

# Haven't Adopted Electronic Financial Services Yet? The Acceptance And Diffusion Of Electronic Banking Technologies

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*Based upon the theory of diffusion of innovation, we 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 we 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 vary across different types of banking technologies.*

*Key Words: Electronic banking technology, Electronic financial services, Retail banking, Diffusion of innovations, Survey of Consumer Finances.*

## Introduction

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 & Gore, 1998; Congressional Budget Office, 1996; Group of Ten, 1997; Kennickell & Kwast, 1997; Pitofsky, 1996; White, 1996). In this study, electronic financial services refer to all the financial activities involving electronic media such as Automated Teller Machines (ATMs), debit cards, direct deposit or payment, and smart cards. Using these electronic banking technologies, consumers can conduct fast and convenient financial transaction activities and obtain their account information.

The discussion on electronic financial services 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 & 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 as 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 & Kramer, 1994; Hirschman, 1987; Ram & Jung, 1991; Ram & Sheth, 1989). Hirschman (1987) pointed out that consumers have a 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.

While diffusion of innovation is, in general, one of the most studied topics in the literature (Mahajan, Muller & 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

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non-adopters, using the 1995 Survey of Consumer Finances (SCF) commissioned by the Federal Reserve Board.

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. Overestimation of consumer adoption can not only misguide financial service providers to an investment which is not ready to give return, but also lead to policy decisions which force consumers to embrace the technologies that they are not ready for. By recognizing the characteristics of adopters versus non-adopters of electronic banking technologies, financial institutions and policy makers can also develop better-targeted programs for diffusing intended technology.

#### **Background: Innovation in Financial Services**

Technical innovation has played a central role in the evolution of the financial services industry over the past 50 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 (Federal Reserve Board, 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 retail transactions and contacts with their customers.

Consequently, recent technological changes have altered the nature of consumer interaction with providers of financial services, reducing the importance of physical location and face-to-face interactions (White, 1996). 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.

As alternative electronic banking options become available, an increasing number of consumers should prefer to use them. However, checks still dominate the U.S. payment system (Bank for International Settlements, 1995), although the relative importance of electronic payments has increased. Overall, consumers have been slow to adopt electronic funds transfers, such as direct deposit and direct payment, through an Automated Clearing House (ACH). Only 55% of private sector workers are paid through direct deposit, and of \$20

billion of annual bill payments, only \$1 billion occurred through an ACH (White, 1996).

Newer innovations, such as home banking and Internet transactions, are still in their nascent stages, and diffusion has been slow. For example, General Accounting Office's 1998 statistics show that less than 7% of U.S. banks offer online banking services, and households engaging in home banking are even less. In addition, electronic stored-value products (so-called "smart cards") are in an early stage of development. As of the late 1990s, fewer than 500,000 smart cards had been issued in the U.S., and most of those were found in controlled environments such as university campuses and military bases (Horovitz & White, 1996).

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 (86.7%) of households preferred to conduct their banking business in person.

#### **Theoretical Framework**

##### *Theory of Innovation and Diffusion*

The theory of diffusion of innovation provides a basis for classifying consumers according to their innovativeness (Rogers, 1995). Rogers defines innovation broadly as "an idea, practice, or object that is perceived as new by an individual or other unit of adoption" (p. 11), and innovativeness as "the degree to which an individual or other unit of adoption adopts new ideas relatively earlier than other members of a system" (p. 252).

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). Rogers (1995) proposed that cumulative adopter distributions tend to follow an S-shaped curve that approaches the cumulative normal distribution over time.

Rogers (1995) classified consumers into five groups of adopters according to a continuum of innovativeness: innovators, early adopters, early majority, late majority, and laggards (p. 262). Rogers suggests that 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.

Bass (1969) proposed a model that conceptualizes the

adoption of an innovation as the probability of adopting or not adopting that innovation at any point in time. Conceptually, Bass's model allows for the possibility of non-adoption over time, while Rogers' model assumes that all consumers will eventually adopt the innovation. This basic dichotomy of adopters and non-adopters at any point in time follows the Bayesian distribution. Following Bass's Bayesian model, Mahajan, et al. (1990) made a distinction between an innovator and imitator based on the source of influence, not the timing of adoption.

#### *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 & Gentry, 1983; Gatignon & Robertson, 1985; Gilly & Zeithaml, 1985; Kennedy, 1983; Midgley & Dowling, 1978; Rogers, 1995; Zeithaml & 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. Zeithaml and Gilly (1987) and Rogers (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 consumer's 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 the specific individual

medium.

Several researchers have investigated demographic characteristics of ATM adopters. Amel (1986) and Taube (1988) found that ATM users tend to be young and have above average incomes and at least some high school education. Marshall and Heslop (1988), El-Haddan and Almahmeed (1992), and Swinyard and Ghee (1987) obtained consistent results of adopter characteristics of ATM using a Canadian sample, a Kuwaiti sample, and a Southeast Asian sample, 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 income, financial assets, and education had positive impacts 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. 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.

#### **Methodology**

The research objectives of this study are:

1. To examine the extent to which consumers adopt electronic banking technologies.
2. To identify adopters and non-adopters of electronic banking technologies.
3. To investigate the factors that describe characteristics of adopters versus 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.

#### *Data*

The 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 & Woodburn, 1996; Kennickell & 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, since consumers who have no financial affiliation cannot make electronic financial transactions.

#### *Dependent Variables*

The probability of a consumer's adoption of electronic banking technologies is 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 respondent's age was coded 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 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 (Table 1).

#### **Analysis**

In order to examine the extent of consumers' adoption of electronic banking technologies, descriptive statistics<sup>a</sup> of the extent to which consumers adopted each of the five electronic banking technologies are reported.

The primary 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 LSMMeans option and adopted Bonferroni adjustments to reduce the type 1 error.

In order 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.

**Table 1**  
Description of Variables

Variables	Description
Adoption of Innovation	
ATM	= 1 adopted ATM, 0 otherwise
Debit card	= 1 adopted debit card
Direct deposit	= 1 adopted direct deposit
Direct payment	= 1 adopted direct payment
Smart card	= 1 adopted smart card
Any of the above	= 1 adopted ATM, debit card, direct deposit, direct payment, or smart card
Education	
Less than high school	=1 if years of education < 12 and no GED, 0 otherwise
High school/GED	=1 if respondents report a high school diploma or pass GED,
Some college	=1 if years of education > 12 and ≤ 16 but no BS
Bachelor's degree	=1 if a college degree is earned
Graduate degree	=1 if years of education > 16
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	=1 if female head, 0 otherwise

Race-ethnicity	=1 if Hispanic, 0 otherwise
Hispanic	=1 if Black
Black	=1 if other non-white
Other non-white	omitted category in logit
Non-Hispanic white	
Marital Status	=1 if divorced or separated, 0 otherwise
Divorced/separated	=1 if widowed
Widowed	=1 if single, never married
Never married	omitted category in logit
Married	

**Results**

*The Extent of Consumer Adoption*

The extent to which consumers adopted electronic banking technologies is presented in Table 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.

**Table 2**  
Adopters and Non-adopters of Electronic Banking Technologies

	Adopters %	Non-adopters %
ATM	66.6 <sup>e</sup>	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 <sup>f</sup>

*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 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.

**Table 3**  
Adoption Rate of Five Electronic Banking Technologies Across Demographic Characteristics

Explanatory Variables (Adoption Rate)	ATM %	Debit %	Direct Deposit %	Direct Payment %	Smart Card %	Any Technology %
<b>Education</b>						
Less than high school	41.68 <sup>a</sup>	10.45 <sup>a</sup>	40.98 <sup>a</sup>	14.11 <sup>ab</sup>	0.57 <sup>ab</sup>	73.45 <sup>a</sup>
High school or equivalent	60.63 <sup>a</sup>	14.68 <sup>a</sup>	45.12 <sup>a</sup>	20.99 <sup>ab</sup>	0.64 <sup>a</sup>	80.13 <sup>a</sup>
Some college	72.86 <sup>b</sup>	23.18 <sup>ac</sup>	50.09 <sup>b</sup>	24.90 <sup>ab</sup>	1.45 <sup>ab</sup>	89.24 <sup>b</sup>
Bachelor's degree	79.38 <sup>b</sup>	24.02 <sup>bc</sup>	56.95 <sup>b</sup>	28.90 <sup>a</sup>	2.59 <sup>b</sup>	90.86 <sup>b</sup>
Graduate degree	82.78 <sup>c</sup>	27.69 <sup>b</sup>	69.21 <sup>c</sup>	32.93 <sup>b</sup>	1.24 <sup>ab</sup>	94.85 <sup>c</sup>
Mantel-Haenszel Chi Square	221.240†	52.665†	77.132†	67.128†	12.654†	127.358†
<b>Communication with professional information provider</b>						
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†
<b>Communication with personal source</b>						
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
<b>Household Income</b>						
Less than \$30,000	55.55 <sup>a</sup>	13.73	44.51 <sup>a</sup>	16.00	0.81	79.86 <sup>a</sup>
\$30,000-\$44,999	72.53 <sup>ab</sup>	20.61	50.73 <sup>bc</sup>	26.02	1.19	86.34 <sup>b</sup>
\$45,000-\$69,999	76.35 <sup>b</sup>	25.19	55.21 <sup>b</sup>	30.93	1.94	88.59 <sup>b</sup>
More than \$70,000	80.10 <sup>b</sup>	26.73	64.95 <sup>ac</sup>	35.69	1.98	92.65 <sup>b</sup>
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†
<b>Age</b>						
18-29	83.41 <sup>a</sup>	29.02 <sup>a</sup>	34.67 <sup>a</sup>	19.00 <sup>a</sup>	1.62	89.44 <sup>a</sup>
30-44	75.03 <sup>b</sup>	25.96 <sup>b</sup>	46.92 <sup>a</sup>	25.96 <sup>b</sup>	1.19	85.65 <sup>b</sup>
45-54	72.21 <sup>c</sup>	18.74 <sup>b</sup>	47.31 <sup>a</sup>	27.80 <sup>b</sup>	1.72	85.35 <sup>b</sup>
55 or older	48.63 <sup>d</sup>	10.82 <sup>c</sup>	62.92 <sup>b</sup>	20.18 <sup>a</sup>	0.86	80.31 <sup>c</sup>
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
F-value	889.33†	441.33†	479.11†	6.48‡	0.00	38.71†
<b>Marital Status</b>						
Married/living with partner	68.73	20.16	49.39 <sup>ab</sup>	25.50	1.52	84.19
Separated/divorced	78.14	20.42	56.79 <sup>ab</sup>	30.02	0.70	90.20
Widowed	41.29	7.39	66.39 <sup>a</sup>	17.10	0.75	80.43
Never married	69.74	23.05	40.05 <sup>b</sup>	18.25	1.28	83.05
Chi-square Statistics	103.098†	23.660†	51.616†	25.260†	1.962	6.906
<b>Race</b>						
Non-Hispanic whites	66.55	19.24 <sup>a</sup>	52.65	25.56 <sup>a</sup>	1.38	84.62
Blacks	64.80	16.71 <sup>ac</sup>	45.62	14.67 <sup>b</sup>	0.81	83.71
Hispanics	66.36	28.87 <sup>b</sup>	33.54	13.36 <sup>ab</sup>	0.53	80.31
Others	71.73	12.65 <sup>bc</sup>	48.07	23.23 <sup>ab</sup>	0.74	87.53
Chi-square Statistics	0.765	14.571‡	15.658†	32.368†	3.603	3.187

Explanatory Variables (Adoption Rate)	ATM %	Debit %	Direct Deposit %	Direct Payment %	Smart Card %	Any Technology %
<b>Female Headed Household</b>						
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†	7.022‡	7.249‡	12.439†	0.823	0.016

The superscripts a, b, c, and d present the results of pair-wise tests using Bonferroni adjustment with alpha level of 0.05. In one group, rates with the same superscript are not significantly different. For instance, for education and direct deposit, none of the rates of the first three education levels are significantly different from each other or from the top two levels, but the rate for bachelor’s degree is significantly different from the rate for graduate degree.

† Significant at the 0.001 level or better. ‡ Significant at the 0.05 level or better.

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

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 age of adopters of ATMs is 45, respectively, compared to 56 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 direct deposit. 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 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 imputations 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 s/he is to adopt ATMs, a result that supports findings of previous studies (Amel, 1986; Taube, 1988; Marshall & Heslop, 1988). 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 s/he 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.<sup>b</sup> 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.

**Table 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	<b>-0.281 (0.025)</b>	-0.122 (0.520)	<b>-0.393 (0.002)</b>	-0.245 (0.124)
Some college	<b>0.440 (0.000)</b>	<b>0.439 (0.001)</b>	<b>0.205 (0.042)</b>	0.163 (0.166)
Bachelor's degree	<b>0.723 (0.000)</b>	<b>0.525 (0.000)</b>	<b>0.432 (0.000)</b>	<b>0.295 (0.005)</b>
Graduate degree	<b>1.019 (0.000)</b>	<b>0.678 (0.000)</b>	<b>0.658 (0.000)</b>	<b>0.484 (0.000)</b>
Communication with professional information provider	<b>0.334 (0.000)</b>	<b>0.246 (0.009)</b>	0.118 (0.100)	<b>0.166 (0.044)</b>
Communication with personal source	0.231 (0.101)	-0.047 (0.755)	0.201 (0.089)	0.129 (0.315)
Age	<b>-0.034 (0.000)</b>	<b>-0.026 (0.000)</b>	<b>0.023 (0.000)</b>	<b>-0.011 (0.000)</b>
Income	0.036 (0.109)	0.036 (0.202)	-0.025 (0.218)	<b>0.049 (0.045)</b>
Race (White as base)				
Hispanic	-0.036 (0.858)	<b>0.570 (0.005)</b>	-0.212 (0.270)	<b>-0.621 (0.011)</b>
Black	0.166 (0.259)	-0.023 (0.892)	0.071 (0.588)	<b>-0.651 (0.000)</b>



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	<b>-0.395 (0.003)</b>	-0.014 (0.924)	-0.232 (0.057)	<b>-0.407 (0.005)</b>
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

Significance levels are in parentheses. Coefficients that are significantly different from zero are in bold.

**Debit Cards.** The RII result of logistic regression on debit card adoption reveals a similar pattern to that of ATM adoption with regard to communication with professional information providers 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 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 professional information providers also has a significantly positive influence on the adoption of debit cards, while communication with personal sources 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 gender of household head, 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 professional information providers and personal source did not have statistically significant effects. More educated consumers are more likely to adopter 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 professional information providers, 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 doesn't have. Those who communicate with professional information providers are about 19%<sup>c</sup> more likely to adopt direct payment than those who do not communicate with professional information providers. 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.

### Discussion

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 is initiated by financial institutions efforts to achieve competitive advantages through delivering innovative financial services and lowering operating costs. Recently, the federal government has also initiated a number of initiatives to facilitate 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 (Department of Treasury, 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 (Department of Treasury, 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 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 this demand side issue.

Under the theoretical framework of diffusion of innovations, we investigated consumer characteristics of adopters versus non-adopters of the five electronic banking technologies. Specifically, we found a positive impact of education level on the adoption of financial innovation, which is consistent with Rogers' (1995) 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. Considering that each type of technology involves different level of complexity, thereby requiring different level of consumer sophistication, it is not surprising to observe non-linearity of education impact. Therefore, it is important for policy makers, consumer educators, and financial industry to identify appropriate levels of consumer knowledge and sophistication for each innovation and to develop diffusion strategies accordingly.

Regarding the impacts of communication patterns, 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. This finding suggests the importance of interpersonal communication in encouraging non-adopters' acceptance of new technology. For those consumers who are less open to innovation, simply handing out brochures of information about new innovation would not lead them to adopt the innovation. On the other hand, interpersonal communication has been proven to be effective regardless of consumers' innovativeness. Therefore, encouraging non-adopters through interpersonal communication is highly recommended.

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). 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, all the other technology requires more frequent consumer involvements. Also both federal and state governments encourage direct deposit for Social Security and other benefits so that a greater number of elderly consumers are the recipients, compared to younger counterparts.

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. We can speculate that affluent households have enough funds not to worry about adequate level of money flow to make arrangements for direct payments, while less affluent households may need to manage their funds more tightly and therefore not able to afford direct payments.

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%<sup>d</sup> 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 race/ethnicity can be understood as a context of culture. Whenever an innovation is introduced, different cultures react to the innovation differently. In helping Hispanics manage

personal finances, consumer educators may encourage the use of debit cards instead of the use of credit cards.

The impact of marital status also varies across different types of financial innovations. Specifically, married households are more likely to adopt ATMs 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.

### 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. 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 households 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 s/he 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.

### Endnotes

- a. *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 (Rubin, 1987; Montalto & Sung, 1996) for a more detailed discussion of RII).

- b. We thank an anonymous reviewer for this suggestion.
- c. The odds ratio for this dichotomous variable is calculated as  $e^{\beta}$ , where  $\beta$  is the coefficient of the communication variable (whether the respondent has communicated with professional information provider). In this case,  $e^{0.166} = 1.1805$
- d. The odds ratio for this dichotomous variable is calculated as:  $e^{-0.651} = 0.5215$
- e. 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.
- f. This 17% consists of 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.

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