A COMPARATIVE STUDY OF HOME COMPUTER ADOPTION AND USE IN THREE COUNTRIES: U.S., SWEDEN, AND INDIA

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ABSTRACT

Technology adoption research has a long tradition in IS literature, particularly in the work context. Recently, several authors have proposed to extend investigation into the household context. In this study, we have proposed a model of use diffusion as a basis for investigating post-adoption computer usage behavior in three countries. The model was tested with data from a large-scale random sample survey collected in the United States, Sweden, and India. We found that the rate of computer usage and the variety of computer uses in households are influenced significantly by variables that fall into five general categories: attitudinal belief structure, normative belief structure, control belief structure, household makeup structure, and technological structure. When we compare our results across the three countries, the cross-country analyses reveal that, in general, the countries do not differ in the direction of effect for these five factors; rather, the country differences are the orders of magnitude with which these factors influence home computer usage. Implications for the making of policy decisions are presented.

Keywords: Use diffusion, technology adoption, household, usage behavior, cross-cultural study.

ISRL: GB03, BD0401, BD05

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INTRODUCTION

Explaining user acceptance of computing technologies in the work place has been a long-standing issue in Information Systems research (Ginzberg 1981; Davis, Bagozzi and Warshaw 1989; Chau and Hu 2001). In addition to the need to understand what drives system usage behavior, another critical but much overlooked area of investigation is the adoption and use of computers in homes. Home is a place where the *social* and *technology* interact, and, as such, it is an area of MIS research in which further study would be very valuable (Lee 1999).

With the advent of the Internet, in just the last five or six years, the diffusion of information technology (IT) has become a global phenomenon. One current approach to the study of IT diffusion globally is country-level analyses using macro factors, such as national wealth, IT investment, and supporting infrastructures (e.g., Dewan and Kraemer 2000). However, comparative studies at the micro- level have been rare, although some micro-level, country-specific studies are just beginning to appear in the literature (Lombardi 2001; Sloane and van Raiij 2000). Prior research suggests that culture and country differences play key roles in decisions regarding technology investments in organizational settings (Keil et al. 2000). Along the same lines, it would be significant from a theoretical standpoint to see whether different countries at different stages of computer diffusion mirror each other in how computers are used in the home.

In this particular study, we have studied home computer adoption and usage in three countries: the U.S., Sweden and India. One important reason for the study is that the

diffusion of the Internet is a global phenomenon, and the more we learn about it in the global context, the greater our understanding of the phenomenon itself. By selecting these three countries for our study, we are able to get a slice of the global diffusion picture. In many respects, Sweden is comparable to the U.S. in that it has a highly developed industrial base with a relatively long history of computer diffusion and is a leader in certain areas of communication technologies such as cellular phone penetration and wireless communication (Schroeder 2000). India represents a distinctly non-Western culture and, as an emerging information economy, it has become a major global player in the software industry. However, diffusion of the home computer is in an early phase in India (Singhal and Rogers 2001). Including India allows us to see how three countries placed along a diffusion curve.

A major strength of our study is the collection of the same primary data from three countries within the same time frame. In particular, we are in a position to test the leapfrogging effect of technology diffusion that has been proposed recently in technology literature. The leapfrogging theory is offered as an alternative to the conventional evolutionary theory of diffusion. According to the leapfrog theory, under certain social, economic and technological conditions, communities or countries can jump several steps in reaching a higher level of technology production and consumption (Brezis and Tsiddon 1998; Pitroda 1993) and attain parity with countries at the top of the ladder in that particular domain. The development of the software industry in India is an example of the leapfrogging effect. The question in this study, therefore, is whether such an effect exists in the case of home computer diffusion.

To summarize, the primary objectives of this research are to identify factors that

drive computer usage behaviors in the home, to compare and contrast differences in usage behaviors across countries/cultures, and to draw conclusions from a diffusion/adoption perspective.

PRIOR RESEARCH ON ADOPTION OF COMPUTERS

Research in the Information Sciences (IS) field on why organizational users accept or reject information technology has resulted in a theoretical explanatory model called the Technology Acceptance Model (TAM) (Davis et al. 1989). Because most researchers are already familiar with TAM, an extensive review will not be attempted here. We refer to various other studies that have tested TAM in organizational contexts (Briggs et al. 1998/1999; Chau 1996;, Igbaria 1997; De Vreede et al. 1998-1999; Szajna 1996; Straub et al. 1997). Overall, TAM was found to be quite robust in explaining the rate at which people use computer systems in organizational settings.

An extension of the TAM model that has been applied to household adoption of computers was recently developed by Venkatesh and Brown (2001). The Model of Adoption of Technology in Households (MATH) incorporates three factors--attitudinal belief structure, normative belief structure, and social control structure--that jointly predict the likelihood that computers will be adopted/not adopted. Although MATH explains home computer adoption behavior well, an aspect that is not extensively investigated in the model is usage behavior in the home. That is, TAM and its variants explicitly treat adoption as a binary process (adopt or not adopt).

An adoption decision does not mark the completion of diffusion of technologies, however. The gap between adoption and saturation has led some researchers to argue

for an approach that is closer to the *use* diffusion approach that we propose here (Dutton et al. 1985; Kraut et. al 1996; Lindolf 1992; Rogers 1995). They contend, as do we, that more understanding of the nature of computer adoption in the home can be gained by systemically examining usage behaviors.

MODEL OF HOME TECHNOLOGY USE

To investigate home technology use, particularly that of personal computers, a theoretical framework that captures the role technology plays in family life is warranted. Here, we adopted as our starting point the model of household-technology interaction developed by Venkatesh (1996). Under this model, the household consists of activity spaces in which actors within the household (i.e. members of the household) are assumed to participate in specific by performing different tasks.[1] In performing these tasks, they engage in the use of different technologies to facilitate the processes in multiple activity spaces.[2]

<< Insert Figure 1 Here >>

Based on Figure 1, we ask how it is that technologies diffuse across different activity spaces within the household. For technologies such as the personal computer,

[1] By activity spaces, we mean a set of activities performed by household members within a certain social and/or physical confines of the household to achieve a common goal. Examples include entertainment/leisure, household maintenance, family communication, work at home, and food preparation.

[2] The link between activities and computer technologies as enabling agents has recently received much attention (Bannon and Bodker 1991, Nardi 1996, Tikhomirov 1999). Known as "activity theory," the spiritual origins of this approach can be traced to the seminal work of the well known Russian~~n~~ psychologist Vygotsky (1962, 1978), who first deconstructed "human activities" in various contexts as emanating from psychological needs and processes. Activity theory was later combined with Herbert Simon's work (1969) on the "sciences of the artificial," ~~where~~in which human activities could be designed in a computer-based environment to yield maximum efficiency and meaning to their performers. As a natural consequence of these approaches, computers were seen as logical vehicles to meet the needs of individuals in various social contexts (e.g. work life, community life). Our study looks at the activity spaces in ~~the~~ homes (that is, within the family context) in which certain domestic activities are performed. Our work is premised on the strong theoretical link between technology diffusion and activity structures.

use can be limited to one activity space, such as *job-related work at home*, or it can also be appropriated into other activity spaces, such as *leisure/entertainment, family communication,* and *home management*. The role played by technology within the household and the direction in which it develops will determine how successfully the technology is integrated into the household.

Rate of Use and Variety of Use

Use of computing technology in the home can be characterized by both the rate of usage and the variety of ways it is used (Dutton et al. 1985). Rate of usage is simply how often computers are used in the household in a given period of time (day, week, etc.), and it is the most common dependent measure used in TAM studies of workplace adoption of computers.

Variety of uses refers to the different applications for which the computers are used in the home, and these can range from single-purpose usage, such as for many home appliances, to multi-purpose machines that take advantage of their full potential.

Intuitively speaking, one can say that usage rate and variety will be correlated, since the more ways a user uses a computer, the more time he/she spends using the computer. Although correlated, they are distinctly different constructs. Theoretically, we can differentiate and contrast the two dimensions on several characteristics. First, usage variety may be driven by available features and, still further, by its interaction in myriad usage situations. Usage rate, on the other hand, is dependent on the task requirements of the users. Second, a high usage rate may signal routinized needs (narrow range and heavy use), while high usage variety is associated with variety-

seeking behavior (wide range and light use). Third, usage rate is likely to be limited by the amount of hours that the users are able to devote to certain tasks. Thus the rate of usage is limited naturally by allocatable time, while variety of usage is less restricted by time and is a function of the imaginative ways in which the users decide to use the product (Leuthold 1981; Robinson and Gobey 1997).

The MATH model of home computer adoption proposes that attitudinal belief, normative belief, and control belief structures jointly determine home PC adoption and usage behavior. Consistent with MATH, we examined these structures as they relate to household rate and variety of computer use and extend the model to include two additional measures, household makeup structure and technological structure. Broadly, household makeup structure relates to the sociological environment surrounding users, and technological structure refers to the technological composition of the usage environment (see Figure 2). The remainder of this section is devoted to explanation and justification of the roles of various determinants in household computer use diffusion.

<< Insert Figure 2 Here >>

Determinants of Use Diffusion

Attitudinal Belief Structure

Typically, behavioral beliefs that relate to an outcome that results from performing a certain behavior comprise an attitudinal belief structure. Prior research on computer adoption has suggested that attitudes towards utilitarian, hedonic and social outcomes are important determinants of computer adoption in the home (Venkatesh

and Brown 2001). We propose that the role of attitudinal beliefs is also relevant and influential in sustaining computer use in the home even after the adoption process has taken place.

Attitude towards technology use is generated by an individual's salient beliefs about the consequences of continued use and his/her evaluation of these consequences (Karahanna et al. 1999). IS literature in the TRA tradition has suggested that a primary motivation for computer adoption and use is the adopter's belief regarding the usage outcome or to his/her perceptions of the usefulness of the technology (Davis et al 1989). A positive attitude toward the consequences/outcomes of computer use results in a higher rate of usage and a greater variety of uses in the household. The effect of attitude on rate of use has been well established in organizational computer use context (Jackson et al. 1997), but we suspect that it should have similar effect on variety of use. Attitude is formed by beliefs, and beliefs regarding computer use can exist on several levels, among which are utilitarian beliefs (Am I more efficient as a result of computer use?) and perceived impact on home life (Do changes in activities occur as a result of computer use?). Diffusion literature also suggests that social outcome belief (public recognition that would be achieved as result of a behavior) is also a strong reason why people adopt certain innovations (Rogers 1985). Similarly, in the mind of adopters, computer usage also provides positive social rewards (Karahanna and Straub 1999).

Normative Belief Structure

Diffusion of innovation literature has always stressed the importance of

interpersonal communication networks. The fundamental principal behind the effect of an interpersonal network is the theoretical position that diffusion is primarily a social process.

Internal Communication: By internal communication, we mean communication among/between members of the unit. The effect of communication should be considered important in diffusion of use. Users of new technological innovations can often become "functionally fixated" with the innovation and tend to use it in familiar or routine ways, especially in the absence of external influences (Warlop and Ratneshwar 1993). Communication with other members serves as a way for individuals to learn about new ideas and integrate new uses for the technology into their usage portfolio. When a communication channel exists by which they can turn to other people with whom questions regarding the technology can be discussed, information can be quickly exchanged to overcome difficulties in using the technology. Once the frustration and difficulties are resolved, rate of usage for the technology may increase as a result. Additionally, new usage may be triggered by the communication exchange as members of the communication network may have different, non-overlapping, usage behaviors so that members of the network may share information about different applications of the technology.

External Communication: External communication occurs when members communicate with people outside their unit. When information about how to use computers and the Internet is communicated solely within the household, a barrier to

diffusion of use may develop. Members of the household are considered a homophilous network, meaning they often share similar experiences and perceptions (Burt 1996). Because of their close ties and commonality in practice and understanding of the technology, it may be that are rehashed and no new ideas are introduced into the household. Instead, if communication channels exist with people outside of the immediate household, such as friends and coworkers, new ideas about the use of the technology may be introduced. This argument is supported by the theory of the strength of weak ties, which argues that diffusion of ideas is often facilitated by contact with people outside of the adoption cluster (Granovetter 1973). However, the strength of the weak ties argument is not meant to be a counter argument to a communication network within the household in that only one of these two effects takes place in the diffusion process. Rather, these two effects are seen as occurring in conjunction with each other.

Control Belief Structure

A theory of planned behavior has shown that the presence of constraints can inhibit the performance of a behavior, and IS research studies have demonstrated that the perception that a technology is difficult to use and a lack of knowledge about the technology serve as barriers to technology adoption (Mathieson 1991, Taylor and Todd 1995). Venkatesh and Brown (2001) refer to such inhibitors as control belief structures, and the concepts can be extended to the current study of computer usage in the home.

Perceived Difficulty: Perceived difficulty of use implies that users have to exert

greater mental effort to gain a desired outcome from computer use. Such mental costs may make computer users reluctant to prolong their computer usage time or to extend computer applications into other areas of their lives. This is because people generally have limited cognitive resources to devote and will vigorously protect their available resources by finding easier ways to do things. The end result is that a perception of "difficult to use" limits the use-diffusion potential of computers, both in terms of variety and rate of usage.

Lack of Knowledge: It is intuitive that the use of any technology requires a certain level of know-how regarding its operation. Information technology is among the most complex of consumer technologies, and its complexity is often cited as a limiting factor in its optimal usability in the home (Kiesler et al. 1997; Norman 1999) despite years of attempts by designers to make the technology more "user friendly." Although operating computers in the home may require only limited computer know-how for simple tasks such as word processing or checking email, their complexity certainly constrains computers' applicability to a wider array of household tasks. Thus, the lack of operating knowledge needed in advance for satisfactory computer use (relative to other household technologies) can act as a barrier to sustained computer usage by negatively impacting computer efficacy and may lead to frustration (and eventual abandonment), resulting in lower rates of usage and less variety of uses.

Household Makeup Structure

Household Size: The composition of the household plays a vital role in determining

how computing technologies are integrated into the home. Since all family members are potential computer technology users, it is clear that the larger the household, the greater the use of the computing technology. As an extension, we can further hypothesize that the variety of computer uses increases as the size of users) sin the home increases. Note: the size of the household is not equivalent to the number of users, though the two can be highly correlated. Size specifies the upper limit of the number of users, and, by corollary, it is also conceivable that there are members of the household who do not use computer. The consequence of household size on computer use diffusion is primarily due to a broadening of needs, which results in increased usage of the computer to solve those needs. Aside from the size of the household, the existence of children also encourages usage diffusion (Kraut et al. 1999). Among some recent developments of IT is educational and family development software. Parents may utilize these technologies as part of their children's educational experience, creating another dimension of use for home computer (Venkatesh 1996). The implication of these household structure variables may suggest that the computer is moving away from a tool of individual productivity that is most often used by individuals in a private space (e.g., study or bedroom). Instead, these variables may suggest an evolution of IT as a social tool, used by multiple members of the household and in the social space (e.g., family room).

Competition: Household dynamics also involve the sharing of limited resources. Tensions arise because of possible claims to resources that are not available to all the members at all times. Daly (2001) calls this "the presence of negative valence." In her

earlier ethnographic work on home computers, Salazar (2000) has shown that members of the household have to "negotiate social boundaries" while working with the computer because others may want to use the computer at the same time or they may tie up the telephone line (e.g., e-mail), making it unavailable to others. Most technologies or technology uses in the domestic context can be distinguished on the basis of whether they are potentially social (shared by multiple users during usage) or personal/individual (shared independently of each other and not shared during usage, or not shared at all). For social technologies, variety and rate of use could be enhanced by the existence of other users within the adopting unit (Lindlof 1992). On the other hand, existence of other users within the adopting unit could impede the rate of use for personal technology by enforcing competition for a limited resource, the technology.

Technological Structure

Technological structure refers to the overall technological environment relevant to the adopting unit in reference to the particular technology in question. It involves the attributes and features of the innovation and other available technologies within the adopting unit. The argument here is essentially that use diffusion is impacted by the potential possibilities as well as the limitations of the innovation.

System Capabilities: Differences in system features predetermine the potential uses of the systems in the home. In a way, the capabilities of the system define the boundaries of what the user can do with the system. The new high-performing computers provide processing capabilities not seen before. They have also become

versatile and now compete with other home technologies, such as the television, stereo, and telephone. Because the computer is in a constant state of flux and rapid evolution, its usage cannot be expected to remain constant. In general, we expect users with access to more advanced systems to exhibit a greater variety of use.

Cognate Technologies: Use of any technology must take into consideration the use of all other technologies in the home. This idea was proposed and tested in a study by Vitalari et al. (1985) under the rubric of cognate technologies. One argument made in this connection is that, given limited time, the use of any technology naturally takes away from the use of other technologies, thus limiting the level of use diffusion within the adopting unit. On the other hand, as Shugan (1980) has shown, the cognitive effort required to accumulate knowledge decreases, making the acquisition of related products easier, therefore more attractive. That is, if we consider the complementary nature of technologies or their inter-connective potential, the use of a given technology may increase with the use of other (complementary/connective) technology(ies). This is particularly true of information technologies, because different systems are capable of being used in conjunction with others, and data within each is sometimes interchangeable and transferable. If complementary capabilities and connectivity are indeed indicators of acquisition of new technologies, it is logical to conclude that households with computers are more likely to adopt new technologies, such as digital cameras, video consoles, etc., and that ownership and use of these technologies increases the potential applications of the computer in the home, thus the variety of uses. However, we may see reverse effect on rate of usage, because time constraints

mean that the use of other home IT necessarily takes time away from computer use. For example, the use of a video game console may limit the time available for playing games on the computer.

Internet: In the last five years, a major development has occurred in the technological frontier with the emergence of the Internet. The Internet has dramatically changed, in ways totally unforeseen, how people communicate with each other, access information on a global scale, and organize their daily routines. As a technological factor, it has increased the versatility of the computer and the potential applications for the average user. Various streams of research (Castells 2001) have shown that new technologies such as the Internet have multiple functionalities which expand user involvement in one major way: they increase the variety of uses, because more things can be accomplished. In addition, the new technology may also increase the rate of usage because of some built-in efficiency. While these outcomes may seem obvious – that is, both use variety and rate of usage may go up – what we would like to propose is that the variety of uses goes up by a higher margin than the rate of usage.

Table 1 summarizes the hypotheses we proposed relating to determinants of rate of usage and variety of uses.

<< Insert Table 1 Here >>

In our conceptual development, we have generated specific hypotheses in relation to computer use in the household context, particularly with regard to rate of usage and variety of uses. In our presentation, we are referring to the general behavior of computer user as a whole, without making specific references to country differences.

Although we are not making specific arguments or hypotheses regarding how usage behavior and the strength of the relations among the five factors proposed and usage behavior will vary between the three countries investigated, our empirical work involved analyzing, in a comparative manner, the strength of associations across the U.S., Sweden and India. A priori, we suspect that drivers of usage rate and variety of uses differ across the three countries and that the patterns of association between the U.S. and Sweden will be closer than either the US or Sweden to India. We base our reasoning on the logic that if we lay out the three countries on a continuum of computer diffusion history or social-economic development, all of which have been suggested to impact computer adoption and use in the organizational context (e.g., Hasan and Ditsa 1999; Dewan and Kraemer 2000), the U.S. and Sweden will be closer to each other in their profiles than either is to India's profile. Therefore, we hypothesize that computer users in the U.S. and Sweden will be more similar to each other in terms of actual behavior and drivers of behavior than to computer users in India. However, the differences between the U.S./Sweden and India will be tempered if there is a leapfrogging effect.

SAMPLING AND DATA COLLECTION

Data for this study were collected in three countries using random digital telephone interviews in the U.S. and Sweden, and personal interviews in India. The sampling scheme included a stratified cluster sampling procedure at the household level, with income and geographic distribution balance as bases of sample selection. At the time of data collection (2000), based on population statistics from the Bureau of

Census, the penetration of computers into U.S. households was estimated to be about 60 percent, slightly skewed towards higher-income households. Therefore, in order to maximize the probability of representing the computer-owning households, we over-sampled households with higher income levels in the U.S. A similar sampling procedure was used in Sweden. In India, since computer diffusion was a relatively recent phenomenon and had not penetrated into rural areas, we limited our sampling scheme to urban areas, which accounted for 95 percent of the computers installed (IMRB report 1999). Personal interviews in India were conducted in eight major cities (Bombay, Delhi, Calcutta, Chennai, Bangalore, Hyderabad, Pune and Ahmedabad). Our final sample consisted of 910, computer-owning households in the U.S. (national probability sample), 906 in Sweden (national probability sample), and 996 in India (urban probability sample).

The questionnaire was pre-tested on 25 households in each of the three countries for accuracy, validity and ease of administration before the full-scale study was launched. Actual interviews were conducted by different external firms in each country, each with its team of trained interviewers. Interviews in the U.S. and India were conducted in English, while Swedish was used in Sweden. The questionnaire was professionally translated (and back-translated) and pre-tested prior to interviews in Sweden. With few exceptions, the questionnaire was similar in content from one country to the next. At the beginning of interview process, respondents were given a brief introduction and background for the research and their participation was elicited. They were then asked whether there currently was a computer in use in their home. Those whose household had a computer were then asked to continue with interview,

while those without a computer at home were asked to respond to another questionnaire that probed into reasons for not adopting or disadopting computers (as the case might be) and what their intentions might be regarding adopting in the future (not part of current study). There were two criteria for the respondent of each computer-owning household: he or she had to be at least 18 years old and needed to be considered as having the best knowledge of computer use of anyone in the household.

The respondents were asked by interviewers to answer questions regarding their household's computer adoption and the usage behaviors of each member of their household. In addition, a series of questions asked about communication patterns within the household as well as attitudes and perceptions concerning computer experiences and the effects of computer use. Ideally, we would have liked individual interviews with every user in the household, but part of our human subject approval precluded our interviewing minors. With these practical constraints, we decided to have one primary respondent in each household act as our liaison to the rest of the household members.

The data collection phase of the project for all three countries took place from February 1999 to February 2000. Collecting all of the data for our study within a twelve-month period ensured that we captured an accurate snapshot of computer adoption and usage behavior at the same point.

RESULTS

Preliminary Analyses

We found in our study that households in the U.S. generally have a much longer

history of home computer adoption than in Sweden and India. Based on our data, the average length of computer ownership in the U.S. is 7.02 years, compared to 5.10 in Sweden and 1.92 in India. In the case of India, however, 75 percent of the PCs in households had been acquired within the two years just prior to data collection. Higher degrees of computer penetration in the U.S. and Sweden can also be observed by noting that households in these two countries exhibited a greater incidence of multiple computer ownership (28% of the households in the U.S. and Sweden compared to only 0.7% in India).

Measures of Rate of Use and Variety of Use

Two dependent variables, rate and variety of use, were the subjects of our analyses. Rate of use was measured by asking the number of hours per week of computer use. Two measures could possibly have been used in this regard, either total household hours per week or average hours per week across all the users in the household. We chose to use the average number of household hours per week instead of total hours to minimize a bias from household size differences. Variety of uses was measured by the total number of different reasons why the computer was used in the household (see Appendix 1). For variety of uses, the total was used instead of the average, because our interest is in establishing how many different activity spaces the computer had diffused into within any given household. Therefore, we see the total number of reasons as a more appropriate measure for variety of uses than the average number of reasons. The correlations between the rate of usage and the variety of uses ranges from 0.257 ($p<0.05$), 0.197 ($p<0.05$) and .003 ($p>0.1$) for the U.S., Sweden and

India, respectively, with an overall correlation of 0.042 ($p<0.05$), all of which indicate that although while the two variables are empirically correlated, the correlation is relatively low. We acknowledge the theoretical distinction between rate of usage and variety of uses and treat the two differently in our study. In general, one might say that the three most important reasons people across all three countries gave for their original computer purchase were Education, Recreation/Entertainment and Job-related work at home (Table 2). When one looks at the top three ways computers were actually used in the households, some differences are noticeable: Communication, Recreation/Entertainment and Job-related activities. Education had dropped considerably. The highest actual use rank went to Communication (highest in the U.S. and Sweden and second in India). In general, one might say that the computer is viewed as a communication tool par excellence in all the countries. Again, in all the three countries, Shopping was given the lowest rank. There are also other interesting comparisons and contrasts. In terms of actual use, the U.S. and Sweden were the closest to each other. The only minor difference is that Home Management was ranked number 2 in the U.S. (number 3 in Sweden), while Recreation/Entertainment was ranked number 3 (number 2 in Sweden). All other rankings were similar. The rankings in India were quite different. The high ranking of Home Management in both the U.S. and Sweden shows that computers had already been domesticated to a greater degree in these two countries than in India.

In diffusion terms, some trends may be observed. First, as already mentioned, the computer is domesticated to a greater measure in the U.S. and Sweden. In some respects, Indian experience resembles the U.S. experience in the late 1980s, which

suggests that India is in the early stages of diffusion. However, with regard to Shopping, household useages show wide differences (U.S., 51%; Sweden, 52%; India, 7%).

<< Insert Table 2 Here >>

<< Insert Table 3 Here >>

When comparing variety (using all the 17 categories – Appendix 1) and rate of use (Table 3), we found some differences across the three countries. Households in the US report the highest variety of uses (8.28), while India has the lowest (4.75). On the other hand, Indian households have the highest rate of use (12.02 hours per week) and Sweden has the lowest (6.94 hours per week). There may be a couple of explanations for these patterns. First, on average, Indian households are larger in size, and there are more users per household compared to U.S. and Swedish households. Second, the lower variety of use combined with high rate of usage indicates that computers in Indian households may, in general, be used in a more tool-like fashion, that is, they may be put to more continuous use in limited applications as opposed to use in the U.S. and Sweden, where the technology has diffused into more activity spaces. Third, in India, the infrastructure is such that there are interruptions in the electric supply and frequent outages, thus Indian users may have to spend more time to accomplish the same amount of work.

Hypotheses Testing

Having presented the preliminary analyses on profiles of computer users and computer usage in the home, we next analyze variables that drive the differences in rate

and variety of use. The analyses are based on OLS regressions, with either rate or variety of use as the dependent variable. First, we pooled data across all the three countries to estimate the overall model. Next, we used country dummy variables (with the U.S. serving as the control group) to separate out the parameters for individual countries. This allows us to better compare country differences and to observe whether the same drivers of usage behavior apply in the U.S. as well as in Sweden and India. The procedure we followed is based on Aiken and West (1991).

Variable Manipulation

As discussed previously, the variety of uses and the rate of usage constitute our dependent variables. In addition, as is consistent with our conceptualization, 12 independent variables in five theoretical categories were used as independent variables in the analyses. The first, the Attitudinal Belief Structure, was measured with 15 questions that probed into users' attitudes towards computer use in the home (see Appendix 2). The questions were assessed on a Likert scale ranging from 1=Strongly Disagree to 5=Strongly Agree. Exploratory factor analyses conducted on these 15 items revealed three underlying factors that we labeled as impacts of PC use, utilitarian outcomes and social outcomes of PC use. The three factors have Cronbach alphas of 0.72, 0.71 and 0.64 respectively. Because Cronbach alpha is sensitive to the number of items in the scale, we observed lower alphas for social outcome. Subsequently, the reliability measures recommended by Fornell and Larcker (1981) were constructed for the three attitudinal belief scales, and the results indicate 0.81, 0.80, and 0.72, all above acceptable range. The mean of the items that loaded on each factor was taken as the

measure for that factor.

Normative Belief Structure measures the degree to which external influences impact computer use. The primary variables considered are communication regarding computer use that occurs within the household and communication from external sources. Regarding internal household communication, respondents were asked the frequency of computer-related communications with other users in the home regarding computer use, and a measure was constructed as follows:

$$HCI_h = \frac{\sum \lambda_{ij}}{H_h}$$

Where:

HCI_h = *Household communication intensity*

λ_{ij} = *frequency of communication with between users i and j (2=frequently, 1=sometimes, 0=Never)*

H_h = *Number of users in the household*

This index makes an upward adjustment when communications about computers between two users are more frequent. To avoid a bias toward larger-sized households, the variable is normalized by the number of computer users in the household.

External communication was measured by asking respondents the frequency with which they communicate with friends, co-workers and other sources (e.g., help lines, online chat groups, bbs) for advice regarding computer use. The frequencies for each of the sources (2=frequently, 1=sometimes, 0=never) were summed to form an external communication index.

Control Belief Structure consists of variables that present barriers to computer use in the home. Perceived difficulty of computer use and knowledge (lack of) are the

variables investigated. Difficulty of use is measured by taking the mean of two items on a scale defined by "I often feel frustrated using computers" and "Computers are difficult to use" with Cronbach alpha of 0.70. Knowledge was measured by asking for the level of computer expertise of the most knowledgeable person in the household where 1=expert and 4=beginner, with intermediate levels in between.

Household Makeup Structure relates to the sociological makeup of the household that influences how the computer is used in the home. The existence of children under 18 in the household is a dummy variable. Competition for computer use in the home is taken as the ratio of the number of computer users to the number of computers in the household. The assumption here is that the higher the ratio of users to computers available, the greater the competition for computer time. A ratio of 1 to 1 would indicate everyone in the household has all the computer time he/she desires.

Technological Structure refers to the technological capabilities of the household and computing environment. Newness of computer is measured by the age of the newest computer available in the home. Internet connection is a dummy variable. Other technology in use was measured by proving respondents with a list of other demestic information technology and asking them which ones currently were being used within their home. The number of technologies in use is then summed as a measure.

Regression Results

In our first analyses, we pooled the data from all the three countries together and ran separate regressions for rate of usage and variety of uses using the same set of independent variables. For rate of usge, the regression model yielded R^2=0.248

(F=52.630, p<0.001), with nine of the 12 independent variables significant (Table 4). The model performed better for variety of uses, with R^2=0.605 (F=322.062, p<0.001), and nine of the 12 independent variable were found to be significant. Five of the significant variables are common to both. Because variables of different scales were used, for ease of comparison we report the standardized coefficients in Table 4.

<< Insert Table 4 Here >>

As the results show, variables relating to attitudinal belief structure were positively related to households' rates and variety of uses, supporting H1-3 (see Table 1 for hypotheses). Households in which the belief exists that computers provide positive impact and utilitarian benefits, as well as positive social outcomes, will experience greater diffusion of uses in terms of both rate of usage and variety of uses.

Consistent with the hypotheses regarding normative belief structure (H4-5), the degree of communication intensity within the household and with external social networks was positively related to variety of uses. As the greater the intensity of communication across different social networks increases, either within the home or outside of the home, so develops the potential to provide assistance related to computer usage problems and to stimulate new usage ideas; this results in the diffusion of technology into other household activity spaces. However, external communication was also positively related to rate of use, which was not hypothesized.

For control belief structure, partial support was found for H6 in that the households that found computers difficult to use exhibited lower rates of use, as expected, but not less variety of uses. Lack of computer expertise in the household was negatively associated with usage rates and variety of uses, as predicted (H7). Overall,

we can conclude that usability and knowledge issues are critical in the diffusion of computing technology in the home.

Households with children exhibited more variety and diffusion of uses, as suggested by H8. The role of children in the diffusion of computer use in the home has received much attention recently (Singer and Singer 2001). Our study validates this view. Supportive of H9, we found that households with high competition for computer time had lower rates of use. The social makeup of a user's environment seems to play a key role in the extent of computer use diffusion.

Finally, in the case of technological structure, the age of the computer in a household was negatively related to the rate of usage, but, contrary to H10, it was not significantly related to variety of uses in that house. Therefore, H10 was only partially supported. Consistent with H11, access to Internet was positively associated with variety of use. Use of other information technologies in the home was found to be negatively related to the rate of usage and positively related to variety of uses, as suggested by H12.

One of our research questions is whether differences in drivers of usage behavior exist and vary across the three countries. We conducted a Chow test of regression coefficients to check for this result. For rate of usage, we found significant differences exist between countries ($F=9.841$, $p<0.001$), which suggests that a separate regression model may be needed for each country. The result of a Chow test for variety of uses also suggests significance differences between countries ($F=29.687$, $p<0.001$). To proceed with analyses of country differences, we ran a regression model and country difference test based on Aiken and West (1991). Results of our test are

reported in Tables 5 and 6.

<< Insert Tables 5 and 6 Here >>

Our analyses of country differences with respect to determinants of home computer usage behavior reveal some interesting insights. We noticed a high degree of similarities in the direction of parameter estimates between the three countries for both rate of usage and variety of uses. Most observed differences between the three countries were attributable to the differential magnitude of influence of the determinants. As most of the country differences are accounted for by differences between the U.S. and India and Sweden and India, we concluded that the U.S. and Sweden are more similar to each other than they are to India.

For rate of usage, 12 out of 36 possible parameter comparisons show significant differences. Of the 12 differences observed, none exhibited reversal in parameter.[3] In general, consistent with results from the pooled data, attitudinal belief structure variables were positively related to the rates of usage throughout the three countries. The only country difference observed was for India, where social outcomes of PC use are not a significant driver of rate of usage as is the case in the U.S. and Sweden. For normative belief structure, household communication was significantly (positively) related to the rate of usage for the U.S. and Sweden, while external communication was the same in Sweden and India. Household communication did not reach significance in India, while external communication was not significant in the U.S. For control belief structure, the difficulty of using a PC at home was significant only in India, while India was the only country in which lack of expertise at home was not significant. For

[3] For some variables, such as age of the newest PC, the estimated parameter changed from negatively significant to positive but not significant. However, there were no direction reversals that went from negatively significant to positively significant or vise versa.

household makeup structure, all parameters were, as hypothesized, negative in all countries. Finally, for technological structure, the two noteworthy differences were age of the newest PC in the household (U.S.) and Internet Connection at Home (India), both negative.

With respect to variety of use, 18 of the 36 possible parameter comparisons show significant differences. But, similar to rate of usage, the differences were mainly due to magnitude of effect rather than to direction changes, as no variables changed from positive significant to negative significance or vise versa. All variables (except one) relating to attitudinal belief structure were significantly positive in determining variety of uses. The only exception was social outcome, which was positive but not significant in India. For normative belief structure, communications, both within the household and external, were significant and positively related to rate of usage for all countries, but household communication was most important in U.S., while external communication was most important in Sweden. For control belief structure, the difficulty of using a PC at home was significant only in India, while that was the only country in which lack of expertise at home was non-significant. Among variables related to household makeup structure, competition for computer use was the only one to achieve significance, and it was so only in India. Finally, in general, technological structure showed a significant positive influence on variety of uses across all the countries. The exception was in the case of the age of the newest computer, which was not significant in the U.S. and Sweden but was significant in India.

DISCUSSION

This study is a snap shot of home computer adoption and use in three countries. It was based on data collected from more than 900 households in each country during the same time frame, 1999/2000. While it is possible and probable that changes have occurred in the past couple of years, the data still provide a rich comparison time frame.

Our general approach to country comparisons differs from some other approaches that emphasize the cultural values based on Hofstede's measures (e.g., Keil et al. 2000). Instead, we approach the issue of country differences from the viewpoint of activity spaces and factors relating to diffusion theory. Activity spaces are culturally robust in that same space categories can be applied to different cultures.

In this paper, we have presented a model of technology use in the home that identified computer usage along two dimensions, rate of use and variety of uses. We found that both rate and variety are useful measures theoretically and empirically. From a diffusion theory perspective, rate of usage suggests the immediate functional value of the computer to the user, and variety of use suggests the versatility of technology and the resourcefulness of users. In addition, rate and variety together point to the social embeddedness of the computer in the household system.

In our conceptual development, we propose that the extent to which households use technology in the home can be explained by five theoretical factors: attitudinal belief structure, normative belief structure, control belief structure, household makeup structure, and technological structure. Our selection of these independent measures is validated based on the R-square values and statistical significance of the measures. That is, using a cross-sectional survey conducted in three countries (the U.S., Sweden and India), we found good empirical support for the proposed model of integration of the

computer into the everyday life of households. Further, the cross-country analyses reveal that countries do not differ in the direction of effect for these five factors, but that, instead, country differences are a matter of magnitude.

Our results show that computer adoption and usage in the U.S. and Sweden are following similar courses in terms of usage levels, impacts and domestication. In the case of India, our intuition originally told us was that it would pursue an evolutionary path similar to those historically observed in the U.S. and Sweden--one that would resemble that in the U.S. in its early phase of computer diffusion. We also concurrently proposed, as an alternative possibility, that there may have been a leapfrogging effect in India, in which case computer use there would more closely resemble that of its western counterparts.

We have provided evidence to suggest that leapfrogging does indeed exist but that it is not manifested across all dimensions. We have compared the reasons users in the three countries gave for their original adoption of the computers in with their actual uses; we found that as adopters became familiar with the technology through continued use, the actual uses varied from the intended uses at adoption. While this is true of all the three countries, the U.S. and Sweden are most alike on this measure.

For example, if we look at the actual uses of the computer, a significant percentage of households in India use the computer for four major activities: communication, recreation/entertainment, information, and job-related work. These are also the major activity spaces in the U.S and Sweden. Since computers represent an important communication/information/work medium, the comparison suggests that India is located at the same point on the diffusion curve on these dimensions.

As for two other activities, home management and education, Indian households are slightly behind those of the U.S. and Sweden. As a domestic tool, performance of the computer on these two activities suggests that it has not been integrated into Indian households to the same extent as in the U.S. or Sweden. With regard to another category, on-line shopping, India is far behind. We feel that various infrastructural and social/cultural factors may explain the situation in India. It must be noted here that online shopping is way behind other activities performed on the computer, even in the U.S. and Sweden.

Indian households report spending more time on computers as measured by hours per week. However, this figure is not normalized for household size. In any event, these reports provide strong evidence that rates of usage, as reported in total number of hours at home, raise the locus of performance to an unexpected level. On a slightly different issue, mention must be made that there is gender parity in terms of male and female use of computers in U.S. and Swedish households, while 73 percent of the adult users sampled in India were males and 27 percent were females. The proportions among children are roughly equal, thus it appears that gender is less of a factor in the younger generation.

Within the attitudinal structure, communication intensity and social networks play key roles, which indicate that communication is a very important element both before and after adoption.

Difficulty of use and lack of expertise at home pose barriers to computer usage. However, it is interesting that, while they negatively impact the usage levels, they do not lead to disadoption, which leaves one with the conclusion that users believe in the

intrinsic value of computers in the home and are willing to put up with the inconvenience associated with computer use. That is, this suggests, on the one hand, that the interactions between usability of technology and levels of user knowledge both impede levels of use and on the other hand, it points to the resourcefulness of the users in taming this technology.

Recently, many countries have made it a matter of national policy to work at making technology available to most households, but they should not overlook making the technology more user-friendly or raising the level of expertise among users. In our study, some expertise was generally available to individual users through their interactions with other users in the household, and some sought external assistance from friends, co-workers, or company help lines. Further research is needed to determine the best means to deliver the needed usage expertise to the users, and community-based help groups (virtual or physical) may be an effective delivery mechanism.

The presence of children in a household has a positive effect on usage, and, while this comes as no surprise, it is interesting to note that it is a global phenomenon.

Finally, access to the Internet has a positive effect on both rate of use and variety of use. It must be noted here that close to 80 percent of the sampled households in the U.S. and Sweden reported having Internet connection at the time of data collection, while only 45 percent of the Indian households reported Internet access.

It is pertinent to mention here that our sample in India is limited to households in the major cities and does not cover the country. The reason is simply computers installed in these major cities account for 90 percent of India's computer base.

However, the rate of growth of computer adoption in India is 15 to 20 percent per year and less than five percent in the U.S. and Sweden.

In summary, the study began with a descriptive account of computer use in three countries and proceeded to hypotheses testing using regression procedures.

First, we theorized about the use in terms of rate of usage and variety of uses. We also developed measures to capture these two constructs. Rate of usage and variety of uses proved to be useful measures in assessing usage levels and impacts. Our study shows that positive attitudes toward consequence/outcomes of computer use result in higher rates of usage and greater variety of uses. Households in the U.S. represent the greatest variety of uses, followed by Sweden.

Second, in terms of theoretical positioning, we identified a framework for use in conducting this study. The framework includes five independent measures that account for significant variance.

Third, we positioned the study in terms of how the countries were placed on the diffusion curve. In this regard, the leapfrogging effect is one aspect that we studied. Our intuition was that, in general, the U.S and Sweden would provide a comparable picture and that India would be different from both. However, we also hypothesized that if the leapfrog effect were to be taken seriously, India should be closer to the U.S. and Sweden on some key dimensions. Our intuition proved to be generally correct on both issues. We identified the dimensions on which similarities and differences exist.

Conclusion

The research presented here is among one of the first efforts towards understanding how technology is being accepted and integrated into households around

the globe. By identifying the dimensions that influence the extent of computer integration in the home, we have extended the traditional technology-acceptance research, which heretofore has focused primarily on adoption into the workplace, to emphasize usage and integration into non-workplace environments. Our research findings suggest that, although there may be some cultural variations as to why computers are adopted and how they are used, the determinants by which they are integrated into households are similar across cultures.

In our study, we found that impact and utilitarian outcomes are strong factors in determining the level of technology use in the home. If technology does not provide observable utilitarian outcomes, the level of use may not be sustained.

For developers interested in developing new information technologies in the home, our study showed a strong relationship between the uses of computer with the uses of other IT products in the home. For future technology design, attention should be paid to how existing technologies are currently being used by adopters and how they interact with other technologies in the home. For example Sony has taken such design steps by bundling computers with digital camera and by introducing PlayStation II, which effectively combines Internet access, video games, and a home theatre into one product offering. Such designs may have great potential for extensive diffusion into the household environment and may integrate well into users' lives.

One limitation of our study is in the number of countries we included in our sample. Certainly, time and costs were key factors. To complement the findings presented here, future research should focus on a different set of countries with different cultural backgrounds.

REFERENCES

Aiken, L. S., and West, S. G. *Multiple Regression: Testing and Interpreting Interactions*, Sage Publications, Thousand Oaks, CA, 1991.

Bannon, L. J., and Bodker, S. "Beyond the Interface: Encountering Artifacts in Use," in *Designing Interaction: Psychology at the Human-Computer Interface*, J. M. Carroll (ed.), Cambridge University Press, Cambridge, UK, 1991, pp. 227-253.

Brezis, Elise S. and Daniel Tsiddon (1998), Economic Growth, Leadership and Capital Flows: The Leapfrogging Effect, *Journal of International Trade & Economic Development*, Vol 7, No. 3, September, 261-277.

Briggs, R. O., Adkins, M., Mittleman, D., Kruse, J., Miller, S., and Nunamaker J. F., Jr. "A Technology Transition Model Derived from Field Investigation of GSS Use Aboard the U.S.S. Coronado," *Journal of Management Information Systems* (15:3), Winter 1998/1999, 151-195.

Bureau of Census, *Current Population Survey, October 1997,* Washington, D.C., 1997.

Burt, R. S., and Janicik, G. A. "Social Contagion and Social Structural," in *Networks in Marketing*, D. Iacobucci (ed.), Sage Publications, Inc., Thousand Oaks, CA, 1996, pp. 32-49.

Chau, P. Y. K. "An Empirical Assessment of a Modified Technology Acceptance Model," *Journal of Management Information Systems* (13:2), Fall 1996, pp. 185-204.

Chau, P. Y. K., and Hu, P. J. "Information Technology Acceptance by Individual Professionals: A Model Comparison Approach," *Decision Sciences* (32:4), Fall 2001, pp. 699-719.

Daly, K. J. "Deconstructing Family Time: From Ideology to Lived Experience," *Journal of Marriage and Family* (63:2), 2001, pp. 283-294.

Davis, F. D., Bagozzi, R. P., and Warshaw, P. R. "Uswer Acceptance of Computer Technology: A Comparison of Two Theoretical Models," *Management Science* (35:8), August 1989, pp. 982-1003.

De Vreede, G., Jones, N., and Mgaya, R. J. "Exploring the Application and Acceptance of Group Support Systems in Africa," *Journal of Management Information Systems* (15:3), Winter 1998/1999, pp. 197-234.

Dewan, S., and Kraemer, K. L. "Information Technology and Productivity: Evidence from Country-Level Data," *Management Science* (46:4), April 2000, pp. 548-562.

Dutton, W. H., Kovaric, P., and Steinfield, C. "Computing in the Home: A Research Paradigm," *Computers and the Social Sciences* (1:1), January-March 1985, 5-18.

Gefen, D., and Straub, D. W. “Gender Differences in the Perception and Use of E-mail: An Extension to the Technology Acceptance Model,” *MIS Quarterly* (21:4), December 1997, pp. 389-400.

Ginzberg, M. J. “Early Diagnosis of MIS Implementation Failure: Promising Results and Unanswered Questions,” *Management Science* (27:4), April 1981, pp. 459-477.

Granovetter, M. “The Strength of Weak Ties,” *American Journal of Sociology* 78, May 1973, 1360-1380.

Hasan, H., and Ditsa, G. “The Impact of Culture on the Adoption of IT: An Interpretive Study,” *Journal of Global Information Management* (7:1), January/March 1999, 5-15.

Igbaria, M. “Personal Computing Acceptance Factors in Small Firms: A Structural Equation Model,” *MIS Quarterly* (21:3), September 1997, pp. 279-305.

Jackson, C. M., Chow, S., and Leitch, R. A. “Toward and Understanding of the Behavioral Intention to Use and Information System,” *Decision Sciences* (28:2), Spring 1997, 357-389.

Karahanna, E., and Straub, D. W. “The Psychological Origins of Perceived Usefulness and Ease-of-Use,” *Information & Management* (35:4), April 1999, 237-250.

Keil, M., Tan, B. C. Y., Wei, K. K., Saarinen, T., Tuunainen, V., and Wassenaar, A. “A Cross-Cultural Study on Escalation of Commitment Behavior in Software Projects,” *MIS Quarterly* (24:2), June 2000, pp. 299-325.

Kiesler, S., Kraut, R., Lundmark, V., Scherlis, W., and Mukhopadhyay, T. “Usability, Help Desk Calls, and Residential Internet Usage,” *Conference Proceedings on Human Factors in Computing Systems*, 1997, pp. 536-537.

Kraut, R., Scherlis, W., Mukhopadhyay, T., Manning, J., and Kiesler, S. “The Home Net Field Trial of Residential Internet Services,” *Communication of the ACM* (39:12), December 1996, pp. 55-63.

Landauer, T. K. The Trouble with Computers: Usefulness, Usability, and Productivity, MIT Press, Cambridge, MA, 1995.

Lee, A. “Inaugrual Editor’s Comments,” *MIS Quarterly* (23:1), March 1999, pp. v-xi.

Leuthold, J. H. “Taxation and the Consumption of Household Time,” *Journal of Consumer Research* (7:4), March 1981, 388-394.

Lewis, L. K., and Seibold, D. R. “Innovation Modification During Intraorganiztional Adoption,” *Academy of Management Review* (18:2), April 1993, 322-354.

Lindolf, T. R. “Computing Tales: Parents’ Discourse About Technology and Family,” *Social Science Computer Review* (10:3), 1992, pp. 291-309.

Lombardi, Gerald (2001), "Young People and Creation of Cultural Meaning," in Helen B. Scwatzman (Ed), *Children and Anthropology: Perspectives for the 21st Century*," Westport, Conn. Bergin and Garvey, 149-166.

Mathieson, K. "Predicting User Intentions: Comparing the Technology Acceptance Model with the Theory of Planned Behavior," *Information Systems Research* (2:3), September 1991, pp. 173-191.

Nardi, B. A. *Context and Consciousness: Activity Theory and Human-Computer Interaction*, MIT Press, MA, Cambridge, 1996.

Norman, D. A. *The Invisible Computer*, MIT Press, Cambridge, MA, 1999.

Pitroda, S. "Development, Democracy, and the Village Telephone," *Harvard Business Review*, (71:6) November/December 1993, pp. 66-80.

Robinson, J. P., and Godbey, G. *Time for Life*, The Pennsylvania State University Press, University Park, PA, 1997.

Rogers, E. M. *Diffusion of Innovations,* Free Press, New York, 1985.

Salazar, C. "Building Boundaries and Negotiating Work at Home," Working Paper, University of Washington, 2000.

Schroeder, R. "The Consumption of Technology in Everyday Life: Car, Telephone, and Television in Sweden and America in Comparative Historical Perspective," *Working Paper*, Chalmers University of Technology, Gothenburg, Sweden, 2000.

Shugan, S. M. "The Cost of Thinking," *Journal of Consumer Research* (7:2), September 1980, pp. 99-111.

Simon, H. A., *The Sciences of the Artificial*, MIT Press, Cambridge, MA, 1969.

Singhal, A. and Rogers, E. *India's Communication Revolution: From Bullock Carts to Cyber Marts*, Sage Publications, Thousand Oaks, CA, 2001.

Sloane, A. and van Raiij F. *Home Informatics and Telematics: Information, Technology and Society*, Kluwer Publishers, London, UK, 2000.

Straub, D. W., Keil, M., and Brenner, W. H. "Testing the Technology Acceptance Model Across Cultures: A Three Country Study," *Information & Management* (33:1), November 1997, pp. 1-11.

Szajna, B. "Empirical Evaluation of the Revised Technology Acceptance Model," *Management Science* (42:1), January 1996, pp. 85-93.

Taylor, S., and Todd, P. "Assessing IT Usage: The Role of Prior Experience," *MIS Quarterly* (19:4), December 1995, pp. 561-570.

Tikhomirov, O. K. “The Theory of Activity Changed by Information Technology,” in *Perspectives of Activity Theory*, Y. Engeström, R. Miettinen and R. L. Punamäki (eds.), Cambridge University Press, Cambridge, UK, 1999, pp. 347-359.

Tipton, F. B. “Bridging the Digital Divide in Southeast Asia: Pilot Agencies and Policy Implementation in Thailand, Malaysia, Vietnam, and the Philippines,” ASEAN Economic Bulletin (19:1), April 2002, 83-99.

Venkatesh, A. “Computers and Other Interactive Technologies for the Home,” *Communications of the ACM* (39:12), December 1996, 47-57.

Venkatesh, A., and Vitalari, N. “A Post-Adoption Analysis of Computing in the Home,” *Journal of Economic Psychology* (8:2), June 1987, pp. 161-180.

Venkatesh, V., and Brown, S. A. “A Longitudinal Investigation of Personal Computers in Homes: Adoption Determinants and Emerging Challenges,” *MIS Quarterly* (25:1), March 2001, pp. 71-102.

Vitalari, N. P., Venkatesh, A., and Gronhaug, K. “Computing in the Home: Shifts in the Time Allocation Patterns of the Household,” *Communications of the ACM* (28:5), May 1985, pp. 512-522.

Vygotsky, L. S. *Thought and Language*, MIT Press, Cambridge, MA, 1962.

Vygotsky, L. S., *Mind in Society: The Development of Higher Psychological Processes*, Harvard University Press, Cambridge, MA, 1978.

Wall Street Journal, February 27, 2002, Eastern Edition, A22.

Warlop, L., and Ratneshwar, S. “The Role of Usage Context in Consumer Choice: A Problem Solving Approach”, in *Advances in Consumer Research, Vol. 20*, L. McAlister and M. L. Rothschild (eds.), Association for Consumer Research, Provo, UT, 1993, pp. 377-82.

Appendix 1: Dependent Variables

Variety of Use	
Activity Space	Activities
Work/Employment Related	1. Job Related 2. E-mail (Work related) School related
Family Communication	3. E-mail (Personal) 4. Writing letters/correspondence other than e-mail
Family Recreation	5. Games/Entertainment
Home Management	6. Home management (Recipes, Family records) 7. Health Information 8. Travel information/Vacation Planning 9. Financial Management 10. Online Banking
Home Shopping	11. Shopping (Frequently purchased goods) 12. Shopping (Large ticket Items) 13. Shopping (Other)
Education/Learning	14. School related
Information Center	15. Reading News 16. Sports Information 17. Community Information
Rate of Use	Sum of total hours of computer use per week in the home

Appendix 2: Independent Variables

Attitudinal Belief Structure	
Impact of PC use	1. The computer has changed the way I do things at home. 2. The computer has replaced the telephone as major communication device in my home. 3. I have more contact with friends as relatives now that I have email. 4. My family watches less TV as a result of using the computer or the Internet. 5. The computer has increased the amount of job-related work I do at home.
Utilitarian outcome PC use	1. The computer is as essential in my home as any other household appliance. 2. It would be difficult to imagine life without a computer in my home. 3. Households with a computer are run more efficiently than those without a computer. 4. The computer has saved me time at home. 5. The computer has become part of the daily routine in my home.
Social outcome of PC use	1. Computers give status to their owners 2. Those who are not knowledgeable about computers are falling behind
Normative Belief Structure	
Household communication	$HCI_h = \sum \lambda_{ij} / H_h$ λ_{ij} = frequency of communication with between users i and j 2=frequently, 1=sometimes, 0=Never H_h = Number of users in the household
External communication	Sum of degree of communication with friends, co-workers and other sources (e.g., help lines, online chat groups, bbs) for advice regarding computer use. 2=Frequently, 1=Sometimes, 0=Never
Control Belief Structure	
Difficulty of using PC at home	1. I often feel frustrated using computers 2. Computers are difficult to use
Lack of expertise at home	Level of computer expertise of the most knowledgeable person in the household 1=Expert, 2=Not an expert but knowledgeable, 3=Can do a few things well, 4=beginner
Household Makeup Structure	
Children in the household	0 = No children 18 or under living at home 1 = At least one child 18 or under living at home
Competition for use	Number of computer at home / Number of users at home
Technological Structure	
Age of newest PC at home	Measured in years (and fraction of)
Internet connection at home	0 = No Internet connection at home 1 = Have Internet connection at home
Use of other IT products	1. Electronic organizer or handheld computer 2. Fax or telex machine 3. Pager 4. Voice mail or an answering machine 5. Video game console 6. DVD, DVIX or laser disk player 7. Stereo system or CD player 8. Satellite TV 9. Cable TV 10. Video Camera 11. VCR 12. Digital camera

Figure 1: Conceptual Model of Household Activity Spaces

Household Activity Space

	Entertainment / Leisure	*Household Finances and Management*	*Work and Employment*	*Family Development and Education*	*Food Management*	*Family Communications*
Sample of Tasks	Watching TV Vacation/travel Playing games	Cleaning Family shopping Budget planning Tax prep. Investments	Telecommuting Job-related work	Children's education Adult education Family gatherings	Grocery shopping Recipe keeping Meal prep.	Telephone Letter/postcard writing
Household Members	Whole family Male and female	Primarily adults Male and female	Primarily adults Male and female	Whole family Male and female	Primarily adults Primarily female	Whole family Male and female
Sample of Technologies	TV, VCR, DVD Video game console Home Stereo Computer Internet	Washer/Dryer Automobile Computer Internet	Telephone Answering machine Fax Automobile Computer Internet	Television VCR Telephone Computer Internet	Kitchen appliances Automobiles Computer Internet	Telephone Answering machine Fax Computer Internet

Adapted and extended from Venkatesh (1996)

Figure 2: Model of Home Technology Use

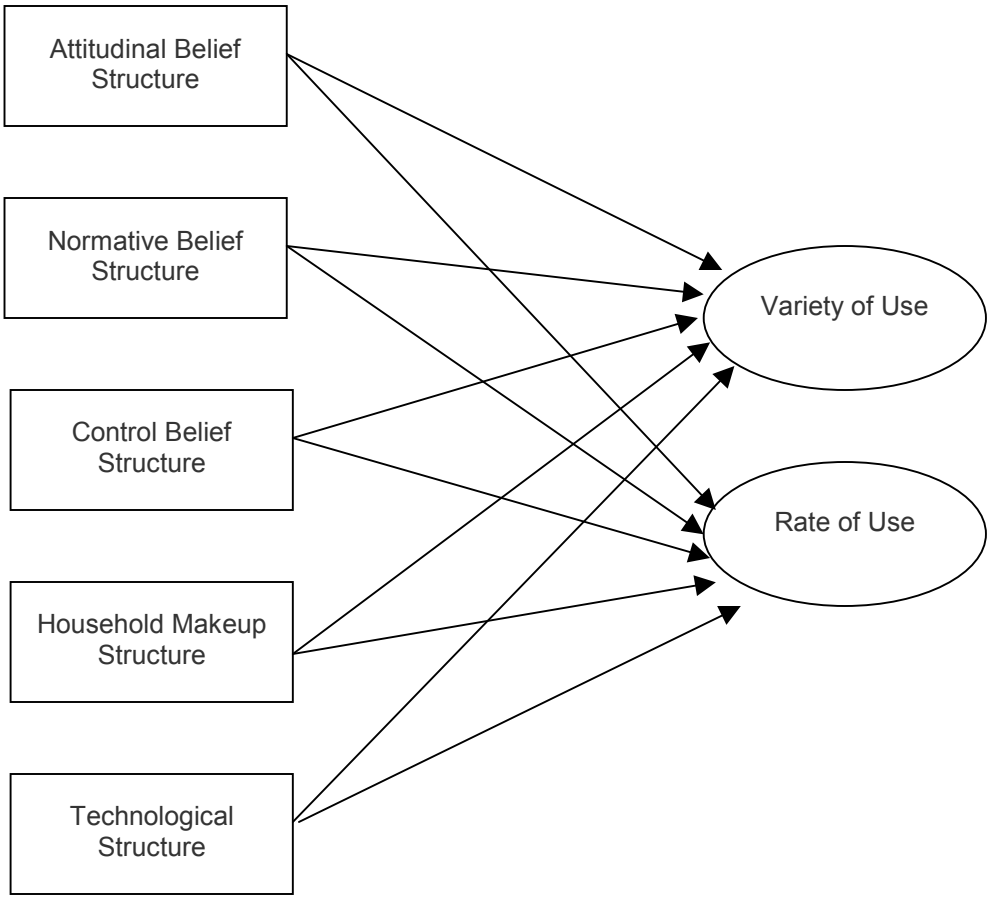

Table 1: Summary of Hypotheses

		Rate of Use	Variety of Use
Attitudinal Belief Structure			
H1	Impact of PC use	+	+
H2	Utilitarian outcome PC use	+	+
H3	Social outcome of PC use	+	+
Normative Belief Structure			
H4	Household communication	0	+
H5	External communication	0	+
Control Belief Structure			
H6	Difficulty of using PC at home	-	-
H7	Lack of expertise at home	-	-
Household Makeup Structure			
H8	Children in the household	0	+
H9	Competition for use	-	0
Technological Structure			
H10	Age of newest PC at home	-	-
H11	Internet connection at home	0	+
H12	Use of other IT products	-	+

Table 2: Reasons for Adopting and Using Computer in the Home

	Reasons to Adopt			Reasons for Use		
	US	**Sweden**	**India**	**US**	**Sweden**	**India**
Job related work	62.7%	56.7%	64.0%	73.7%	68.7%	76.1%
Communication	35.2	41.5	42.5	92.4	87.1	78.2
Recreation / Entertainment	68.0	57.6	59.4	85.7	79.1	84.7
Home Management	47.3	21.7	26.4	85.9	71.2	41.9
Shopping	--	--	--	50.8	52.8	6.5
Education	72.4	66.7	70.5	59.0	53.4	42.0
Information	39.2	42.1	45.2	64.2	62.0	31.5

Table 3: Rate and Variety of Use Across Countries

	US	Sweden	India
Variety of Use	8.28	7.55	4.75
$F(2, 2811) = 282.181, p < 0.001$			
Rate of Use	8.81	6.94	12.02
$F(2, 2811) = 86.78, p < 0.001$			

Table 4: Standardized Regression Coefficient from Pooled Data

	Rate	Variety
Attitudinal Belief Structure		
Impact of PC use	0.166[d]	0.104[d]
Utilitarian outcome PC use	0.193[d]	0.141[d]
Social outcome of PC use	0.092[d]	0.075[d]
Normative Belief Structure		
Household communication	-0.020	0.063[d]
External communication	0.074[d]	0.064[d]
Control Belief Structure		
Difficulty of using PC at home	-0.046[b]	0.019
Lack of expertise at home	-0.106[d]	-0.070[d]
Household Makeup Structure		
Children in the household	-0.032	0.039[b]
Competition for use	-0.208[d]	-0.016
Technological Structure		
Age of newest PC at home	-0.041[b]	-0.001
Internet connection at home	-0.038	0.546[d]
Use of other IT products	-0.098[d]	0.261[d]
R^2	0.248	0.605
F	52.630[d]	322.062[d]

[a] p<0.10 [c] p<0.01
[b] p<0.05 [d] p<0.001

Table 5: Standardized Regression Results for Three Countries: Rate of Use

	US	Sweden	India	US vs. Sweden	US vs. India	Sweden vs. India
Attitudinal Belief Structure						
Impact of PC use	0.126[c]	0.154[d]	0.045			
Utilitarian outcome PC use	0.234[d]	0.232[d]	0.084[b]			
Social outcome of PC use	0.088[c]	0.159[d]	0.048			a
Normative Belief Structure						
Household communication	0.067[a]	0.084[b]	0.016		a	b
External communication	0.022	0.091[c]	0.115[d]		c	
Control Belief Structure						
Difficulty of using PC at home	-0.013	-0.020	-0.064[b]		b	
Lack of expertise at home	-0.112[c]	-0.185[d]	-0.013		a	c
Household Makeup Structure						
Children in the household	-0.040	-0.012[a]	-0.059[a]			
Competition for use	-0.241[d]	-0.132[d]	-0.291[d]	b	b	d
Technological Structure						
Age of newest PC at home	-0.099[c]	-0.010	0.010	b	b	
Internet connection at home	0.004	-0.015	-0.086[b]			
Use of other IT products	0.033	0.018	-0.031			
R^2	0.256	0.231	0.225			
F	23.290[d]	20.079[d]	19.431[d]			

[a] p<0.10 [c] p<0.01
[b] p<0.05 [d] p<0.001

Table 6: Standardized Regression Results for Three Countries: Variety of Use

	US	Sweden	India	US vs. Sweden	US vs. India	Sweden vs. India
Attitudinal Belief Structure						
Impact of PC use	0.200[d]	0.192[d]	0.112[d]		c	c
Utilitarian outcome PC use	0.121[d]	0.153[d]	0.052[a]			b
Social outcome of PC use	0.078[c]	0.075[d]	0.038		a	
Normative Belief Structure						
Household communication	0.113[d]	0.048[a]	0.050[b]	a	c	
External communication	0.049[b]	0.086[d]	0.045[b]	a		a
Control Belief Structure						
Difficulty of using PC at home	-0.022	-0.014	-0.049[b]		b	a
Lack of expertise at home	-0.152[d]	-0.091[d]	-0.004	a	d	c
Household Makeup Structure						
Children in the household	-0.016	0.045	0.015			
Competition for use	-0.019	-0.010	0.161[d]		d	d
Technological Structure						
Age of newest PC at home	0.010	0.002	0.050[b]			
Internet connection at home	0.507[d]	0.545[d]	0.594[d]	b	d	d
Use of other IT products	0.078[d]	0.078[d]	0.080[d]			
R^2	0.612	0.591	0.528			
F	106.839[d]	96.970[d]	81.641[d]			

[a] p<0.10 [c] p<0.01
[b] p<0.05 [d] p<0.001