$, $p=0.08$). However, when a consumer receives conversational information from financial institutions and also from family and friends, the odds ratio increases from 2.5 to 6.22 (see Figure IV-1). Thus, for consumers who receive both types of information, the odds of belonging to the Innovators over the Laggards increases by a factor of 6.2. Likewise, the effect of conversational information from financial institutions on $\ln(P_4/P_5)$ is not significant by itself ($\beta=0.0453$, $p=0.85$); however, when it is combined with information received from family and friends, the odds of belonging to the Bill Collectors over the Laggards increases from 1.09, to a significant 3.88 (see Figure IV-2).

Demographic variables were included as control variables and their effects are reported briefly below. It was found that the effect of age was negative for consumer

adoption of electronic banking. The quadratic term of age was significant on $\ln (P_1/P_5)$, suggesting a non-linear relationship between age and the probability of belonging to the Bill Payers over the Laggards. Income and education had positive effects on consumer adoption of electronic banking innovations, whereas being black and married did not have any significant impact on adoption.

CHAPTER 6

DISCUSSION, CONCLUSIONS, AND IMPLICATIONS

Despite the importance of the communication process in the successful diffusion of new technology, few studies have examined how channels and modes of communication can affect consumer adoption. This study investigated the effects of channel and mode of communication on consumer adoption of electronic banking innovations under the theoretical framework of diffusion of innovations.

We found that communication factors are indeed significant predictors of consumer adoption of electronic banking innovations. Among the three channels identified from the proposed taxonomy, financial institutions are currently the most active diffusion agents for consumers. Specifically, receiving written information from financial institutions is likely to increase the probability of adopting electronic banking innovations, which indicates that written communication devices issued by financial institutions are effective tools.

As the previous literature suggests, the government's effort to enhance information flow can help consumers make more informed decisions (Brown, Berry, and Goel 1990). The government's diffusion-facilitating efforts were found to be positively associated with industry's adoption of the innovation (Moon and Bretschneider 1996). However, the effect of receiving information from a third party was not significant in our study. It appears that, presently, the role of government in the diffusion of electronic banking innovations is limited, because only a small portion of the population has received any electronic banking information from government agencies. Despite

significant efforts made by the government under the Electronic Funds Transfer Act, only a small number of consumers have been influenced by the initiative.

The importance of personal communication networks for the successful diffusion of innovations has been emphasized in the literature. Successful diffusion and its full penetration to the entire population depends on whether the development of diffusion can reach the critical mass by activating interpersonal communication channels. Interestingly, we found that a significant interaction effect between interpersonal communications and conversational communications initiated by financial institutions because some consumers are susceptible to interpersonal influences (Bearden, Netemeyer, and Teel 1989). For those consumers, the combination of conversational information from financial institutions and family and friends' advice has a strong impact on their adoption decision. Therefore, diffusion agents need to promote active outreach programs that seek current adopters of electronic banking and encourage them to talk about the new technology to their close family, neighbors, and friends, in addition to disseminating written information.

Currently, the Laggards seem to be isolated from the scope of communication activities because they do not appear to receive sufficient information from financial institutions, government/ consumer agencies, and family and friends. Although this group of consumers needs the most assistance, they are getting the least attention from the diffusion agents in practice. Such uneven distribution of information and lack of communications can widen the gaps between the audience segments' previously high and low socioeconomic status (Rogers 1995, p.432). Targeting communication campaigns, especially for this Laggard audience, is necessary to narrow such gaps. For that purpose, our findings indicate that professional information in literature might not be

the best way to reach the Laggard consumers, as they perceive conversational communication as more useful than written information. Therefore, there is a need to promote the conversational mode of communication in developing consumer education programs aimed at the Laggards population.

Midgley and Dowling (1993) proposed that even non-innovative individuals could adopt a technology at the early stage of diffusion when they are exposed to the right communication. This paper provides empirical evidence that an individual consumer's adoption is indeed influenced by communication factors. Disseminating information through the right channel and mode of communication will increase the probability to adopt electronic banking innovations. Specifically, innovators are likely to use both written and conversational information from various channels, and thus, reinforcing the intended message through multiple channels is recommended. We also found that, in general, conversational information is perceived as more useful than written communication. Conversational communication is especially effective in reaching the Laggard consumers since they do not tend to perceive written communication as useful. Therefore, consumer education efforts should promote the conversation information dissemination strategy, especially to reach the Laggard consumers.

This study conceptualized that information flows from one point to another, mostly from marketers or government consumer/agencies and did not address the issue that communication might be initiated by consumers. For example, consumers may seek, instead of receive, information about technological innovations and use the information in making their decisions. Further specification of the direction of information flow might shed additional light on the perceived usefulness of different types of communication.

REFERENCES

- Barczac, Gloria, Ellen, Pam Scholder, and Bruce K. Pilling (1997), "Developing Typologies of Consumer Motives for Use of Technologically Based Banking Services," *Journal of Business Research*, 38, 131-139.
- Bass, Frank M. (1969), "A New Product Growth Model for Consumer Durables," *Management Science*, 15 (January), 215-227.
- Bayus, Barry, Vincent Carroll, and Ambar Rao (1985), "Harnessing the Power of Word-of-Mouth," In *Innovation Diffusion Models of New Product Acceptance*. Eds. V. Mahajan and Y. Wind. Cambridge, MA: Ballinger, 61-83.
- Beales, Howard, Michael B. Mazis, Steven C. Salop, and Richard Staelin (1981), "Information Remedies for Consumer Protection," *American Economic Review*, 71 (May), 410-413.
- Bearden, William O., Richard G. Netemeyer, and Jesse E. Teel (1989), "Measurement of Consumer Susceptibility to Interpersonal Influence," *Journal of Consumer Research*, 15 (March), 473-481.
- Beatty, Sharon E. and Scott M. Smith (1987), "External Search Effort: An Investigation Across Several Product Categories," *Journal of Consumer Research*, 14 (June), 83-95.
- Bloch, Peter H., Daniel L. Sherrel, and Nancy M. Ridgway (1986), "Consumer Search: An Extended Framework," *Journal of Consumer Research*, 13 (June), 119-126.
- Brown, Jacqueline Johnson, and Peter Reingen (1987), "Social Ties and Word-of-Mouth Referral Behavior," *Journal of Consumer Research*, 14 (December), 350-362.
- Brown, M. A., Berry, L., and Goel R. (1990), "Guidelines for Successfully Transferring Government-Sponsored Innovations," *Research Policy*, 20 (2), 121-143.
- Capon, Noel and Richard J. Lutz (1979), "Model and Methodology for the Development of Consumer Information Program," *Journal of Marketing*, 43, 58-67.
- Celsi, Richard and Jerry C. Olson (1988), "The Role of Involvement in Attention and Comprehension Processes," *Journal of Consumer Research*, 15 (September), 210-224.
- Claxton, John D., Joseph N. Fry, and Bernard Portis (1974), "A Taxonomy of Prepurchase Information Gathering Patterns," *Journal of Consumer Research*, 1 (December), 35-44.
- Consumers' Research Magazine (1999), "So Much for the Checkless Society," 82 (February), pp. 7.

- Dalton, Gregory (1999, April 19), "E-Bills Arrive," *IW*, [WWW Document] URL <http://www.informationweek.com>.
- Davis, Fred D. (1989), "Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology," *MIS Quarterly*, (September), 319-339.
- Deshpande, Rohit and Gerald Zaltman (1984), "A Comparison of Factors Affecting Research and Manager Research Information," *Journal of Marketing Research*, 19 (February), 32-38.
- Fain, Deborah, and Mary Lou Roberts (1997), "Technology vs. Consumer Behavior: The Battle for the Financial Services Customer," *Journal of Direct Marketing*, 11 (Winter), 44-55.
- Furse, David, Girish Punj, and David Stewart (1984), "A Typology of Individual Search Strategies Among Purchasers of New Automobiles," *Journal of Consumer Research*, 10 (March), 417-431.
- Herr, Paul M., Frank R. Kardes, and John Kim (1991), "Effects of Word-of-Mouth and Product-Attribute Information on Persuasion: An Accessibility-Diagnosticity Perspective," *Journal of Consumer Research*, 17 (March), 454-462.
- Hirschman, Elizabeth C. (1980), "Innovativeness, Novelty Seeking and Consumer Creativity," *Journal of Consumer Research*, 7 (December), 289-295.
- Katona, George, and Eva Mueller (1955), "A Study of Purchase Decisions," in Lincoln H. Clark, ed., *Consumer Behavior-The Dynamics of Consumer Reaction*. New York: New York University Press, 30-87.
- Kiel, Geoffrey C. and Roger A. Layton (1981), "Dimensions of Consumer Information Seeking Behavior," *Journal of Marketing Research*, 18 (May), 233-239.
- Lee, Eun-Ju, and Jinkook Lee (2000), "Haven't Adopted Electronic Financial Services Yet? The Acceptance and Diffusion of Electronic banking innovations," *Journal of Financial Counseling and Planning*, in press.
- Lee, Jinkook, and Jean Hogarth (2000), "Relationship among Information Search Activities When Shopping for a Credit Card," *Journal of Consumer Affairs*, in press.
- Lynch, John G., Howard Marmorstein, and Michael F. Weigold (1988), "Choices from Sets Including Remembered Brands: Use of Recalled Attributes and Prior Overall Evaluations," *Journal of Consumer Research*, 15 (September), 188-196.
- Mahajan, Vijay, Eitan Muller, and Frank M. Bass (1990), "New Product Diffusion Models in Marketing: A Review and Directions for Research," *Journal of Marketing*, 54 (January), 1-26.

- Mazis, Michael B., Richard Staelin, Howard Beales, and Steven Salop (1981), "A Framework for Evaluating Consumer Information Regulation," *Journal of Marketing*, 45 (Winter), 11-21.
- Mester, Loretta J. (2000), "The Changing Nature Of The Payments System: Should New Players Mean New Rules?" *Business Review - Federal Reserve Bank of Philadelphia, Philadelphia*, March/April, 3-27.
- Midgley, David F. and Grahame R. Dowling (1993), "A Longitudinal Study of Product Form Innovation: The Interaction between Predispositions and Social Messages," *Journal of Consumer Research*, 19 (March), 611-625.
- Moon, Myung Jae and Stuart Bretschneider (1997), "Can State Government Actions Affect Innovation and Its Diffusion?: An Extended Communication Model and Empirical Test," *Technological Forecasting and Social Change*, 54 (1),
- Newman, Joseph W. and Richard Staelin (1972), "Prepurchase Information Seeking for New Cars and Major Household Appliances," *Journal of Marketing Research*, 9 (3), 249-57.
- O'Connell, Brian (1999), "Microsoft's Smart Card Play," *Bank Technology News*, January 20.
- Petty, Richard E. and John T. Cacioppo (1982), *Communication and Persuasion: Central and Peripheral Routes to Attitude Change*, New York: Springer.
- Price, Linda L., and Lawrence F. Feick, and Robin A. Higie (1987), "Information Sensitive Consumers and Market Information," *Journal of Consumer Affairs*, 21 (2), 328-341.
- Rogers, Everett M. and F. Floyd Shoemaker (1973), *Communication of Innovations*, New York: Free Press.
- Schmidt, Jeffrey B., and Richard A. Spreng (1996), "A Proposed Model of External Consumer Information Search," *Journal of the Academy of Marketing Science*, 24 (3), 246-256.
- Sheth, Jagdish N. and Rajendra S. Sisodia (1999), "Revisiting Marketing's Lawlike Generalizations," *Journal of the Academy of Marketing Science*, 27 (1), 71-87.
- Talmor, S.(1995), "New Life for Dinosaur," *The Banker*, 145 (September), pp.77.
- Thomas, Gloria Penn (1992), "The Influence of Processing Conversational Information on Inference, Argument Elaboration, and Memory," *Journal of Consumer Research*, 19 (June), 83-92.
- Thorelli, Hans B. (1971), "Concentration of Information Power Among Consumers," *Journal of Marketing Research*, 8 (November), 427-432.

- Thorelli, Hans B. and Jack L. Engledow (1980), "Information Seekers and Information Systems: A Policy Perspective," *Journal of Marketing*, 44 (Spring), 9-27.
- U.S. Department of Treasury (1999, March 4), "Federal Acquisition Regulation: Electronic Funds Transfer," [WWW Document] URL <http://www.fms.treas.gov/efr/regs/fareft.txt>. [viewed July 8, 2000].
- Westbrook, Robert, A. and Claes Fornell (1979), "Patterns of Information Source Usage Among Durable Goods Buyers," *Journal of Marketing Research*, 16 (August), 303-312.
- White, Lawrence. J. (1998). "*Technological Change, Financial Innovation, and Financial Regulation in The U.S.: The Challenges For Public Policy*," Working Paper, Stern School of Business, New York University.
- Wilkie, William L, and Peter R. Dickson (1985), *Shopping for Appliances: Consumer Strategies and Patterns of Information Search*. Cambridge, MA: Marketing Science Institute.
- Wilton, Peter C., and John Myers (1986), "Task, Expectancy, and Information Assessment Effects in Information Utilization Processes," *Journal of Consumer Research*, 12 (March), 469-486.

APPENDIX

TABLES AND FIGURES

Table IV-1. Taxonomy of Channels and Communication Modes

	Marketer-Provided	Independent Third-Party	Interpersonal
Written	Publications by Marketers (brochures or print advertisement)	Consumer Reports Government Publications	N/A
Conversational	Discussions with employees of the business	Discussions with employees at government or consumer agency	Family Friends

Table IV-2. Variables

Source	Mode	Questions
Financial Institution	Written	Have you received written information about electronic banking from financial institutions?
		How useful was this information in making decisions to use or not to use electronic banking services?
	Conversational	Have you received information about electronic banking through discussions with employees at financial institutions?
		How useful was this information in making decisions to use or not to use electronic banking services?
Consumer/ Government Agencies	Written	Have you received written information about electronic banking from consumer agencies or government agencies?
		How useful was this information in making decisions to use or not to use electronic banking services?
	Conversational	Have you received information about electronic banking through discussions with employees of consumer or government agencies?
		How useful was this information in making decisions to use or not to use electronic banking services?
Family or Friends	Conversational	Have you received information about electronic banking from family or friends?
		How useful was this information in making decisions to use or not to use electronic banking services?

Table IV-3. Results of Cluster Analysis: Percentage of Respondents Who Used a Particular Electronic Banking Technology during the Past 12 Months

Electronic Banking Usage	Laggards	Bill Collectors	Bill Payers	Phone-Callers	Innovators	All
ATM	0%	47.12%	65.67%	82.35%	88.29%	55.1%
Computer Banking	0%	0%	0%	0%	100%	11.1%
Direct Deposit	0%	100%	73.82%	48.63%	75.68%	57.1%
Direct Bill Payment	0%	0%	100%	0%	51.35%	29.0%
Phone Banking	0%	0%	48.5%	72.16%	61.26%	36.5%
N	210	191	233	255	111	1000
Percent	21.0%	19.1%	23.3%	25.5%	11.1%	100%

Table IV-4. Demographic Characteristics by Cluster

Demographics	Laggards (N=210)	Bill Collectors (N=191)	Bill Payers (N=233)	Phone- Callers (N=255)	Innovators (N=111)	TOTAL (N)
Age						
18-24	28.57%	10.99%	14.29%	36.26%	9.89%	91 (100%)
25-34	14.13%	14.67%	16.30%	36.41%	18.48%	184 (100%)
35-44	18.67%	9.54%	29.46%	28.22%	14.11%	241 (100%)
45-54	20.99%	14.92%	29.28%	24.31%	10.50%	181 (100%)
55-64	28.26%	20.29%	18.12%	25.36%	7.97%	138 (100%)
over 65	21.82%	46.06%	24.85%	4.85%	2.42%	165 (100%)
Mean (Median)						
F = 28.86	46.80 ^b	53.66 ^a	47.01 ^b	39.96 ^c	39.77 ^c	45.63 (39.5)
(p<0.0001)						
Income						
\$10,000 or less (=1)	52.50%	20.00%	20.00%	7.50%	0%	40 (100%)
\$10,000-\$14,999 (=2)	38.18%	23.64%	10.91%	25.45%	1.82%	55 (100%)
\$15,000-\$19,999 (=3)	33.33%	22.81%	12.28%	29.82%	1.75%	57 (100%)
\$20,000-\$24,999 (=4)	28.79%	24.24%	16.67%	24.24%	6.06%	66 (100%)
\$25,000-\$29,999 (=5)	15.69%	29.41%	23.53%	23.53%	7.84%	51 (100%)
\$30,000-\$34,999 (=6)	24.49%	16.33%	16.33%	36.73%	6.12%	49 (100%)
\$35,000-\$39,999 (=7)	23.64%	21.82%	16.36%	25.45%	12.73%	55 (100%)
\$40,000-\$44,999 (=8)	17.24%	15.52%	24.14%	27.59%	15.52%	58 (100%)
\$45,000-\$49,999 (=9)	28.87%	19.72%	21.83%	22.54%	7.04%	142 (100%)
\$50,000-\$59,999 (=10)	14.02%	19.63%	40.19%	17.76%	8.41%	107 (100%)
\$60,000-\$74,999 (=11)	13.86%	19.80%	24.75%	25.74%	15.84%	101 (100%)
\$75,000-\$99,999 (=12)	5.94%	19.80%	25.74%	31.68%	16.83%	101 (100%)
\$100,000-\$124,999	8.93%	5.36%	30.36%	16.83%	23.21%	56 (100%)
(=13)	9.68%	8.06%	25.81%	5.94%	27.42%	62 (100%)
\$125,000 or more (=14)						
Mean (Median)	6.54 ^d	7.58 ^a	9.05 ^b	8.53 ^{ab}	10.33 ^c	8.25 (9)
F = 27.05						
(p<0.0001)						
Education						
Less than High School (=1)	48.84%	22.09%	13.95%	11.63%	3.49%	86 (100%)
High School (=2)	25.91%	22.59%	22.92%	22.59%	5.98%	301 (100%)
Some College (=3)	18.07%	20.59%	21.43%	27.73%	12.18%	238 (100%)
Bachelor's Degree (=4)	16.12%	13.64%	27.27%	28.51%	14.46%	242 (100%)
Graduate Degree (=5)	6.02%	16.54%	26.32%	31.58%	19.55%	133 (100%)
Mean (Median)	2.49 ^d	2.85 ^a	3.18 ^b	3.25 ^{bc}	3.57 ^c	3.03 (3.00)
F = 22.57 (p<0.0001)						
Ethnicity						
White	18.18%	19.72%	24.33%	26.12%	11.65%	781 (100%)
Black	31.43%	20.00%	19.05%	22.86%	6.67%	105 (100%)
Other	30.70%	14.04%	20.18%	23.68%	11.40%	114 (100%)
$\chi^2 = 19.52 (0.0123)$						
Marital Status						
Married	15.88%	17.63%	27.05%	26.18%	13.26%	573 (100%)
Separated or Divorced	26.80%	22.22%	20.26%	24.18%	6.54%	153 (100%)
Widowed	31.33%	34.44%	21.11%	12.22%	1.11%	90 (100%)
Never Married	27.17%	13.59%	15.22%	30.98%	13.04%	184 (100%)
$\chi^2 = 31.27 (<0.0001)$						

^{abcd} present the results of pair-wise tests using Bonferroni adjustment with alpha level of 0.05.

Table IV-5. Percentage of Respondents Who Received a Particular Type of Information

Communication	Laggards (N=210)	Bill Collectors (N=191)	Bill Payers (N=233)	Phone- Callers (N=255)	Innovators (N=111)	All (N=1000)
Financial Institutions- <i>Written</i> $\chi^2 = 135.7386$ (<.0001)	10.95% ^d	37.17% ^a	48.93% ^{ab}	53.73% ^b	68.47% ^c	42.1%
Financial Institutions- <i>Conversational</i> $\chi^2 = 59.8130$ (<.0001)	4.76% ^c	12.04% ^{ac}	13.73% ^{ac}	19.61% ^a	36.04% ^b	15.5%
Government/ Consumer Agencies- <i>Written</i> $\chi^2 = 16.4796$ (0.0024)	4.29% ^b	12.04% ^{ab}	16.31% ^a	12.94% ^a	11.71% ^{ab}	11.6%
Government/ Consumer Agencies- <i>Conversational</i> $\chi^2 = 8.7434$ (0.0678)	2.38% ^a	5.24% ^a	7.3% ^a	7.84% ^a	9.01% ^a	6.2%
Family/ Friends $\chi^2 = 73.3223$ (<.0001)	7.62% ^{ad}	17.80% ^a	26.61% ^{ab}	38.81% ^c	38.74% ^{bc}	25.2%

^{a b c d} present the results of pair-wise tests using Bonferroni adjustment with alpha level of 0.05.

Table IV-6. Perceived Usefulness of Information Among Consumers Who Received Information

Communication		Laggards	Bill Collectors	Bill Payers	Phone-Callers	Innovators	All
Financial Institutions- <i>Written</i>	Received (N)	23	71	114	137	76	421
	Not at all Useful	47.83%	40.85%	35.09%	38.69%	18.42%	34.92%
	Somewhat Useful	39.13%	47.09%	49.12%	46.72%	53.95%	48.46%
	Useful	13.04%	11.29%	15.79%	14.60%	27.63%	16.63%
	Very Useful	100%	100%	100%	100%	100%	100%
$\chi^2 = 16.0410$ (0.0030) F = 4.13 (0.0027) Mean		1.65 ^a	1.70 ^a	1.81 ^{ab}	1.80 ^a	2.09 ^b	1.82
Financial Institutions- <i>Conversational</i>	Received (N)	10	23	32	50	40	155
	Not at all Useful	20.00%	30.43%	12.50%	22.00%	7.50%	13.42%
	Somewhat Useful	40.00%	52.17%	53.13%	44.00%	40.00%	45.81%
	Useful	40.00%	17.39%	34.98%	34.00%	52.50%	36.77%
	Very Useful	100%	100%	100%	100%	100%	100%
$\chi^2 = 10.5093$ (0.0327) F = 2.75 (0.0305) Mean		2.20 ^{ab}	1.87 ^a	2.22 ^{ab}	2.12 ^{ab}	2.45 ^b	2.19
Government/ Consumer Agencies- <i>Written</i>	Received (N)	9	23	38	33	13	116
	Not at all Useful	22.22%	34.78%	39.47%	36.36%	30.77%	35.34%
	Somewhat Useful	55.56%	39.13%	42.11%	63.64%	38.46%	48.28%
	Useful	22.22%	26.09%	18.42%	0%	30.77%	16.38%
	Very Useful	100%	100%	100%	100%	100%	100%
$\chi^2 = 4.2215$ (0.3769) F = 1.06 (0.3811) Mean		2.00 ^a	1.91 ^a	1.79 ^a	1.64 ^a	2.00 ^a	1.81
Government/ Consumer Agencies- <i>Conversational</i>	Received (N)	5	10	17	20	10	62
	Not at all Useful	0%	0%	17.65%	15.00%	0%	9.68%
	Somewhat Useful	60.00%	80.00%	47.06%	65.00%	50.00%	59.68%
	Useful	40.00%	20.00%	35.29%	20.00%	50.00%	30.65%
	Very Useful	100%	100%	100%	100%	100%	100%
$\chi^2 = 4.2547$ (0.3726) F = 1.07 (0.3806) Mean		2.40 ^a	2.22 ^a	2.18 ^a	2.05 ^a	2.50 ^a	2.21
Family/Friends	Received (N)	16	34	62	97	43	252
	Not at all Useful	37.50%	32.35%	19.35%	27.84%	6.98%	23.41%
	Somewhat Useful	43.75%	47.06%	51.61%	48.45%	60.47%	50.79%
	Useful	18.75%	20.59%	29.03%	23.71%	32.56%	25.79%
	Very Useful	100%	100%	100%	100%	100%	100%
$\chi^2 = 9.4176$ (0.0607) F = 2.30 (0.0593) Mean		1.81 ^a	1.88 ^a	2.10 ^a	1.96 ^a	2.26 ^a	2.02

Note

* Cochran-Mantel-Haenszel statistics are used to test cluster differences in mean scores of perceived usefulness.

^{ab} present the results of pair-wise tests using Bonferroni adjustment with alpha level of 0.05.

Table IV-7. Communication Mode and Perceived Usefulness

	Financial Institutions		Government/ Consumer Agencies		Combined	
Communication Mode	Written	Conversational	Written	Conversational	Written	Conversational
Not at all useful	147 34.92 %	27 17.42%	41 35.34%	6 9.68%	188 35.61%	33 15.21%
Somewhat useful	204 48.46 %	71 45.81%	56 48.28%	37 59.68%	260 47.54%	108 49.77%
Very useful	70 16.63 %	57 36.77%	19 16.38%	19 30.65%	89 16.86%	76 35.02%
Total (N)	421	155	115	62	528	217
χ^2 *	31.064 7		13.489 2		44.574 5	
p-value	<.0001		0.0002		<0.000 1	

Note

* Cochran-Mantel-Haenszel statistics are used to test differences in mean scores of perceived usefulness by communication mode.

Table IV-8. Results of Multinomial Logit Analysis: Maximum Likelihood Analysis

$\ln(P_1 / P_5)$ = probability of being a Bill Collector over a Laggard
 $\ln(P_2 / P_5)$ = probability of being a Bill Payer over a Laggard
 $\ln(P_3 / P_5)$ = probability of being a Phone-Caller over a Laggard
 $\ln(P_4 / P_5)$ = probability of being an Innovator over a Laggard

	$\ln(P_1/P_5)$	$\ln(P_2/P_5)$	$\ln(P_3/P_5)$	$\ln(P_4/P_5)$	χ^2
Intercept	1.8880 (0.0805)	-0.5056 (0.6332)	0.7690 (0.4413)	-0.8719 (0.5127)	7.53 (0.1103)
Communication					
Financial Institutions- <i>Written</i>	0.7123*** (<0.0001)	0.7938*** (<0.0001)	0.8511*** (<0.0001)	1.0200*** (<0.0001)	46.74*** (<0.0001)
Financial Institutions- <i>Conversational</i>	0.0453 (0.8454)	-0.0651 (0.7683)	0.1104 (0.5980)	0.5561* (0.0133)	18.84*** (0.0008)
Government/Consumer Agencies	0.1764 (0.4102)	0.2985 (0.1538)	0.1585 (0.4390)	0.0938 (0.6868)	2.89 (0.5760)
Family/Friends	-0.0021 (0.9926)	0.1382 (0.5235)	0.4582* (0.0256)	0.3824 (0.0820)	13.79** (0.0080)
Interaction between Financial Institutions- <i>Conversational</i> & Family/Friends	0.6331* (0.0054)	0.6389** (0.0032)	0.4559* (0.0263)	0.4608* (0.0362)	10.19* (0.0374)
Demographic					
Age	-0.1512** (0.0017)	-0.0268 (0.5685)	-0.0294 (0.5236)	0.0801 (-0.2059)	12.08* (0.0168)
Age ²	0.0029*** (<0.0001)	0.0004 (0.3772)	0.0000 (0.8677)	0.0001 (-0.3919)	19.92*** (0.0005)
Income	0.0633 (0.0585)	0.1081** (0.0011)	0.0600 (0.0667)	0.2141*** (<0.0001)	24.90*** (<0.0001)
Education	0.2366* (0.0234)	0.2910** (0.0036)	0.3441*** (0.0006)	0.4696*** (0.0002)	16.81** (0.0021)
Black	-0.0854 (0.6056)	-0.2244 (0.1948)	-0.2534 (0.1318)	-0.3827 (0.1240)	3.66 (0.4543)
Married	0.1105 (0.3335)	0.2547* (0.0234)	0.1655 (0.1385)	0.2603 (0.0768)	6.00 (0.1990)

*** $p < 0.001$

** $p < 0.01$

* $p < 0.05$

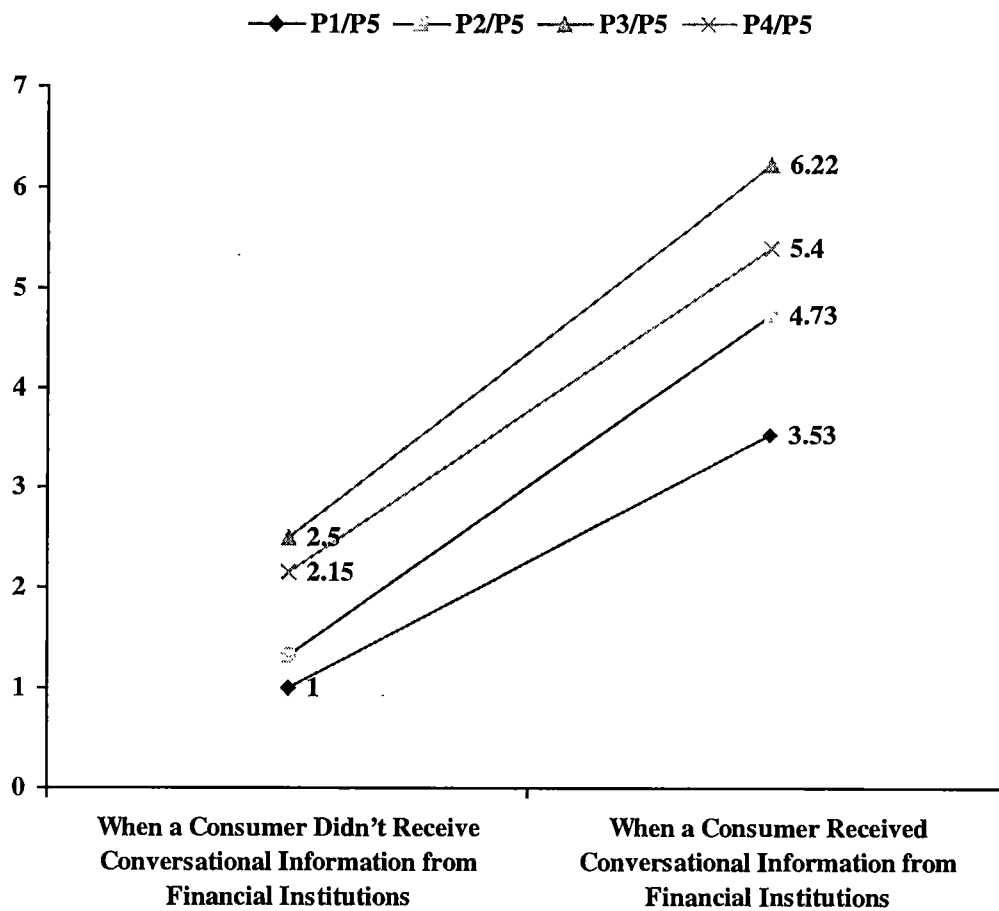


Figure III-1. Odds Ratios: The Effect of Receiving Information from Family and Friends on Adoption of Electronic Banking Technologies

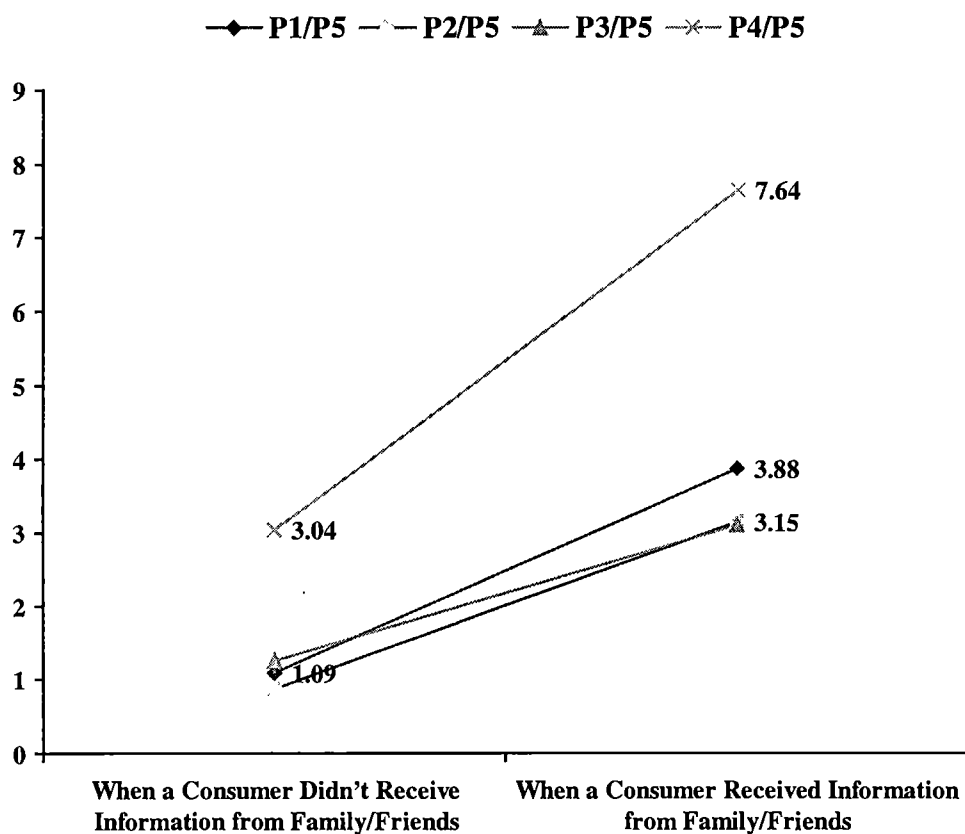


Figure III-2. Odds Ratio: The Effect of Receiving Conversational Information from Financial Institutions on Adoption of Electronic Banking Technologies

PART V

SUMMARY

CHAPTER 1

SUMMARY AND CONCLUSIONS

This project investigated consumer adoption and diffusion of technological innovations. In investigating consumer adoption and diffusion of technological innovations, electronic banking technologies were chosen because (1) they are readily available technological innovations to consumers, and (2) they include technological innovations at different diffusion stages.

Three independent yet related studies were conducted to provide a holistic understanding of consumer adoption and diffusion of electronic banking technologies. In doing so, a model -- that conceptualizes that an individual consumer's adoption of technological innovations is influenced by consumer, innovation, and communication factors -- was introduced. Based on this conceptual model, three research objectives investigating these three influencing factors arose.

The first study examined the extents of consumer adoption of various electronic banking technologies such as ATMs, debit cards, smart cards, direct deposit, and direct payment, along with the characteristics of adopters and non-adopters of those technologies. Using the 1995 Survey of Consumer Finances, it was found that, in general, more educated, more affluent, and younger consumers who are likely to communicate with professional information providers tend to adopt electronic banking technologies more readily than their counterparts. However, the specific factors that describe adopters and non-adopters varied across different types of banking technologies.

The second study investigated the impacts of innovation and consumer factors on adoption of both mature and newer innovations, i.e., ATM and computer banking. Accessibility is an important factor that needs to be accounted for in modeling consumer adoption of computer banking, because a consumer's decision to adopt the electronic banking technologies can be restricted by whether the consumer has access to the technologies. Therefore, accessibility was explicitly incorporated in modeling consumer adoption of computer banking. An adjustment to avoid biased estimation was made by employing a censored probit model. Using a national sample of 890 consumers, the empirical model estimated the effects of perceived innovation characteristics and consumer characteristics on the adoption of computer banking and the ATM.

Results suggested that there was significant sample selection bias with regard to access when estimating the consumer adoption of computer banking. It was found that individual socioeconomic characteristics were significant predictors of accessibility to computer banking. Perceived innovation characteristics were highly significant in influencing consumers' adoption of both computer banking and ATMs. Furthermore, when sample selection bias was adjusted, perceived characteristics were found to be more significant predictors of computer banking than socioeconomic characteristics, thereby suggesting the importance of communication strategies to change consumers' perceptions of electronic banking technologies as secure, reliable, convenient, and easy-to-use.

The third study explored communication strategy to facilitate diffusion of innovations. More specifically, the effects of channel and communication mode on consumers' adoption of electronic banking innovations were examined. Taxonomy of channel and communication mode was proposed, and subsequently used as a guideline

for explanatory variables in multinomial logit analysis. Using data from the 1999 University of Michigan Survey of Consumers, consumers were classified into five electronic-banking-user clusters. It was found that individual consumers' adoption is influenced by communication patterns and that innovators and laggards have different preferences for channel and communication mode. These results suggest that innovators and laggards can be reached effectively by adopting the right channel and communication mode. Laggards need tailored communication efforts that consider their preference for interpersonal, conversational communication. Innovators can be reached relatively easily via both written and conversational communication from professional *and* interpersonal information sources.

In conclusion, this study examined the extent to which consumers adopt a variety of electronic banking technologies and described the characteristics of adopters versus non-adopters of a variety of electronic banking technologies. This study also identified the underlying factors, including socioeconomic characteristics and perceived innovation characteristics, which affect consumer adoption of electronic banking technologies. Finally, the role of communication in consumers' adoption of electronic banking technologies was also investigated.

The three research studies have demonstrated that the conceptual model proposed in Part I is a valid explanation of consumer adoption and diffusion of electronic banking technologies. Individual consumers' adoption of electronic banking technologies is a complex phenomenon that is influenced by consumer, innovation, and communication factors. Having a holistic understanding of three influencing factors provides an improved explanation of consumer adoption of technological innovations and make more solid suggestions to various stakeholders. Based on this improved

understanding, potential contributions to various stakeholders are discussed in the next section.

CHAPTER 2

IMPLICATIONS

The examination of consumer adoption and diffusion of electronic banking technologies can provide contributions to a variety of stakeholders. The potential contribution to practitioners, policy makers, and academicians and future research are discussed in this section.

Implications for Practitioners

This study furnishes some guidance to financial institutions as to the current status of consumer acceptance of electronic banking technologies and responses to communication efforts put forth by financial institutions.

The first study indicates that, to some extent, there exists consumer resistance to electronic banking technologies. The fact that one-third of consumers who have at least one account with a financial institution still have not adopted ATMs -- a technology that is believed to have reached its maturity stage and is available to almost everyone -- demonstrates that a considerable number of consumers are still hesitant to adopt technological innovations regardless of their availability.

An accurate description of the characteristics of adopters and non-adopters of various electronic banking technologies is helpful for financial institutions to achieve profitable positions by identifying different consumer segments. The findings of adopters and innovators -- young, highly educated, and wealthy consumers -- are in good agreement with Rogers's propositions. Additionally, we found that there are differences in adopter profiles across the types of financial innovations. Therefore,

generalizing previous patterns of financial innovation and applying them to a new medium may not be appropriate. In particular, age has an opposite impact on the adoption of direct deposit versus the adoption of ATMs, debit cards, and direct payment. Although age is associated with avoidance of technology in general, older consumers are more likely to adopt direct deposit than their younger counterparts. On the other hand, highly educated, high-income, young consumers are likely to adopt ATMs, computer banking, and direct payment. Some fundamental differences between direct deposit and other technologies may explain these opposite directions in effects. Adoption of direct deposit requires only first-time sign up, whereas other technologies involve rather continuous commitment throughout usage. Also, elderly consumers' heavy usage of direct deposit reflects the mandate of electronic transfer of federal and state benefits.

The third study showed that communication factors are indeed significant predictors of consumer adoption of electronic banking innovations. From both the first and the third study, adopters were found to be susceptible to communication with professional information providers; they could be reached both by written and conversational communication. On the other hand, non-adopters did not seem to receive information from professional information providers and even if they have received information, they did not find the information useful. Non-adopters were found to more open to conversational communication and the reinforcement from both professional and interpersonal information providers were found to be more effective.

In developing promotion messages, the findings from the second study are insightful. Consumers' positive perceptions about innovation were found to be associated with heightened likelihood of adoption. In fact, the effects of perceived

innovation characteristics were greater than the effects of socioeconomic variables on consumers' adoption of the electronic banking technologies. Specifically, consumers who perceive electronic banking useful, reliable, secure, and easy to use tended to adopt electronic banking technologies, while observability did not influence their decision. Therefore, financial institutions should emphasize that electronic banking technologies are useful, reliable, secure, and easy way to conduct financial businesses. Giving customers various opportunities to try out the technologies can also facilitate their adoption.

Similarly, addressing negative perceptions, such as reducing security concerns, can increase the likelihood of adoption of electronic banking. In fact, changing negative consumer perceptions favorably to electronic banking technologies seems to be the key to successful diffusion. Then, through what channels, should financial institutions promote convenient and secure features of electronic banking technologies to their potential adopters? In answering this question, financial institutions should consider different consumer segments. For consumers who have already adopted electronic banking technologies, financial institutions should continuously reach them through both written and conversational communications. For non-adopters, who are prone to listen to interpersonal information providers, learning from other people, as opposed to from promotional brochures, can enhance their adoption of electronic banking technologies. As such, financial institutions need to provide "word-of mouth" incentives to early adopters to encourage discussion with their friends and families about benefits of electronic banking technologies. Also, more manpower needs to be allocated in banks to provide "hands-on" trial opportunities to customers.

Implications for Policy Makers

A government's effort to enhance information flow can help consumers make more informed decisions. In doing so, an accurate description of the characteristics of adopters and non-adopters of various electronic banking technologies is helpful in implementing effective electronic funds/benefits transfer plans (EFT and EBT) through development of targeted education and communication programs for the non-adopters.

Identifying differential effects of age, education, income, race/ethnicity, and marital status allow public policy makers to develop a profile of non-adopters of EFT plans and thus to create a more targeted diffusion strategy for those Social Security recipients who have difficulty in dealing with electronic checks. The results suggest that consumers with less than high school education have some difficulty in adopting direct deposit. Therefore, special efforts are needed to reach these low educated consumers to facilitate their adoption of EFT. However, the present role of government in the diffusion of the electronic banking innovations appears to be limited as the third study shows that only a small number of consumers reported receiving any information about electronic banking from government agencies.

In general, non-adopters of electronic innovations are less likely to engage in communication with professional information providers than are adopters. However, the extent of non-adopters' use of interpersonal communication was not significantly different from the extent of adopters' use of interpersonal communication. Professional information delivered through a third party or literature might not be an effective way to reach non-adopters. Instead, using an interpersonal communication channel is recommended. Policy makers need to promote active outreach programs, which seek

the current adopters of electronic banking and encourage them to talk about the new technology with their close family, neighbors, and friends.

Currently, laggard consumers -- those who did not adopt electronic banking technologies -- seem to be isolated. Financial institutions do not spend much effort to communicate with laggard consumers. In addition, laggards were found to receive limited information from government/consumer agencies as well. In contrast, innovator consumers -- those who use newer innovations, i.e., computer banking -- receive information through multiple channels of communication. Uneven distribution of information between laggards and innovators can widen the gaps between the audience segments previously high and low socioeconomic status (Rogers 1995, p.432). In order to narrow gaps, special communication campaigns focusing on interpersonal and conversational communication should be developed for laggards.

Implications for Academicians and Future Research

The major contribution to the researchers is that this study provides a rather holistic understanding of consumer adoption and diffusion of technological innovations by considering a broad range of influencing factors. The role consumer characteristics, innovative characteristics, and communication patterns are all interrelated influences on consumer adoption and diffusion of technological innovations. Therefore, investigations of these three influences within a research project provide us with a fairly complete understanding.

In addition, accessibility to innovative technologies was also considered as a determining factor of consumer adoption decision. Using a two-step estimation analysis of a censored probit model, limited accessibility to innovative technology was found to

influence consumer adoption of new technologies, thereby suggesting that the bias caused by limited accessibility should be properly addressed in future studies of adoption of newer innovations.

This study furthered the diffusion research by presenting an integrative framework that incorporate contributions of important models in diffusion research (Rogers's and Bass's models) and tested applicability of the proposed model within the context electronic banking technologies. By doing so, this study provided further information regarding the role of consumer, innovation, and communication factors in consumer adoption and diffusion of technological innovations. Future research in diffusion of technological innovations needs to investigate other technological product and services contexts to test and verify (or falsify) the proposed model.

The findings from this research suggest that consumer perceptions of the technology are more significant predictors of adoption than demographic characteristics such as gender or ethnic differences. More research is needed in identifying relevant dimensions of consumer perceptions that have implications for adoption decisions. In fact, a consumer's contact with technologies could be an individual and subjective experience. What do consumers feel when they use a technology? What makes them happy and want to continue using the technology or frustrated and avoid using it? Qualitative studies may shed light on these individual and subjective aspects of consumers' interaction with technologies.

Another suggestion for future research is related to the socialization process. Different consumer socialization processes may shape varying predispositions to technological innovations. What will today's techno-savvy consumers do when they get old? Does age still negatively affect their attitudes toward technologies? These

questions may initially be answered by comparing the current elderly consumers and baby-boomers, who had more experiences with technologies than their parents.

In this research, the effects of communication factors on only individuals' adoption at the micro level, not on diffusion of innovations at the macro level, were investigated. As this study did not delve into the relationship between an individual consumer's adoption and the macro diffusion of innovations, more research is needed to investigate the linkage between micro adoption and macro diffusion.

Although this research employed two databases collected at different times, it did not account for the "time" factor within its examination. In order to investigate the time factor in the diffusion process, future research may focus on what influences the rate of adoption or diffusion speed of various technologies. Finally, it should be noted that this study addressed only initial and recent adoption and did not account for any "after-adoption" phenomenon. It is possible that some consumers first adopt a technology, but may eventually discontinue using it. What factors will influence consumers' continued use of the technology after the initial adoption? These are some examples of research questions that need to be answered by future research.

VITA

Eun-Ju Lee was born on 9 April 1971 in Dae-Gu, Korea. She grew up in Seoul, and graduated from Se-Hwa High School in 1990. She entered Seoul National University in March 1990, where she met her husband, Sung Keun Lee. She graduated from Seoul National University in 1994 with a Bachelor of Human Ecology, Clothing and Textiles major. She continued her study on fashion marketing and retailing toward her Master of Human Ecology degree, which she thereafter received in 1996. After the six years at Seoul National University, she worked briefly in a fashion company as a fashion-trend researcher. She moved to the United States to pursue dual degrees in retail/consumer sciences, and marketing, at the University of Tennessee, Knoxville. Her first doctoral degree in retail/consumer sciences was awarded in December 2000.
