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RESEARCH ARTICLE

MODEL OF ADOPTION OF TECHNOLOGY IN HOUSEHOLDS: A BASELINE MODEL TEST AND EXTENSION INCORPORATING HOUSEHOLD LIFE CYCLE[1]

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Abstract

Individual adoption of technology has been studied extensively in the workplace. Far less attention has been paid to adoption of technology in the household. In this paper, we performed the first quantitative test of the recently developed model of adoption of technology in households (MATH). Further, we proposed and tested a theoretical extension of MATH by arguing that key demographic characteristics that vary across different life cycle stages would play moderating roles. Survey responses were collected from 746 U.S. households that had not yet adopted a personal computer. The results showed that the integrated model, including MATH constructs and life cycle characteristics, explained 74 percent of the variance in intention to adopt a PC for home use, a significant increase over baseline MATH that explained 50 percent of the variance. Finally, we compared the importance of various factors across household life cycle stages and gained a more refined understanding of the moderating role of household life cycle stage.

Keywords: Adoption, technology adoption, household, personal computers

Introduction

More and more technologies are transitioning from the workplace to the home (DeMaria 2002; Venkatesh 1996; Wagner 2001) and technologies are being designed specifically for household use

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(e.g., Kapoor 2004). Despite this decade-long trend, most work on technology adoption has focused on the workplace as the context (for a review, see Venkatesh et al. 2003). The household differs from the workplace on a number of dimensions, such as the complexity of interactions and negotiations among household members (Beatty and Talpade 1994; Childers and Rao 1992; Lackman and Lanasa 1993; Sherman and Delener 1987; Spiro 1983), differences in types of tasks, and the intricacies inherent in the various stages of household life (Danko and Schaninger 1990; Gilly and Enis 1982). Further, since technology is embedded in a context and the context is an important aspect of understanding the technology and its use (Orlikowski and Iacono 2001), the household context, given its tremendous growth as a target for implementation of technologies, is an important aspect of theorizing about technology. In response to the need to theorize about household technology adoption, our earlier work (Venkatesh and Brown 2001) introduced the model of adoption of technology in households (MATH) that presented various factors influencing adoption and use of technologies in households. With this backdrop, the objectives of the current research are:

1. *Extending MATH*: Using household life cycle theory (e.g., Gilly and Enis 1982; Schaninger and Danko 1993) and income (Wagner and Hanna 1983), we extend MATH to account for the complex array of issues that distinguish the household context (e.g., Childers and Rao 1992; Lackman and Lanasa 1993) from work or educational settings. By accomplishing this objective, we will be able to further enhance the explanatory and predictive power of MATH.

2. *Operationalizing the constructs of MATH*: MATH was initially developed and tested using qualitative data. In this study, we operationalize the MATH constructs for survey research and demonstrate their reliability and validity.

3. *Longitudinal empirical test of MATH and the extension of MATH:* We conduct an empirical test of MATH and the proposed extension. The target technology that we examine is the personal computer.

MATH: Original Model and Proposed Extension

MATH presented factors influencing household technology adoption by using the theory of planned behavior (TPB; Ajzen 1991) as the framework. Specifically, the three constructs predicting intention in TPB are attitude, subjective norm, and perceived behavioral control. Attitude is formed from cognitive beliefs and refers to an "individual's positive or negative feeling (evaluative affect) about performing the target behavior" (Fishbein and Ajzen 1975, p. 216). Subjective norm represents the social influences on behavior and refers to the perception about whether others who are important to a person believe that he or she should engage in a particular behavior (Fishbein and Ajzen 1975). Finally, perceived behavioral control represents the constraints on behavior and refers to the "perceived ease or difficulty of performing a behavior" (Ajzen 1991, p. 188). Control-related constructs have been separated into internal or external depending on whether the construct relates to an individual's internal abilities and constraints (e.g., self-efficacy) or external constraints (e.g., environmental constraints); this line of reasoning has conceptual and empirical support in psychology and information systems research (for a discussion, see Venkatesh 2000). In keeping with the dominant line of thought in technology adoption, MATH presented the roles of three major classes of constructs: attitudinal beliefs, normative beliefs, and control beliefs. MATH was initially developed via a two-wave, longitudinal phone survey of households regarding their current and future ownership of a PC for home use (Venkatesh and Brown 2001). Through an analysis of qualitative data, anchored in the trichotomous classification of TPB, our earlier study identified the attitudinal, normative, and control beliefs. Many of these beliefs were unique to the household context. Table 1 lists the key constructs and their definitions.

Table 1. Constructs and Definitions from MATH

Belief Structure	Core Constructs	Definitions
Attitudinal Beliefs	Applications for personal use	"The extent to which using a PC enhances the effectiveness of household activities" (Venkatesh and Brown 2001, p. 82).
	Utility for children	The extent to which using a PC enhances the children's effectiveness in completing homework and other activities (Venkatesh and Brown 2001).
	Utility for work-related use	The extent to which using a PC enhances the effectiveness of performing work-related activities (Venkatesh and Brown 2001).
	Applications for fun	"The pleasure derived from PC use" (Venkatesh and Brown 2001, p. 82). These are specific to PC use, rather than general traits (see Webster and Martocchio 1992, 1993).
	Status gains	The increase in prestige that coincides with the purchase of a PC for home use (Venkatesh and Brown 2001).
Normative Beliefs	Friends and family influences	"The extent to which members of a social network influence one another's behavior" (Venkatesh and Brown 2001, p. 82). In this case, the members are friends and family.
	Secondary sources' influences	The extent to which information from TV, newspaper and other secondary sources influences behavior (Venkatesh and Brown 2001).
	Workplace referents' influences	The extent to which coworkers influence behavior (see Taylor and Todd 1995).
Control Beliefs	Fear of technological advances	The extent to which rapidly changing technology is associated with fear of obsolescence or apprehension regarding a PC purchase (Venkatesh and Brown 2001).
	Declining cost	The extent to which the cost of a PC is decreasing in such a way that it inhibits adoption (Venkatesh and Brown 2001).
	Cost	The extent to which the current cost of a PC is too high (Venkatesh and Brown 2001).
	Perceived ease of use	The degree to which using the PC is free from effort (Davis 1989; see also Venkatesh and Brown 2001).
	Requisite knowledge	The individual's belief that he/she has the knowledge necessary to use a PC. This is closely tied to computer self-efficacy (Compeau and Higgins 1995a, 1995b; see also Venkatesh and Brown 2001).

One of the aspects that makes the household an important context to study is the sheer complexity of household decision making. The various members of a household—spouses (e.g., Davis 1976; Filitraut and Ritchie 1980; Qualls 1987), adolescents (e.g., Beatty and Talpade 1994; Belch et al. 1985; Foxman et al. 1989; Palan and Wilkes 1997), and others (Childers and Rao 1992)—exert an influence on household decision making. In addition, the presence of children in the household necessitates different purchasing and spending patterns, as the needs of the household tend to reflect the changing nature of the needs of the children (Beatty and Talpade 1994; Belch et al. 1985; Foxman et al. 1989; Palan and Wilkes 1997). Household life cycle models capture some of this complexity through the characteristics of marital status and presence of children (Gilly and Enis 1982). In addition, socio-economic factors such as income influence total household spending (Wagner and Hanna 1983).

Household Life Cycle

We examine the *household life cycle* and *income* as key factors in improving our understanding of household technology adoption. There is a rich body of research, spanning several decades, studying household life cycles and their impact on household purchase decisions. Household life cycle models suggest that families progress through a fairly methodical set of stages during the course of their lives (e.g., Gilly and Enis 1982; Schaninger and Danko 1993; Wells and Gubar 1966; Wilkes 1995). While a number of life cycle models have been proposed, Gilly and Enis' (1982) delineation has received the most attention and appears to be most appropriate for newer familial forms—e.g., single parents, older parents, and same sex couples (Schaninger and Danko 1993). As seen in Table 2, the defining characteristics of the 11 household life cycle stages are marital status, age, and presence/age of children in the household (Danko and Schaninger 1990). Differences in purchase patterns across stages are argued to be a result of the complex interactions among the factors associated with a family's position in the life cycle.

Household life cycle models suggest that purchase behavior is a function of a household's life cycle stage. For example, Danko and Schaninger (1990) identified the following patterns: younger singles and newlyweds (stages 1, 2, and 3 in Table 2) tend to spend more on eating out than families in the other stages, while older couples (stages 6, 7, 8, 9, and 10 in Table 2) spend more on automobiles than families in the other stages; younger singles (stages 1 and 2 in Table 2) spend more on social leisure activities, while full nesters (stages 6, 7, and 8 in Table 2) spend more on major appliances. Finally, stages 8 and 9 in Table 2 spend the greatest amount on personal computers.

In contrast to the life cycle model, Wagner and Hanna (1983) propose that income is the key determinant of household expenditures and life cycle stages, simply reflecting the changes in income over time. Yet, Wagner and Hanna demonstrated that while life cycle stage is significant, its effect is minimal compared to the effects of income. It should be noted that total consumption expenditure was used as a proxy for income in the Wagner and Hanna study. Given a societal trend toward over consumption—i.e., using excessive debt (see Alt Powell 2001; Williams 2001)—their results come into question. In fact, Wagner and Hanna indicate that when gross or disposable income is used, the life cycle factors are indeed significant in explaining consumption patterns across stages. This suggests that both life cycle stages and income are potentially relevant in understanding household technology adoption decisions. By integrating MATH with a life cycle view that includes income, we will be able to provide a richer explanation of household PC adoption than that provided by MATH alone. Specifically, we propose that there will be an interaction among the life cycle stages, income, and MATH constructs such that the MATH constructs play differential roles in the various household life cycle stages in influencing technology adoption decisions.

Table 2. Stages in the Gilly-Enis (1982) Family Life Cycle

No.	Stage	Characteristics		
		Marital Status[a]	Age[b]	Children[c]
1	Bachelor I	Single person living alone	Under 35	None
2	Bachelor II	Single person living alone	Age 35-64	None
3	Newlywed	Two adults living together	Female under age 35 (if both males, younger under age 35)	None
4	Single parent	One adult	Any age	Any number of children, any age
5	Full nest I	Two adults living together	Female adult under age 35 (if no female, younger male)	Youngest child under age 6
6	Delayed full nest	Two adults living together	Female adult 35 or older (if no female, younger male)	Youngest child under age 6
7	Full nest II	Two adults living together	Female adult under age 35 (if no female, younger male)	Youngest child age 6 or above
8	Full nest III	Two adults living together	Female adult 35 or older (if no female, younger male)	Youngest child age 6 or above
9	Childless couple	Two adults living together	Female under age 65 (if no female, younger male)	None
10	Older couple	Two adults living together	Female 65 or older (if no female, younger male)	None
11	Bachelor III	Single person living alone	Age 65 or older	None
12	Other	Any household that does not fit in the above		

Notes:

a. Marital status is defined broadly to include two adults cohabitating. This includes same-sex couples and is consistent with Gilly and Enis' (1982) conceptualization.

b. While Gilly and Enis use a three-category view of age (< 35, ≥ 35, and ≥ 65), recent life cycle research has experimented with alternative age cutoffs and found greater explanatory power with differing age ranges (Schaninger and Lee 2002). In keeping with research on age and technology adoption (e.g, Morris and Venkatesh 2000), and in light of the recent life cycle research, we conceptualize age as a continuous variable.

c. Gilly and Enis use a categorical variable to represent child's age (< 6 or ≥ 6). We treat child's age as a continuous variable.

Integrating MATH and the Household Life Cycle

Consistent with most technology adoption models (see Venkatesh et al. 2003) and the broader attitude-behavior literature (Ajzen 1991; Albarracin et al. 2001; Sheppard et al. 1988), MATH begins with intention to purchase as the key dependent variable. In keeping with this, we employ intention to purchase as the key dependent variable. To consider how the drivers of adoption may change across household life cycle stages, we incorporate three key demographic variables—*age, marital status,* and *child's age*—as presented in Table 2. Age refers to the age of the (younger)[2] female or younger male adult in the household. Marital status of "married" includes those officially married as well as those who cohabitate. Child's age refers to the age of the youngest child in the household. Extending beyond Gilly and Enis' (1982) life cycle stages, and consistent with Wagner and Hanna (1983), we incorporate household income as an additional differentiator beyond the three variables that define life cycle stages.[3]

We depart from the original formulation of MATH in three ways. First, we have renamed two constructs in order to be consistent with prior research and to reflect what we believe is the nature of the construct. We have renamed "high cost" as "cost" to be consistent with Rogers (1995); we have renamed "fear of obsolescence" to be "fear of technological advances" to reflect the spirit of the definition. Second, MATH employed attitude, subjective norm, and perceived behavioral control to develop the underlying belief structure influencing household PC adoption. However, prior information systems research has employed beliefs to directly predict intention in order to develop more parsimonious models (see Davis et al. 1989; Thompson et al. 1991; Venkatesh and Davis 2000; Venkatesh et al. 2003). Consistent with that view, we integrate the beliefs from MATH with the household life cycle constructs—age, marital status, child's age, and income—to predict intention. Finally, in keeping with previous models of adoption, we include the influence of workplace referents as an additional social influence, not previously included in the model. The inclusion of this factor stems from the potential for peers in the workplace to influence household decisions because peers are important referents similar to friends and family.

In the remainder of the section, we develop the theoretical arguments for the model proposed in Figure 1, which integrates MATH's belief structure with the household life cycle variables outlined above. Although we develop specific arguments related to PCs (the technology being studied), we expect that the arguments would apply to household technologies in general. Moreover, recent research has demonstrated that, when faced with *really new products*, consumers make a cognitive connection to the most similar product with which they are familiar (Gregan-Paxton et al. 2002; Moreau et al. 2001). Such a connection is consistent with the anchoring hypothesis where prior experience serves as an anchor to form judgments about new situations (see Venkatesh 2000). Thus, understanding the factors important in PC adoption should aid in anticipating adoption of related new products (i.e., various new technologies).

Attitudinal Beliefs

MATH presents five attitudinal beliefs, grouped into three sets of outcomes: *utilitarian, hedonic,* and *social.* Utilitarian beliefs are most consistent with those found in the workplace and can be divided into beliefs related to *personal use, children,* and *work.* Personal use can include tasks such as food preparation (e.g., automated recipes), bill payment and checkbook balancing, and correspondence (Venkatesh 1996). A focus on household utility is suggestive of a more well-established, responsible household. In households with older, married couples, we would expect

[2]Either the age of the younger female or the younger male is used in the case of same sex couples.

[3]In terms of Table 3, households in which there are multiple adults who are not married or in committed relationships would fall in the "other" category. Likewise, households in which an adult child lives at home would be categorized as "other."

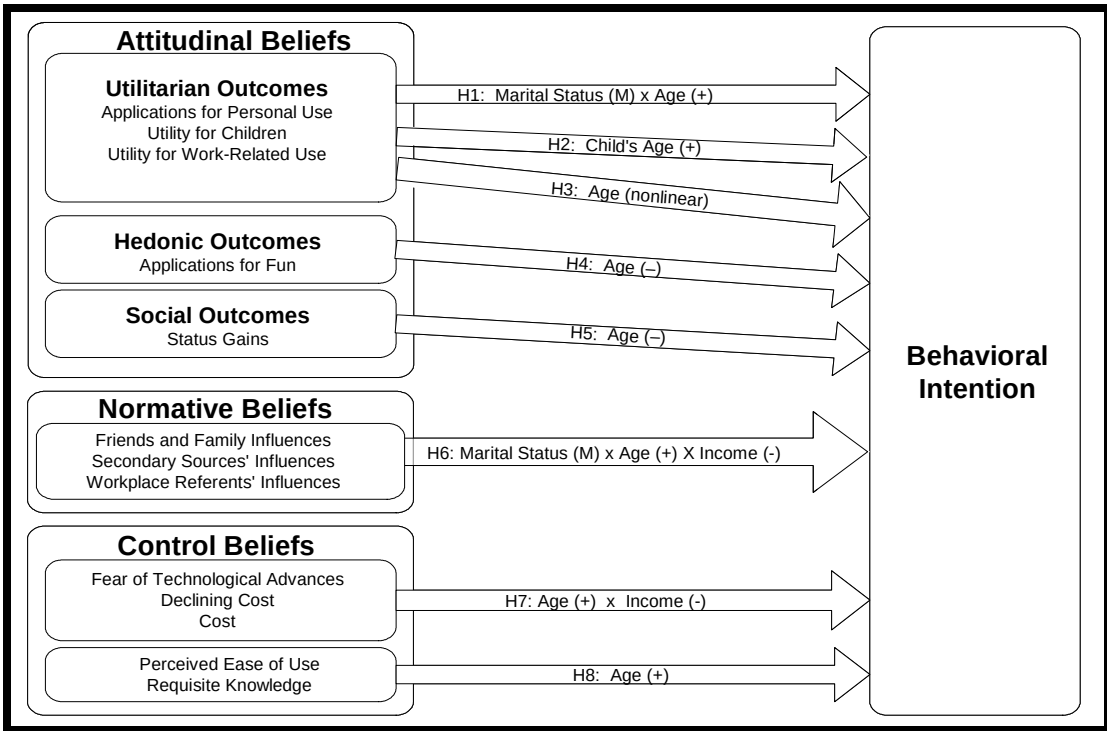

Figure 1. Research Model

to see a greater focus on utility either because of, or in anticipation of, children (Schaninger and Danko 1993; Wells and Gubar 1966). Further, research has shown that age is significantly positively associated with a greater emphasis on utilitarian outcomes, while income is not (Morris and Venkatesh 2000). Thus, we expect that applications for personal use will interact with marital status and age to impact household adoption of PCs.

H1: Marital status and age will moderate the relationship between applications for personal use and intention to adopt a PC for household use, such that applications for personal use increases in importance as age increases, particularly for those households in which there are married couples.

Children's needs differ from those of adults and will likely change as children age. For products that are important to them and about which they have knowledge, children can exert significant influence on the purchase decision (Foxman et al. 1989). Further, the child's age is positively correlated with the degree of influence. Parents tend to refuse the requests of younger children while involving older children in purchase decisions and more often granting their requests (Atkin 1978; Mangleburg 1990; Nelson 1978; Ward and Wackman 1972). Likewise, as children enter school and progress through their education, their needs change. Thus, we expect that utility for children will interact with the child's age to impact household adoption of PCs.

H2: Child's age will moderate the relationship between utility for children and intention to adopt a PC for household use, such that utility for children increases in importance as the child's age increases.

In general, as people age their position in the organization tends to rise (Schaninger and Danko

1993; Wells and Gubar 1966). A by-product of the rising organizational position is increased e-mail use (Rice and Shook 1988). Increasingly, these tasks are performed at home (Feldman and Gainey 1997; Morrow 1999; Venkatesh and Vitalari 1992). Just as work-related computer use at home increases with rising organizational position, it will decline appreciably or become non-significant as one reaches retirement. Thus, we expect that utility for work-related use will interact with age to impact household adoption of PCs.

H3: Age will moderate the relationship between utility for work-related use and intention to adopt a PC for household use, such that utility for work-related use increases in importance until retirement age, at which point utility for work-related use is no longer relevant.

Beyond utilitarian applications, household PC use could be for *hedonic purposes*. The role of fun has received some attention in the technology adoption literature via constructs such as enjoyment (Davis et al. 1992; Venkatesh 2000) and playfulness (Webster and Martocchio 1992). Although in workplace settings the role of fun has been downplayed, applications for fun (hedonic outcomes) have been shown to be particularly relevant in the context of household PC adoption (e.g., Malone 1981; Venkatesh and Brown 2001). Age is expected to moderate this relationship given the evidence that younger people tend to be likely to use technology as an end in itself (Assael 1981; Brancheau and Wetherbe 1990) when compared to older people who evaluate utility more closely (Morris and Venkatesh 2000). Using technology for its own sake is an indication that an individual is intrinsically motivated to use the technology (Davis et al. 1992). The tendency to use technology for its own sake ties closely to the affective components that are the essence of enjoyment and fun.

H4: Age will moderate the relationship between applications for fun and intention to adopt a PC for household use, such that applications for fun decreases in importance as age increases.

While results have been mixed, earlier adopters are generally younger than later adopters. (e.g., Brancheau and Wetherbe 1990; Rogers 1995). According to Rogers (1995), innovators are more strongly influenced by *status outcomes* than later adopters. The statistics on household adoption indicate that 40 to 50 percent of households have adopted (Kraut et al. 1998). With the focus in this study on those who have not yet adopted, we examine households in the late majority and late adopter categories. Thus, we would expect to see little relationship between age and status gains, and what we do see can be expected to decline as age increases.

H5: Age will moderate the relationship between status gains and intention to adopt a PC for household use, such that status gains decreases in importance as age increases.

Normative Beliefs

Our extension of MATH presents three normative beliefs: *influence of friends and family*, *secondary sources*, and *workplace referents*. Childers and Rao (1992) suggest that socially proximal referents are important for the consumption of luxury goods. Since luxury goods are those not commonly owned or necessary (Childers and Rao 1992), and only about half of the households in the United States own a PC (Venkatesh and Brown 2001), we classify PCs as luxuries. Thus, influence of friends and family members should be important in PC adoption. Secondary sources are thought to play a role throughout the adoption and diffusion process (Rogers 1995). However, the influence of mass media on adoption occurs early in the innovation-decision process. Therefore, secondary sources will be more significant for those who are early in their decision-making process (i.e., those who have not yet made the decision to purchase a PC). In terms of the life cycle variables, age, marital status, and child's age will each moderate the impact of social referents on intention to purchase a PC for home use. Specifically, because older people have greater affiliation needs (Rhodes 1983), they are more

likely to conform to others' views (Hall and Mansfield 1975; Porter 1963). This indicates that social influences would be more important for older people. These influences may be further moderated by marital status (Hultsman and Black 1989). Married people are more likely to visit with friends and relatives (Szinovacz 1992), rely on family more than singles do (Connidis and McMullin 1994), and experience more pressure to "be like the Joneses." Thus, marital status should accentuate the influence of others in adoption decisions (McConocha et al. 1993). However, income levels may attenuate these effects. Higher income groups experience less of an influence of others due to the limited financial consequences of any purchase (McConocha et al. 1993). Finally, the influence of others is especially important when there are children, particularly for single parents who experience intense time pressures (Beatty and Talpade 1994). In sum, as age increases, the influence of others will become more important, but this will be moderated by marital status and income. Specifically, we expect married people are most likely to be influenced by others and this will be more pronounced for those with a lower income.

H6: Age, marital status, and income will moderate the relationship between the normative beliefs (i.e., friends and family, secondary sources, and workplace referents) and intention to adopt a PC for household use, such that normative beliefs increase in importance with increasing age and decreasing income, particularly for those who are married.

Control Beliefs

Control beliefs are represented in MATH by five factors: *fear of technological advances*, *declining cost, cost, perceived ease of use,* and *requisite knowledge.* Control beliefs include external and internal factors, depending on whether they are constraints tied to the environment or cognitive ability/effort (Venkatesh 2000). The first three factors (fear of technological advances, declining cost, cost) are external, and the latter two (perceived ease of use and requisite knowledge) are internal. The external constraints reflect the reactions to technology change and cost characteristics and are, in essence, characteristics of the PC and its environment. It is important to note that declining costs can be viewed as a facilitating condition or a constraining condition. In this case, and consistent with MATH, we treat declining costs as a constraint on adoption. Overall, we would expect lower income households to be more sensitive to these cost-related issues due to their price sensitivity and overall price/deal consciousness (Vakratsas 1998). Age also plays a role, as older people are more sensitive to issues of obsolescence due to heightened price sensitivity as they approach retirement. Once again, it is likely that there is a nonlinear relationship, such that fear of technological advances, declining cost, and cost will be less important as age increases, until retirement approaches. This is quite likely due to the associated increase and leveling-off of income over time. Thus, we argue that the first three control factors are influential based on an interaction of age and income, such that their importance is highest for older people with lower income.

H7: Age and income will moderate the relationship between the external control beliefs (i.e., fear of technological advances, declining cost, and cost) and intention to adopt a PC for household use, such that external control beliefs increase in importance as age increases and income decreases.

As noted earlier, perceived ease of use and requisite knowledge are internal factors. Consistent with MATH (Venkatesh and Brown 2001), perceived ease of use and requisite knowledge reflect perceptions of the individual's relationship with the technology: Is it easy to use and do they know enough to use it? The effects of perceived ease of use and requisite knowledge on intention are expected to be moderated by age alone. While income may appear to be relevant as increased income is often associated with higher education, there is empirical evidence to suggest that after controlling for age, income does not influence technology use decisions (see Morris

and Venkatesh 2000). The theoretical rationale for the increasing importance of perceived ease of use and requisite knowledge with age is related to the difficulty of processing visual cues (Kline and Schieber 1982) and functioning in complex information environments (Plude and Hoyer 1985). We argue that the last two control beliefs will be moderated by age alone.

H8: Age will moderate the relationship between the internal control beliefs (i.e., perceived ease of use and requisite knowledge) and intention to adopt a PC for household use, such that internal control beliefs increase in importance as age increases.

Method

The study was designed to gather information regarding PC adoption decisions in American households. A second wave of data was gathered about purchase behavior 6 months after the initial survey. Our focus in this paper is on individuals who do not yet own a PC. We conducted a nationwide survey with the assistance of a market research firm and an electronics retail store. In this section, we describe the participants, their selection, the instrument development and validation, and the data collection process.

Participants

There are different approaches to studying household decisions: one of the common approaches is to rely on the opinions of the head of household (i.e., primary decision maker) to understand household-level decisions (e.g., Wagner and Hanna 1983). Such an approach is more pragmatic when compared to approaches that study all members of the household. Further, it is consistent with a role-based view of family decision making in which individuals in a household take on different roles. These roles can be classified into gatekeepers, influencers, decision makers, buyers, and consumers (Engel et al. 1990). Gatekeepers initiate the decision-making process, while the household seeks the opinions of the influencers. The decision maker is the person responsible for actually making the decision and the person paying for the product is the buyer. The consumers are the household members who use the product. The primary decision maker typically makes the "decision," but it is not done in a vacuum; rather, the decision is implicitly or explicitly influenced by other members of the household (Lackman and Lanasa 1993). Based on this view, we chose to survey the primary decision maker, under the assumption that the decision maker's responses represent input from the gatekeepers, influencers, buyers, and consumers in the household.

A market research firm provided a random list of 5,400 households by drawing from their database of residential addresses, including resident names. As an incentive to increase response rate, a $5 gift certificate to the sponsoring retail chain was offered to all respondents completing the survey. In addition, a lottery grand prize of a $500 gift certificate was offered. A total of 1,247 usable responses were received over an 8-week period, resulting in a response rate of just over 24 percent. Of these 1,247 households, 746 did not possess a PC at the time of the survey—i.e., the potential adopters—and constituted the sample for this study. Of these 746 participants, 610 participated in the follow-up survey conducted 6 months after the initial survey.

Instrument Development

The dependent variable of intention has been employed extensively in previous technology adoption research (e.g., Davis et al. 1989; Taylor and Todd 1995). In order to measure the constructs in MATH, a combination of existing and new scales was used. The specific measures are shown in Appendix A. Each of the beliefs under utilitarian outcomes was measured using three-item scales that were developed and validated as part of this research. Hedonic outcomes, specifically applications for fun, were measured con-

sistent with perceived enjoyment or intrinsic motivation in previous research (Davis et al. 1992; Venkatesh and Speier 1999, 2000) but with a new scale developed to focus on applications for fun. Social outcomes were measured using the image items from innovation diffusion theory (e.g., Agarwal and Prasad 1998; Moore and Benbasat 1991). The normative belief structure was measured using items adapted from Taylor and Todd (1995) who described items to measure peer influence and superior's influence in the workplace; the current work measured social influences from friends and family, secondary sources (e.g., newspapers), and workplace referents. The control belief structure included two beliefs with scales from previous research—i.e., perceived ease of use (Davis 1989; Davis et al. 1989; Venkatesh and Davis 1996)—and requisite knowledge for PC use or self-efficacy (Taylor and Todd 1995). New scales were developed to measure the other three underlying beliefs: fear of technological advances, declining cost, and cost. In adapting items, we made every attempt to maintain equivalence with the original construct definition. The demographic characteristics were measured consistent with the U.S. Census Bureau measurement. In order to measure follow-up purchase behavior, a simple yes or no question was used along with a question about the date of purchase.

Instrument Validation and Pilot Study

Although some of the scales were validated in prior studies, none of them had been previously applied in the context of household adoption. Further, new scales were developed to measure some constructs. The survey instrument was evaluated by peers, a panel of managers at the market research firm, and a panel at the sponsoring retail store. These reviews assessed face and content validity (see Straub 1989). As a result, changes were made to reword items and, in some cases, to drop items that were possibly ambiguous, consistent with DeVellis's (2003) recommendations for scale development.

Four focus groups were then conducted with eight heads of household in each group to evaluate the instrument and provide feedback. Once again, minor wording changes were made. Subsequent to this, a pilot study was conducted with 36 heads of household. Participants in the pilot study were residents proximal to one of the locations of the electronic retail store. They completed the survey instrument and received a $10 gift certificate. On average, respondents took about 15 minutes to complete the survey. Although the sample size in the pilot study was small, the reliability and validity of the scales were assessed and found to be within acceptable ranges, thus giving us some confidence that we could proceed with the large-scale data collection.

Data Collection Procedure

Questionnaires were mailed to 5,400 U.S. households in late 1999 and early 2000. Each questionnaire included a cover letter from the sponsoring retail store. Respondents were assured of confidentiality of their responses. In addition to the incentives discussed earlier, prepaid return envelopes were provided to further increase response rate. Consistent with estimates regarding the extent of diffusion of PCs to homes (e.g., Kraut et al. 1998; Newburger 2001), we found that about 40 percent of all households (501 out of 1,247) participating in this study possessed a PC. Given the focus of this research on future adoption, the data used here were from 746 households without a PC. During the first 2 weeks of the mailing, 194 responses were received. A reminder postcard was sent after the initial 2-week period; 210 responses were received in the second 2-week period. After the first 4 weeks had elapsed, another copy of the survey was mailed to non-respondents; 174 responses were received in weeks 5 and 6. Finally, a second reminder postcard was sent after 6 weeks; 168 responses were received in the last 2 weeks. A total of 13 (eight without a PC) responses were received in 4 weeks after the data collection window of 8 weeks concluded—these 13 responses were not included

in the study. The data were entered, verified, and random checks were conducted to ensure data accuracy.

About 6 months after the initial survey, a follow-up survey was conducted asking about PC purchases over the past 6 months. This allowed us to examine the predictive validity of the various models by using not only intention but also actual purchase behavior. The follow-up data were gathered over a 4-week period using various approaches to contact the respondents. Mail, e-mail, and phone surveys were sent out to gather the data using two simple questions: (1) whether or not a household PC was purchased in the past 6 months, and (2) the specific date of purchase. The survey was kept short to ensure the highest response rate possible. The question about the date of purchase helped ensure that the purchase could be tracked to exactly 6 months after the initial survey, allowing comparison across the data from individuals who responded to surveys at different times. A total of 610 responses were received for the follow-up survey.

Results

Preliminary Analysis

Our response rate of approximately one-quarter of the target sample may raise concerns about possible response bias. To evaluate this possibility, we conducted two sets of analysis. We first examined how well the sample represented the population of American households, consistent with the analysis conducted in Venkatesh and Brown (2001). The results confirmed that the sample was representative of the U.S. population in terms of family status, gender, racial background, age, nativity, region, residence, and household income. The second assessment was to examine early and late survey respondents for systematic differences. We compared the data from the last 2 weeks with that of the first 6 weeks. In addition, we examined differences across the groups of data in 2-week increments. There were no significant mean or correlation differences in the important variables across the groups. These results, combined with the representativeness of the sample, provide reasonable evidence that response bias was not an issue.

PLS-Graph Version 2.91.03.04 was used to analyze the data. Table 3 presents the descriptive statistics for the measures, the internal consistency reliabilities (ICR), the AVEs and the correlation matrix for all constructs in the study. All ICRs were .75 or greater, thus supporting reliability. We tested the baseline specification of MATH. We examined the measurement model in each of the cases. The factor loadings in all cases were greater than .65 and cross-loadings were .35 or lower. Further, the AVEs for each construct were greater than the inter-construct correlations. This pattern supported convergent and discriminant validity. The loadings and cross-loadings for the items are presented in Appendix B.

Structural Model Results

Table 4 presents results related to baseline MATH that explained 50 percent of the variance in intention. Our expectations regarding the categories of constructs and specific constructs received support. In Table 4, we also report the results of the extended MATH test. Within the attitudinal beliefs, two out of the three constructs related to utility were significant and the construct related to fun was significant. Within normative beliefs, status gains was not significant, quite likely due to shared variance with the three social influence constructs in the model. Within control beliefs, four of the five constructs were significant. Although requisite knowledge (tied to self-efficacy) was not significant, the result was likely due to the presence of perceived ease of use also as a predictor in the model. Previous research has shown self-efficacy to be a determinant of ease of use and the effect of self-efficacy self-efficacy on intention to be fully mediated by ease of use (see Venkatesh 2000).

Table 3. Internal Consistency Reliabilities, Descriptive Statistics, and Correlation Matrix

		ICR	M	SD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	Applications for personal use	.81	3.57	0.98	.89																	
2	Utility for children	.80	3.98	1.02	.31***	.85																
3	Utility for work-related use	.79	4.10	0.88	.41***	.22**	.84															
4	Applications for fun	.85	4.01	1.02	.22**	.36***	.22**	.90														
5	Status gains	.81	4.23	0.88	.08	.06	.10	.11	.80													
6	Friends and family influences	.80	3.57	0.96	.22**	.30***	.20*	.22*	.11	.80												
7	Secondary sources' influences	.75	3.99	0.74	.20**	.31***	.10	.03	.09	.29**	.87											
8	Workplace referents' influences	.75	3.45	0.59	.08	.16*	.18*	.19*	.26***	.69***	.36***	.77										
9	Fear of technological advances	.80	5.18	0.86	.07	-.20*	-.17*	.10	-.20**	.06	.13	-.23**	.80									
10	Declining cost	.82	4.87	0.80	.06	.10	.03	.06	.09	.02	.06	.09	.40***	.75								
11	Cost	.80	4.91	0.66	.06	.06	-.16*	.05	.09	.06	.09	.12	.23***	.39***	.83							
12	Perceived ease of use	.90	2.87	0.82	.19**	.02	.16*	.19*	.10	.02	.09	.08	-.19*	.07	.14	.90						
13	Self-efficacy	.82	3.98	0.65	.18*	.06	.10	.12	.07	.16*	.07	.17*	-.20*	.08	.12	.31***	.82					
14	Age	NA	NA	NA	-.28***	.28***	.25***	-.22**	.17*	.19*	.21**	.25***	.32***	.16*	.19*	-.26***	-.22***	NA				
15	Marital status	NA	39.40	8.19	.22**	.28***	.17*	-.19*	.19*	.17*	.20**	-.22**	.28***	.15*	.18*	.21**	-.21**	.31***	NA			
16	Child age	NA	11.20	3.71	.17*	.30***	.15*	.17*	.21**	.17*	.17*	-.25***	.20**	.21**	.20**	.22***	.15*	.35***	.40***	NA		
17	Income	NA	39137	8177	.22**	.19*	.28***	.15**	.25***	.12	.17*	.21**	-.25***	-.26***	-.27***	.17*	.22***	.41***	.28***	.20**	NA	
18	Intention	.90	4.01	1.01	.27***	.25***	.23**	.20**	.19*	.19*	.20**	.19**	-.36***	.19*	.22**	.24***	.23**	.18**	-.15*	.22***	.19*	.89

Notes: 1. *** $p < .001$; ** $p < .01$; * $p < .05$; NA: Not Applicable

2. The average variance extracted (AVE) between the construct measures is shown on the diagonal. For discriminant validity, the diagonal elements should be greater than the correlations (off-diagonal elements).

3. ICR: Internal Consistency Reliability; M: Mean; SD: Standard Deviation

Moderated MATH

The results of the structural model test are also shown in Table 4 (additional information regarding the coding of demographic variables is shown in the notes of Table 4). The interaction terms were modeled per the guidelines provided in Chin et al. (2003). It is clear that the integration of household life cycle variables improves the explanatory power of MATH. First, note that, as suggested by H1, the A1–intention[4] relationship was moderated by marital status and age such that it was increasingly significant with age, and even more so for those who were married. H2 was supported with child age moderating the A2–intention relationship. As suggested by H3, the A3–intention relationship was moderated by age such that there was a nonlinear relationship. In this case, we plotted the data to observe the pattern of the A3–intention relationship with age. We found that the A3–intention relationship was stronger at lower levels of age and the relationship became weaker at higher levels of age, thus indicative of a negative quadratic (inverted-U) pattern. The A4–intention relationship was moderated by age such that as age increased, A4 became less important, thus supporting H4. While as suggested by H5, age moderated the A5–intention relationship, the direction was opposite to that predicted: the observed relationship was such that the influence of status gains on intention increased with age.

H6 predicted that the effects of SN1, SN2, and SN3 on intention would be moderated by age, income, and marital status. The four-way interaction terms with SN1 and SN2 as predictors were significant. However, none of the terms associated with SN3 were significant. Thus, H6 was partially supported. H7 predicted that the effects of PBC1, PBC2, and PBC3 on intention would be moderated by age and income. PBC1 and PBC2 were moderated both by age and income such that the relationship was stronger for lower income households with increasing age. While PBC3 was moderated by age and income, unlike PBC1 and PBC2, only the two-way interaction terms were significant and the three-way interaction term was nonsignificant. Thus, H7 was supported. H8 predicted that the effects of PBC4 and PBC5 on intention would be moderated by age. The predicted pattern was supported, with the effects increasing with age.

Predicting Purchase Behavior

As noted earlier, 610 participants provided responses to the questions about follow-up purchase behavior. However, 746 responses were received for the initial survey. Testing the model including use as the dependent variable would limit the sample size to 610. In order to limit the loss of sample size, we examined the correlation between intention and behavior, thus retaining the sample size of 746 for the model testing. Since intention is the *only* predictor of use, using this approach would not impact any of the relationships that employ intention as the dependent variable. Further, the correlation of the intention–behavior relationship will, in fact, be the beta coefficient of the relationship since there is only one predictor of behavior. We found that the correlation between intention and behavior was. 61. Intention and its determinants are predictive of purchase behavior of household technology. This result underscores the importance of the effective prediction of intention.

From Statistical Significance to Practical Significance

To further validate the results shown in Table 5, relate the results to the life cycle stages, and emphasize *practical significance*, we conducted additional analyses by life cycle stage. The data were broken down into the various life cycle stages based on the three key household life cycle stage variables of age, marital status, and child's age. While the categorization into most stages follows directly from Table 2, as noted earlier, the "other" category was populated with households that did not fit any other category (e.g., households with

[4]The abbreviations used in this section are defined in Table 5.

Table 4. Predicting Intention: Results of Model Testing

	Model I	Model 2		MATH	MATH + HLC
	MATH	**MATH + HLC**	SN2 × Age		**.16***
Adjusted-R^2	.50	.74	SN2 × MaritalStatus		**.15***
A1: Applications for personal use	**.28*****	.02	SN2 × Income		**–.16***
A2: Utility for children	ns	**.14***	Age × Income		Listed earlier
A3: Utility for work-related use	**.21****	.07	Age × MaritalStatus		Listed earlier
A4: Applications for fun	**.17***	.02	Income × MaritalStatus		Listed earlier
A5: Status gains	ns	.04	SN2 × Age × MaritalStatus		.07
SN1: Friends and family influences	**.17***	.06	SN2 × MaritalStatus × Income		.03
SN2: Secondary sources' influences	**.17***	**.19***	**SN2 × Age × Income**		**–.12**
SN3: Workplace referents' influences	ns	.09	Age × Marital Status × Income		Listed earlier
PBC1: Fear of technological advances	**–.22****	**–.16***	SN2 × Age × MaritalStatus × Income		**–.17***
PBC2: Declining cost	**.15***	.07	SN3 × Age		Ns—removed
PBC3: Cost	**–.16***	.02	SN3 × MaritalStatus		Ns—removed
PBC4: Perceived ease of use	**.16***	.07	SN3 × Income		Ns—removed
PBC5: Requisite knowledge	ns	.01	Age × MaritalStatus		Listed earlier
Age		.01	Age × Income		Listed earlier
Marital Status		.02	Income × MaritalStatus		Listed earlier
Child Age		.04	SN3 × Age × MaritalStatus		Ns—removed
Income		.00	SN3 × Age × Income		Ns—removed
A1 × Age		.03	SN3 × MaritalStatus × Income		Ns—removed
A1 × MaritalStatus		.04	Age × Marital Status × Income		Listed earlier
Age × MaritalStatus		.01	SN3 × Age × MaritalStatus × Income		Ns—removed
A1 × Age × MaritalStatus		**.24****	PBC1 × Age		**.16***
A2 × ChildAge		**.16***	PBC1 × Income		**–.15***
Age × Age		**.06**	Age × Income		Listed earlier
A3 × Age × Age		**–.23***	PBC1 × Age × Income		**–.19***
Age × Age		.06	PBC2 × Age		.12
A3 × Age × Age		**–.23***	PBC2 × Income		.09
A4 × Age		**–.15***	Age × Income		Listed earlier
A5 × Age		**.18***	PBC2 × Age × Income		**–.20****
SN1 × Age		.02	PBC3 × Age		**.22****
SN1 × MaritalStatus		.04	PBC3 × Income		**–.17***
SN1 × Income		.08	Age × Income		Listed earlier
Age × Income		.02	PBC3 × Age × Income		Ns—removed
Income × MaritalStatus		.04	PBC4 × Age		**.15***
Age × MaritalStatus		Listed earlier	PBC5 × Age		**.16***
SN1 × Age × Income		**–.20****			
SN1 × MaritalStatus × Income		.13			
SN1 × Age × MaritalStatus		**.16***			
Age × Marital Status × Income		.02			
SN1 × Age × MaritalStatus × Income		**–.15***			

Notes:
1. Age was coded as a continuous variable. Marital status was coded as number of adults in the household; this reflects modern households of two adults living together even though they are not married and same sex couples. This coding is consistent with the conceptualization of Gilly and Enis (1982). Child age is coded as a continuous variable to reflect the age of the youngest child. Income is a continuous variable reflecting gross income.
2. Life cycle stage is coded as an ordinal variable from 1 to 11.
3. ***$p < .001$; **$p < .01$; *$p < .05$.
4. Shaded areas are not applicable.

Table 5. MATH by Life Cycle Stages: Model Tests

	S1: Bachelor I & Bachelor II	S2: Newlywed	S3: Single Parent	S4: Full Nest I & Delayed Full Nest	S5: Full Nest II & Full Nest III	S6: Childless Couple	S7: Older Couple & Bachelor III
N	131	99	89	125	96	86	120
R^2	.32	.35	.48	.48	.54	.46	.48
Income	.02	.04	.01	.07	.01	.02	.04
A1: Applications for personal use	.09	.17*	.03	.14*	.17**	.19**	.17*
A2: Utility for children	.00	.13*	.17*	.14*	.11*	.02	.01
A3: Utility for work-related use	.13*	.02	.04	.02	.11*	.21**	.02
A4: Applications for fun	.13*	.04	.02	.14*	.12*	.01	.04
A5: Status gains	.02	.00	.04	.12*	.11*	.06	.04
SN1: Friends and family influences	.01	.01	.04	.02	.01	.01	.04
SN1 × Income	.04	–.18**	.01	–.15*	.08	–.16*	–.20**
SN2: Secondary sources' influences	.02	.04	.01	.01	.02	.02	.00
SN2 × Income	.01	–.19**	–.14*	.02	–.12*	–.15*	–.20***
SN3: Workplace referents' influences	.02	.02	.06	.01	.04	.02	.04
SN3 × Income	.02	.01	–.17*	.01	.04	.02	.02
PBC1: Fear of technological advances (–)	.00	.00	.01	.04	.02	.01	.00
PBC1 × Income	.04	.02	–.17*	–.14*	–.12*	.04	–.17**
PBC2: Declining cost (–)	.03	.06	.05	.01	.01	.02	.01
PBC2 × Income	–.15*	.04	–.14*	–.12*	.07	.02	.01
PBC3: Cost (–)	.04	.02	.02	.06	.01	.00	.02
PBC3 × Income	.06	.00	–.14*	–.16*	–.16*	.04	.01
PBC4: Perceived ease of use	.17*	.04	.02	.01	.12*	.17**	.19**
PBC5: Requisite knowledge	.09	.02	.01	.01	.06	.17**	.18**

Note: ***p < .001; **p < .01; *p < .05

adult children) and those households were excluded from this analysis. Consistent with prior studies, some stages were collapsed, as shown in Table 5, given our sample size was not sufficiently large in all stages. The collapsing of stages has been theoretically justified when based upon similarities in consumption patterns (such as across Full Nest II and III) and has been successfully employed in marketing research, particularly when sample size is an issue (see Danko and Schaninger 1990; Reilly et al. 1984; Schaninger and Danko 1993). Finally, we incorporate income as a moderator when applicable per our theory (hypotheses).

In terms of attitudinal beliefs, applications for personal use were significant for nearly all life cycle stages, increased in importance with age,

and when there were two adults in the household. Not surprisingly, utility for the children was relevant for the stages in which there were children, and increased in importance with the child age—stronger beta for Full Nest II and III compared to Full Nest I and Delayed Full Nest. Work-related use was more important for those stages where there was greater or returning emphasis on career; it increased with age and then declined again. The importance of hedonic outcomes decreased with age. Consistent with what we observed in Table 4, we noted that status was more significant at a few later stages, contrary to what was predicted. Interestingly, in this analysis, only the full nesters found it to be significant, suggesting a possible moderation by the presence/age of children as well.

Age and number of adults in the household moderated the effect of normative beliefs on purchase intention. At each stage where normative beliefs were important, with increasing income, others' opinions were less influential, perhaps due to the reduced financial burden of the purchase. Income played a further moderating role on the effects of the influences of friends and family and the influences of secondary sources at several stages, confirming our earlier finding (Table 4) that as income increased, the effect of normative influences reduced. Workplace referents were not influential except in the case of single parents; however, it is quite possible that the important workplace referents were mostly subsumed in friends and family, supported by a correlation of .69.

In general, control beliefs increased in importance later in the life cycle, or in the early stages where income is an issue. Fear of technological advances and the cost-related factors increased in importance with age, and tended to become more salient in the later stages (except for Bachelor II, possibly due to limited family responsibilities), quite possibly due to the greater emphasis on more careful spending in later stages of life. The effects of fear of technological change, declining cost, and cost were moderated by income in most of the life cycle stages where the effects were significant such that the constructs were less influential when the income was higher. The effects of perceived ease of use and requisite knowledge for PC use were quite similar with the effect being more important in the later stages.

Discussion

The present research conducted the first quantitative empirical test of MATH by developing a survey instrument that included new scales that were developed in this research. Through the integration of MATH with a household life cycle model (incorporating life cycle stage characteristics and income), this research resulted in a powerful model of household technology adoption that accounted for 74 percent of the variance in intention to adopt a PC, compared to 50 percent for the baseline MATH.

The results demonstrated that the influence of attitudinal beliefs varies by life cycle stage. Further, income interacts with the normative and control beliefs within life cycle stage. Thus, research in household adoption of PCs and other innovative technologies for the household will need to account for life cycle factors. Contrary to popular belief, income, although influential, is not the sole driver of non-adoption. This study provides empirical evidence for the inclusion of one quadratic effect. Future research should examine the possibility of additional quadratic, or even cubic, relationships. This study provided clear evidence that household PC adoption, like household decision making in general, is a complex phenomenon.

The presence/age of children in the household elevated utility for children to a significant position in the integrated model. MATH suggested that utility for children was a significant factor (see Venkatesh and Brown 2001); our empirical test of MATH demonstrated that it was not significant. However, it was significant when the life cycle factors were integrated with MATH. This finding is of particular significance given that 4- to 12-year-olds influence purchases in excess of $130 billion annually (Power 1991), while adolescents influence $200 billion to $300 billion in purchases

(Johnson and Lino 2000; Wood 2001). The greatest influence is for products they will consume (Jenkins 1979; Mangelburg 1990) and for which they have the most product-related knowledge (Belch et al. 1985; Spiro 1983); it is likely that the present generation of children is quite knowledgeable about PCs (Kiesler et al. 2000). This finding does raise important questions for future research in understanding household behaviors in an increasingly technology-centric society: What is the relationship among household member technology knowledge and PC adoption decisions? How do children influence the PC adoption decision? Will these influence patterns transfer to newer technologies for the home?

Limitations

As with any empirical field study, this work has limitations. The primary limitation is the reliance on a single informant. It is possible that other members of the household would have provided different responses regarding the motivations to adopt (or not) a PC for household use. Future research in household adoption of technology should incorporate responses from multiple members of the household to truly assess the nature of household adoption. A focus on the primary decision maker alone was important in this work due to considerations noted earlier in the paper. If the individual focus was introducing a significant bias, we would expect that MATH, when integrated with the household life cycle, would predict best for smaller households and more poorly for larger households. Instead, our results are exactly the opposite, with the greatest predictive ability for the full nests, thus alleviating the concern and suggesting that the primary decision makers did, indeed, respond with the household in mind. Finally, it is important to note that we have only touched on one aspect of household decision-making. While this study provides support for the use of household life-cycle characteristics in understanding technology adoption, it represents only a small component of household decision-making research. Thus, future research should delve more deeply into the nuances and interactions that occur *during* the household decision-making process, and among household members.

Implications and Directions for Future Research

Several issues for future research emerge from this investigation because, as suggested earlier, different household members will have differential impacts on product purchase decisions (Belch et al. 1985; Jenkins 1979; Mangelburg 1990). This is due, in part, to their role in the household (Qualls 1987), which is based on factors such as age, income earning, and knowledge of the product (Belch et al. 1985; Carlson and Grossbart 1988; Jenkins 1979; Mangelburg 1990; Spiro 1983). Future research should delve more deeply into the characteristics of the household, and household decision-making, that interact to impact technology adoption decisions. While the outcome may be to adopt or not, understanding the process of arriving at that decision will provide greater insight into why later adopters continue to wait. Examining the process will shed light on the relative influence of each member of the household. Such studies will contribute to our understanding beyond Rogers' (1995) work and current developments in household technology adoption research. For example, Sherman and Delener (1987) found that children actually had a significant influence early in decision-making processes, as initiators. However, when research focuses on the outcome (i.e., adoption), that influence is often overlooked. Three decades ago, Davis and Rigaux (1974) found an interaction between the decision-making process and the relative influence exerted by husbands and wives. Their results suggested that different processes were associated with different influence patterns. Research in this area will require longitudinal, multiple-respondent surveys and interviews. Transcripts of decision-making processes would provide depth of understanding into how the process unfolds; key informant studies could be equally useful for obtaining a richer picture of household adoption. Finally, we study the first PC adoption decision here; given that there are pre- versus post-adoption decision

differences (e.g., Karahanna et al. 1999), the adoption of the second or third PC may be different from our current findings. Such future work will provide a more complete understanding of how the household technology adoption decision is made, who initiates it, who perpetuates it, and who closes the deal. This work will provide technology firms with insights into design, bundling, and marketing strategies.

A key future research direction would be a comparison of prior technology adoption models (Venkatesh et al. 2003) with the baseline MATH and extended (moderated) MATH. Although Venkatesh et al. (2003) compared eight technology adoption models, the context was that of a workplace. One approach would be to compare constructs from different models through the use of the construct classes. If practical constraints prevent an exhaustive comparison of models, richer models such as the decomposed theory of planned behavior (DTPB; Taylor and Todd 1995) and unified theory of acceptance and use of technology (UTAUT; Venkatesh et al. 2003) should be compared to MATH. Specifically, an examination of the performance of the technology acceptance model (TAM; Davis et al. 1989) in the household setting would be worthwhile, since as of early 2004, there were well over 1,000 citations to the two articles that introduced TAM. Further, the differences in context are likely to play an even more significant role in TAM, due to its emphasis on utility. In sum, the rationale for the differential roles played by the different constructs in the context of households when compared to previous contexts represents an important future research direction.

While other, future household technologies will have similarities with PC adoption, there will also be differences. This, combined with the importance of conceptualizing about various aspects of the technology in question, suggests that it is important to examine the generalizability of these results to other household technology-oriented decisions such as the purchase of mobile phones, Internet appliances, and network entertainment centers that have not diffused to the same extent as PCs. Given where they are on the diffusion curve, the newer technologies are particularly well-suited for longitudinal studies that follow a technology through the diffusion curve, within household life cycle stages, thus allowing a variety of factors to be examined simultaneously. In addition to the life cycle stages, research might incorporate Rogers' adopter categories as a means of more thoroughly refining the model (see also Brown and Venkatesh 2003). In fact, the decomposition of life cycle stages into the underlying factors of age, marital status, and child's age and the integration with income presents an important basis for future work studying household technologies.

Understanding the nature of PC adoption may shed light on the process of Internet adoption. However, the Internet as an application poses some interesting issues. Consider that the Internet can be used for information gathering, entertainment, and communication (Kraut et al. 1998), as well as commerce, each of which can be characterized in utilitarian and hedonic terms. Life cycle factors are likely to be tightly linked with the attitudinal beliefs associated with the Internet. For example, in the life cycle stages of Bachelor I and II, Full Nest III, and Childless Couple, with the emphasis on work-related use, the communication and information gathering components of the Internet may be perceived as utilitarian. On the other hand, Full Nest I and II, and Delayed Full Nest, for whom applications for fun is a significant determinant of adoption, may obtain Internet access in order to reap hedonic benefits. It is also possible that the roles of different beliefs regarding the Internet may evolve and change over time. For instance, as the multimedia capabilities of home PCs improve, communication may become richer and more enjoyable, thus increasing a PC's potential hedonic value. Future research should examine such possible changes in the belief structures over time.

The current work is particularly relevant for explaining business-to-consumer e-commerce adoption as PC adoption is a necessary, although not sufficient, condition for e-commerce adoption (Hoffman et al. 1996). Given that no overarching framework exists to explain Internet user behavior

in B2C contexts, the model tested in the current work may serve as a generalizable model from which models of software and Internet application adoption in households can be developed. In this context, the role of socio-economic variables can be expected to be quite significant as the U.S. Department of Commerce notes that the Internet population has already reached an equal split in terms of gender and is moving toward parity with the population in terms of age, income, and race. Further, as discussed at the outset, those currently without a PC are important to understand since they are more conservative compared to earlier adopters, especially as we have reached the stage in the adoption cycle where diffusion is slow (see Moore 1999; Rogers 1995). An interesting issue regarding B2C e-commerce adoption is the relative importance of applications for home use (i.e., utilitarian outcomes) and applications for fun (i.e., hedonic outcomes). While some people see shopping as a means to an end, others derive great pleasure from it (Babin et al. 1994). However, those who derive pleasure are often influenced by the immediacy of the shopping experience, such as the integration of the sights, sounds, and action of the event (Fischer and Arnold 1990). Thus, it is likely that those who derive pleasure from the traditional shopping experience will not derive pleasure from the e-shopping experience, unless some of the hedonic aspects can be replicated in this environment. Future research can use the notion of utilitarian and hedonic beliefs developed in MATH and supported here to obtain a greater understanding of e-commerce adoption.

Contributions to Practice

Norman (1998) suggests that when products are designed for later adopters, three factors are of significant importance: technology, user experience, and marketing. Technology refers to issues of technical reliability and functionality. The lack of significance of technology facilitating conditions suggests that perceptions of technical reliability and functionality are not significant issues influencing purchase decisions, at least among later adopters when the technology has typically reached "stability." Thus, the technology leg of Norman's three-legged stool appears to be reasonably well-established for the household PC market. User experience and marketing, on the other hand, represent areas in which the stool's foundation requires strengthening. These are the areas in which this work provides insights to practice.

User experience refers to how the product (in this case, a PC) is perceived, used, and learned (Norman 1998). The results of this research indicate that perceptions of ease of use and usefulness influence the purchase of PCs. In addition, self-efficacy is a significant factor, suggesting that designers have not yet conquered the consumer's feelings regarding their ability to use this technology. This will be particularly critical in gaining the favor of later adopters. Together, these results suggest the need for increased user-centered design which incorporates physical, cognitive, and emotional aspects of the user's experience with technology (March 1994). This requires an emphasis on usability, defined by Thomson electronics as products that are "engaging, foster a sense of discovery, and eliminate fear" (March 1994, p. 145). This credo represents an important direction for designers of PC hardware and software.

The marketing leg refers to the expense and presentation of the product. The results of this research suggest that the expense may still be too high, as demonstrated by the significance of resource facilitating conditions. Beyond design issues, this research suggests that marketing initiatives designed to convey lower prices are appropriate to spur PC purchases for those who do not yet own a household PC. Further, potential adopters could benefit from bundling tutorials to help ease self-efficacy issues. Organizations, particularly in the PC industry, stand to benefit from this new knowledge as they plan their marketing strategies to attempt to sell a first PC to current non-adopters. More broadly, these findings may be applicable to other technologies, both hardware and software, in households. Thus, firms in other hardware areas (besides PCs) and the software industry will also benefit from the insights derived from this work.

Conclusions

The present work represents one of the first efforts to systematically understand technology adoption decisions in households. We identify key classes of constructs represented in existing models of technology adoption. We test the recently developed MATH (Venkatesh and Brown 2001) and find support for its superiority in predicting adoption of PCs. We further extend and test a model that was developed in this paper by integrating MATH with household life cycle stages and income. The resulting model presented a significantly richer and more comprehensive understanding of household technology adoption. The present work is expected to serve as a starting point for future scientific investigations of technologies in households, especially as the electronic and mobile commerce revolutions continue to grow. From a practical perspective, organizations designing existing and emerging technologies for households stand to benefit from this new knowledge regarding effective technology design and marketing strategies.

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Appendix A

List of Items

Instructions were provided to the respondents to focus on the adoption of computers at home. Further, these instructions were provided:

> This survey should be completed by the primary decision maker in the household. More specifically, the person who is responsible for making decisions regarding large (in excess of $1000) purchases should complete this survey. We ask that as you respond to the items, you keep in mind the overall household's view. There will necessarily be some areas where the household will disagree and that is where the views of the primary decision maker for large purchases are most valuable.

Construct	Items (Seven-point Likert scales, unless otherwise noted, with 1 = strongly disagree and 7 = strongly agree)
Applications for Personal Use	I find that the computer has tools for personal productivity.
	I find that the computer has tools to support household activities.
	The computer has software that helps with activities in the house.
Utility for Children	The computer provides applications that my kid(s) can use.
	The computer has useful software for my child (or children).
	I find the computer to be a useful tool for my child (or children).
Utility for Work-Related Use	The computer is useful for me to work-at-home.
	The computer provides applications related to my job.
	I am able to work at home more effectively because of software on my computer.
Applications for Fun	The computer provides many applications that are enjoyable.
	I enjoy playing computer games.
	My computer has applications that are fun.
	I am able to use my computer to have fun.
Status Gains	People who use a computer at home have more prestige than those who do not.
	People who use a computer at home have a high profile.
	Using a computer is a status symbol.
Friends and Family Influences	My friends think I should use a computer at home.
	Those in my social circle think I should use a PC at home.
	My family members think I should use a computer at home.
	My relatives think I should use a computer at home.

Construct	Items (Seven-point Likert scales, unless otherwise noted, with 1 = strongly disagree and 7 = strongly agree)
Secondary Sources' Influences	Information from newspapers suggest that I should use a computer at home.
	Information that I gather by watching TV encourages me to use a computer at home.
	Based on what I have heard on the radio, I am encouraged to use a computer at home.
Workplace Referents' Influences	My coworkers think I should use a computer at home.
	My peers at work think I should use a PC at home.
Fear of Technological Advances	The trends in technological advancement are worrisome to me.
	I fear that today's best home PC will be obsolete fairly soon.
	I am worried about the rapid advances in computer technology.
Declining Cost	The cost of PCs are constantly declining.
	I believe the cost of computers will continue to decline in the future.
	I think we will see better computers for a lower price in the near future.
Cost	Computers that are available today are too expensive.
	I think computers are quite pricey.
	I consider a computer to be big-ticket item.
Perceived Ease of Use	My interaction with a computer is clear and understandable.
	Interacting with a computer does not require a lot of my mental effort.
	I find a computer to be easy to use.
	I find it easy to get a computer to do what I want it to do.
Self-Efficacy	I feel comfortable using a computer on my own.
	If I wanted to, I could easily operate a computer on my own.
	I can use a computer even if no one is around to help me.
Behavioral Intention	I intend to adopt a computer at home.
	I predict that I would adopt a computer at home.
	I expect to adopt a computer at home in the near future.

Notes:

[a]These items use "I," "my," and "me." Future use of this instrument should consider using "we," "us," and "our." This is discussed in more detail in the directions for future research.

[b]MATH indicated that "declining cost" was the degree to which the cost is declining *too rapidly*.

[c]MATH used "high cost." We use the term "cost" to be consistent with the work of Rogers (1995).

Appendix B

Loadings and Cross-Loadings

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1: Applications for personal use	.81		.28											
	.83		.24											
	.80		.21											
2: Utility for Children	.24	.77												
	.25	.79												
	.23	.85												
3: Utility for Work-related Use			.81											
		.21	.80											
		.23	.79	.27										
4: Applications for Fun			.29	.73	.28									
	.28	.31	.30	.88	.27									
				.89										
				.93										
5: Status Gains			.21		.88									
	.26	.27	.22		.80									
					.82									
6: Friends and Family Influences						.90	.26	.28						
						.84	.25	.27						
						.79	.22	.24						
						.79	.24	.30						
7: Secondary Sources' Influences						.26	.87	.21						
							.80	.22						
						.25	.82	.21						
8: Workplace Referents' Influences								.77						
								.76						
9: Fear of Technological Advances									.81	.22				
									.70	.23				
									.78					
10: Declining Cost									.32	.71	.28	.30	.28	
									.25	.73	.26	.25	.24	
										.70		.25		
11: Cost											.71			
											.73			
										.24	.77	.26		
12: Perceived Ease of Use												.90		
									.28	.30	.25	.84	.28	
												.82		
												.88		
13: Requisite Knowledge													.86	
											.22	.21	.84	
													.83	
14 Behavioral Intention														.80
														.85
														.88

Notes: Loadings < .20 are not shown