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Dynamic Use Diffusion Model in a Cross-National Context: A Comparative Study of the United States, Sweden, and India*

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This study proposes a model of dynamic use diffusion that serves as a basis for investigating post-adoption technology-usage behavior. Dynamic use diffusion measures the extent to which technology usage has evolved since the time of adoption. Herein, antecedents and consequences of dynamic use diffusion are investigated. A large-scale, random sample survey was conducted in the United States, Sweden, and India on the use of Internet and computing technology. The survey results suggest that while the antecedents of dynamic use diffusion are similar across the three countries, the consequences are somewhat different for India. These differences can be attributed to the national cultural differences of India compared with the United States and Sweden with regard to power distance beliefs.

Introduction

During the past decade, there has been much interest among management scholars in technology diffusion in the global context (Bajwa, Lewis, Pervan, and Lai, 2005; Chandrasekaran and Tellis, 2008; Corracher and Ordanini, 2002; Ganesh, Kumar, and Subramaniam, 1997; Spencer, 2003; Stremersch and Tellis, 2004; van Everdingen, Aghina, and Fok, 2005; Wolcott and Goodman, 2003). The focus on global diffusion has become even more intense with the emergence of the Internet (ITU, 2007). According to some authors, Internet technologies seem to be diffusing across different countries more rapidly than any other technology in recent memory (Castells, 2001; Deuze, 2006; Hoffman, Novak, and Venkatesh, 2004).

Research on the issue of technology diffusion at the consumer level has concentrated predominately on the act of adoption—more specifically, on individual or household adoption (Golder and Tellis, 1998; Lim, Leung, Choon, and Lee, 2004; Robertson and Gatignon, 1986). The process of diffusion that takes place after adoption is reported less frequently in the literature. Post-adoption use of technology, which we call use diffusion, considers how the technology, once adopted, is integrated in the adopting unit through use (Mick and Fournier, 1998; von Hippel, 1995; Wood and Moreau, 2006). The distinction between adoption and use lies in the fact that mere adoption does not complete the diffusion process because it does not guarantee that the product will be integrated within the adoption unit in a meaningful way. This is because, throughout the life cycle of the innovation, both disadoption and abandonment could occur, thus derailing the diffusion process. Adoption is therefore a necessary, but not a sufficient, condition for the diffusion process to be considered complete. For an innovation to be accepted by its users, it must be put to discernible patterns of use after adoption (Lindolf, 1992; Rogers, 1995).

As new technologies are introduced to consumers, a formal study of the use patterns has significant managerial implications (Jung and Yeoum, 2010; Wood and Moreau, 2006; Ziamou and Ratneshwar, 2002). Technologies that are more integrated into a household will become more indispensable to daily life (Hoffman et al., 2004). Furthermore, consumers who intensely use a particular technology are often prime candidates for early adoption of the next generation of that technology. We believe that the examination of technology-usage behavior and the process by which usage patterns change can lead to insights into many issues that are of interest to both marketing scholars and practitioners.

In examining the use-diffusion process, Shih and Venkatesh (2004) proposed the use diffusion model that describes technology usage behavior along the dimensions of rate and variety of use, which combine to form four categories of usage behavior: intense, specialized, nonspecialized, and limited. However, their model is static in that it examines usage behavior at a point in time by comparing usage from one household relative to

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another. Building on the work of Shih and Venkatesh (2004), we propose a dynamic use diffusion model that explicitly captures changes in technology usage from the time of adoption. We also examined the consequences of dynamic use diffusion on household perceptions of usage changes that have impacted their lives, and how dynamic use diffusion leads to satisfaction with the technology in general.

An empirical investigation was conducted in the context of computer usage across three countries: the United States, Sweden, and India. The countries were selected on the basis of the participation of three prestigious research organizations in each of the countries: Marknadstekniskt Centrum (Sweden), National Science Foundation (United States), and IMRB International (India). In many respects, Sweden and the United States are highly comparable in that they have a highly developed industrial base with a relatively long history of computer diffusion. While the United States is ahead in personal computer (PC) diffusion, Sweden is a leader in certain areas of communication technologies such as mobile phones and wireless communication (Chandrasekaran and Tellis, 2008; Dobers and Schroeder, 2001; Kruse and Carlsson, 2005). India represents a distinctly non-Western culture, and, as an emerging information economy, it has become a major global player in the software industry (Angell and Ezer, 2006; Heitzman, 2004; Johnson and Tellis, 2008). A major strength of our study is the collection of primary data on a national scale from three countries during the same time frame using probability sampling procedures. This method allows us to compare technology application across country/culture while controlling for extraneous effects that may arise over time. Therefore, differences observed are more likely to be due to inherent country/culture differences as opposed to time-dependent variations such as new innovations in the marketplace or increasing fluency and experience with technology over time. We next present our conceptual model for dynamic use diffusion.

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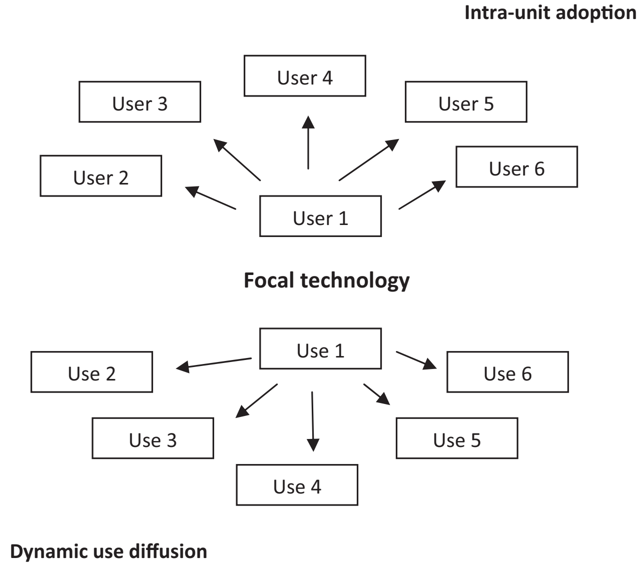

Figure 1. Two Post-Adoption Diffusion Processes

Dynamic Use Diffusion

When a household adopts a focal technology, the diffusion process is not considered complete. Instead, it is the starting point of the post-adoption diffusion process. Conceptually, the post-adoption diffusion process can take two distinct forms. The first form is the spreading of technology use by one member of the adopting household to another member. For example, the first person in the household to adopt or use a newly purchased exercise machine can, over time, influence his or her spouse to also use the exercise machine at a subsequent time. The focus of this post-adoption diffusion process is on the actors within the adopting unit, and the extent of such diffusion would rely on the imitation of behavior or personal communication and influence among the members. In Figure 1, we label this as intra-unit adoption.

The second process by which a technology can diffuse throughout the adopting unit is by the way in which it is used. In this case, the focal technology may be adopted for one set of purposes initially, but over time, the use of the technology may spread or diffuse to incorporate additional usage scenarios and become increasingly incorporated into the activities of the household. We depict this process as a dynamic use diffusion in Figure 1. Both intra-unit adoption and dynamic use diffusion signify the evolving nature of technology within the household, and it is logical to assume that either process would lead to the increasing integration and importance of technology in the household.

A parallel can be drawn between the dynamic use diffusion process we are studying here and the use diffusion model proposed by Shih and Venkatesh (2004), which we will refer to as static use diffusion to differentiate between the two models, in that both models are explicitly addressing technology usage behavior within the household. The static use diffusion patterns measure the relative degree of use for one user against other users at one point in time. However, we should not expect individuals' use to remain constant over the life cycle of the focal technology.

An individual's use of technology may evolve as new uses are discovered, and more time may be devoted to using the technology if it provides the expected benefits. Thus, using the dimensions of variety of use proposed by Shih and Venkatesh (2004), we can describe changes in usage behavior for an individual over time. For example, a person may begin personal computing in a limited way at the time of initial adoption, using a few popular productivity applications (e.g., word processing and spreadsheets), and progressively branch out to graphics, video games, and so on. In such a case, there is an increase in the ways in which the technology is used, and we can say that a higher amount of use diffusion has taken place.

While the common expectation for technology use is that there is an increase in the variety of use over time, actual patterns of change are more likely to be far more variable, and consumers might even limit their use. Opposite to use diffusion increase is use contraction, a state of use diffusion in which there is no increase (i.e., it remains the same or decreases) in the ways in which the technology is being used. Such a decrease may occur when replacement technologies are introduced or when there are fundamental changes in the user's environmental context.

Use contraction is also the most likely dynamic use diffusion pattern when the technology has not met (or just met) the expectations of the adopters. For example, it is often the case that at the initial periods of adoption, the technology is met with great enthusiasm, followed by periods of intense activity on the part of users trying to determine how the technology fits in the household. If the initial expectation is not confirmed by trial, the use of the technology slowly decreases and, in extreme cases, may even reach zero. At this extreme point, the technology is essentially disadopted. Conversely, if the technology meets expectations exactly, barring any motivations to change behaviors, the use of the technology will remain stable over time without any increase in reasons for use.

To summarize, static use diffusion describes the usage behavior of users relative to other users. Dynamic use diffusion describes the change an individual may undergo as his/her experiences with the technology change. Dynamic use diffusion is the link between different static use diffusion patterns across time because it describes the longitudinal changes in technology use. Given the above conceptualization of dynamic use diffusion, we next present the conceptual model for dynamic use diffusion, focusing on the antecedent factors that are predictive of changes in usage behavior. Further, attitudinal consequences of dynamic use diffusion are presented with its implications. A graphical illustration of our conceptual model is presented in Figure 2.

Antecedents of Dynamic Use Diffusion

We propose categories of factors that can potentially influence the extent of dynamic use diffusion: communication patterns, technological structure of the household, and individual-use innovativeness.

In the consumer literature, it is well accepted that how we behave and how we choose are often a result of our socialization within our close personal network (Nguyen, Moschis, Shannon, and Gotthelf, 2009). The effect of communication within an immediate social network, such as other household members, should be critical in dynamic use diffusion. 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 household members serves as a way for an individual to resolve usage difficulties. When confronted with technological problems, users may feel discouraged and limit the amount of time they spend using the technology. They may even discontinue the use of the technology altogether. However, when a household network exists in which users can pose questions regarding the technology, information can be quickly exchanged to overcome difficulties in using the technology. Once the frustration and difficulties are resolved, not only is usage sustained but also new usage may be triggered by the communication exchange, as members of the household network may have different, nonoverlapping usage behaviors such that members may share information with respect to different applications of the technology. The resulting behavior of individuals in the network may trigger a new, unanticipated set of usage behaviors as these individuals draw on the experiences of other members, leading to dynamic use diffusion.

H1: Higher frequency of communication with other users about the technology leads to higher dynamic use diffusion.

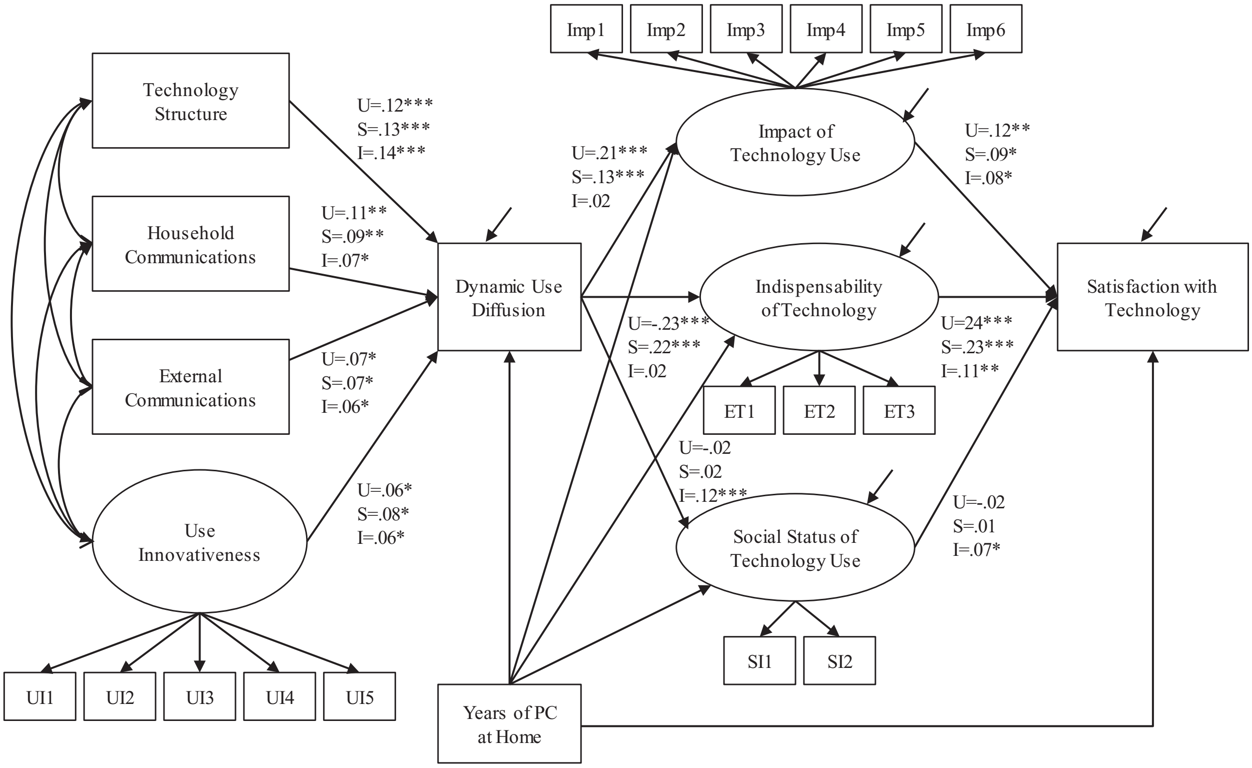

Figure 2. Structural Model of Dynamic Use Diffusion
Note: U = United States; S = Sweden; I = India. *p < .05; **p < .01; ***p < .001.

When communication related to the use of technology resides solely within the household, although positive, its impact may be limited in terms of dynamic use diffusion. Members of a household comprise a homophilous network, meaning that they often share similar experiences and perceptions (Burt and Janicik, 1996). Because of the commonality in practice and understanding of technology through close ties, there may seldom be ideas that are not shared among members of the household. In other words, ideas are rehashed, and new ideas will not be introduced into the household. Instead, where communication channels exist with people outside of the immediate household, such as with friends and co-workers, new ideas about the use of technology may be introduced to the user through a more distant communication network. This argument is supported by the theory of the strength of weak ties, which argues that the spreading of ideas is often facilitated by contact with people outside of the adoption cluster; in our case, it is the household (Granovetter, 1973). However, the strength of the weak ties argument is not meant to be a counterargument to the 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 parallel and often complement each other in diffusion.

In addition, it is also possible that communication regarding the technology may not even take place within the home. For example, the social structure of the family may make it difficult for elder family members (i.e., parents) to seek advice from the children, who are often more knowledgeable about computing technology. This may be done out of fear that the parents may somehow lose their dominance in the social structure. Instead, they may seek help outside of the home. The concept of structural equivalence in social network theory (Burt and Janicik, 1996) suggests that members of a social network will often adopt new ideas just to keep up with other members of the network so as to maintain their position within the network. Therefore, one way diffusion of technology use may occur is for an individual to gain information from members outside of the household so that the individual's dominance within the household is not threatened.

H2: External communication frequency pertaining to the innovation leads to higher dynamic use diffusion.

The use of any technology must take into consideration the use of all other technologies in the home. Vitalari, Venkatesh, and Gronhaug (1985) refer to this as cognate technologies, while Rode, Toye, and Blackwell

(2004) refer to this as the technological cluster. One argument made in this context 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. Conversely, as Shugan (1980) has shown, the cognitive effort required to accumulate knowledge decreases, making the acquisition of related products easier and therefore more attractive. That is, if we consider the complementary nature of technologies or their interconnection potential, the use of a given technology may increase with the use of other (complementary/connected) technologies.

If complementary capabilities and connectivity are indeed predictors for the 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, and so on, and that ownership and use of these technologies increase the potential applications of the computer in the home and thus the variety of its uses (Kim, Shin, Lee, and Lee, 2009). However, the reverse would be true for the rate of use because time constraints cause the use of other technologies (e.g., video game consoles) to take time away from computer use.

H3: Access to complementary (cognate) technologies results in higher dynamic use diffusion.

Several authors have adopted inherent novelty-seeking behavior and consumer creativity into models of multiple-usage behaviors. Ridgeway and Price (1994) presented the first instance of such efforts. Among their contributions is the development of a scale to measure use innovativeness. The use innovativeness scale, as developed by Ridgeway and Price (1994), is operationalized as the personality trait that an individual possesses, as opposed to actual or observed multiple-usage behavior. The relationship between what is being measured by the scale and actual behavior is akin to innate and actualized use innovativeness.

In developing the scale, Ridgeway and Price (1994) incorporated two major components: creativity and curiosity. They hypothesized that for consumers to use existing products in novel ways, they must have the ability (creativity) and the incentive (curiosity) to do so. The scale is meant to tap into the inherent characteristics of consumers in these two areas, in addition to risk preference, voluntary simplicity, and multiple-use potential. It was suggested that these factors should be positively related to a consumer's actual multiple usage of a product. However, the authors did not measure actual multiple-usage behavior (nor was it tested in subsequent work), so the existence of a relationship between the scale and the actual behavior remains an untested hypothesis. Cotte and Wood (2004) have also examined innovativeness in the context of family dynamics and found it to be an integral part of usage. Based on previous theory and empirical work, we hypothesize:

H4: Higher use innovativeness results in higher dynamic use diffusion.

Consequences of Dynamic Use Diffusion

Increasing dynamic use diffusion implies that the focal technology is becoming part of one's daily routine, and we predict that this will lead to a higher perceived impact of technology on daily lives. It is entirely possible that a low level of the dynamic may still lead to a positive perception of the impact of technology use. For example, the adoption of a washer and dryer is unlikely to spread to other usage contexts in the home, and thus has low levels of dynamic use diffusion. But most adopters will agree that it has a significant positive impact on daily life simply because it frees up people's time, thus allowing them to pursue other activities.

However, for the general-purpose technology that our conceptual model is aimed at addressing, the more ways in which the technology is used, the greater the impact should be. This is because daily routines involve micro-level practices, and the adoption and use of general-purpose home technologies are meant to help facilitate and automate many of these practices. As the use of computing technology spreads from one area of the household to the next (e.g., communication, entertainment, and household management), it can often lead to the ritualization of activities (checking e-mail during breakfast, catching the latest TV shows each night, and paying credit card bills). Ritualization can provide a sense of security and predictability in daily lives and help people cope with everyday stresses and strains. In due course, familiar routines generally have a positive impact in that they can lead people to become more familiar with normal routines, become more efficient, and live more productively. If general-purpose technology is limited to only one aspect of a household, then its impact will not be as strong as that of technology undergoing high dynamic use diffusion.

The concept of indispensability refers to something people cannot live without. Similar notions, such as "necessities" or "essential products," have been extensively investigated by other researchers (Chaudhuri, 1998; Childers and Rao, 1992). In contrast, products deemed to be dispensable are seen as frivolous, unnecessary, and wasteful. They tend to be products people feel they can do without. Hoffman et al. (2004) have argued that the Internet and computing technology have become increasingly indispensable to families and to society at large. While this finding is generally well accepted, the process by which the Internet and computing technology are becoming indispensable is less clear. We propose that increasing dynamic use diffusion leads to the indispensability of a technology. This is because as technology penetrates and takes hold across various aspects of household life, it becomes more vital for everyday activities and more difficult to replace. In essence, the technology becomes indispensable. Further, any technology adopted later can perhaps replace one function of the focal technology, but it is unlikely to be an acceptable substitute across multiple functional areas, which adds to the focal technology's indispensability.

H5: Higher dynamic use diffusion leads to higher perception of the (a) impact of technology and (b) higher indispensability of technology.

Finally, we propose that as users perceive the focal technology to have a greater impact and to be indispensable in their daily lives, they are more likely to be satisfied with the technology. At the time of adoption, all consumers have certain expectations about the effect of technology on their life. As usage increases over time, and as it leads to a higher impact and perceived indispensability of the technology, the effect of the technology reaches a level above and beyond users' initial expectations. Based on expectation-confirmation theory (Oliver, 1980), we expect this to lead to higher satisfaction with the focal technology. Thus, we predict the following:

H6: Satisfaction with technology is driven by (a) higher perceived impact of the technology and a (b) higher perceived indispensability of the technology.

Social Status Outcome of Technology Use and the Moderating Effect of National Culture

Although the popular press has speculated that converging technologies and shrinking income differences across countries will lead to the homogenization of consumer behavior (Friedman, 2005), some academic researchers actually think that consumer behaviors will become more heterogeneous because of cultural differences (Venkatesh, 1995). This divergence in consumer behaviors makes it increasingly important to understand the values of national cultures and their impact on consumer behavior. While culture is a fuzzy concept and difficult to define, a commonly accepted definition refers to the distinct ways that people living in different parts of the world act out their daily lives and their experiences and symbolic values. Thus, cultures vary based on their values and belief systems, and this has implications to product choice, adoption, and usage practices (Roth, 1995). For example, among the three countries under study, Sweden is the most egalitarian, and India has a somewhat rigid class system while the United States is in the middle but closer to Sweden. As an emerging market economy, India probably seems to demonstrate high status-signaling potential in their adoption of new products and brand consumption behaviors.

Beyond luxury brand purchases and consumption, we believe that the use of technology can also be used to convey class boundaries. This is perhaps particularly true in developing countries where the technology has not widely diffused. In such countries, ownership and usage of technology can signal that one is a member of the technological elite class. As the use of technology increases over time, it can convey a greater sense of progressiveness for its users, which sets them apart from the people around them. Given that India is a developing country, and clearly, of the three countries we examined, it has the highest social class orientation, we thus expect that Indian respondents will be most likely to believe that the use of technology can act as a signal to others of their social standing.

H7: Higher dynamic use diffusion leads to stronger social status outcome of technology use; however, this effect is stronger for India than the United States and Sweden.

H8: Higher social status outcome of technology use leads to higher satisfaction with technology, but the effect is stronger for India than the United States and Sweden.

Next, we describe our data collection across the three countries and present the results of our empirical analysis.

Methodology

Sampling and Data Collection

Data for this study were collected in three countries using random digital telephone interviews in Sweden and the United States and personal interviews in India. The interviews were administered by highly reputable professional marketing research agencies in the three countries specially commissioned for this study: Marketing Technology Center, Stockholm, Sweden; The Field Research

Institute, San Francisco, United States; and the Marketing Research Bureau, a subsidiary of J. Walter Thompson, 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, based on population statistics from different sources, the penetration of computers into Swedish and U.S. households was estimated to be slightly skewed toward higher income households. Therefore, to maximize the probability of representing the computer-owning households, we oversampled households with higher income levels in Sweden and the United States. In India, because 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% of the computers installed (IMRB, 2004). 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 United States, 906 in Sweden (both national probability samples), and 996 in India (urban probability sample).[1]

The questionnaire was pretested on 25 households in each of the three countries for accuracy, validity, and ease of administration before the full-scale study was launched. Interviews in the United States and India were conducted in English, while Swedish was used in Sweden. The questionnaire was professionally translated (and back-translated) and pretested prior to interviews in Sweden.

Interviewers asked the respondents 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 focused on 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 to have conducted individual interviews with every user in the household, but this was not practically feasible. With these practical constraints, we decided to have one primary respondent in each household act as the main informant for the rest of the household members.

Table 1. Usage of a Computer at Home

Use Categories	Specific Activities
1. Education	Education (for yourself or children)
	School-related work
2. Financial management	Managing finances
	Online banking or stock trading
3. Job	Employment-related work
4. Games/entertainment	Games
	Entertainment
5. Communication	E-mail
	Writing letters or correspondence
6. Web surfing	Reading news or information
	Sports information
	Community information
7. Home management	Home management (recipes and family records)
	Health information
	Travel information or vacation planning
	Shopping

Measures

To measure dynamic use diffusion, we first asked our respondents to reflect back to when they first acquired the computer for the home and tell us what were the activities they adopted the computer for at home. A checklist of activities (see Table 1) falling into seven categories (education, financial management, job, games and entertainment, e-mail and communications, web surfing, and household management) was read to the respondents, and they responded either "yes" or "no." The respondents were then asked to indicate how they were currently using the computer at home according to the same list of activities. We created a dynamic use diffusion index (UDI) by taking the difference between the total number of different categories the computer was currently used for and the total number of different categories that a computer was adopted for initially.[2] A higher UDI indicated growth in how households use the computer from the time of adoption, or a greater level of dynamic use diffusion, while a smaller UDI reflected a lower level of dynamic use diffusion. The number can be negative when computers are being used in fewer ways than were intended at adoption.[3]

For antecedents of dynamic use diffusion, we measured the extent of computer-related communication between members of the household and communication

[1] At the time of data collection, roughly 64% of the households in the United States and 59% in Sweden owned at least one computer. In India, the penetration for the entire country was about 1%. In terms of actual numbers, this translates into about 50 million households in the United States, 5 million households in Sweden, and 5 million households in India. However, in India, since more than 90% of the computers were owned by households living in major metropolitan areas, our study covered the urban population base for computer households.

[2] While Shih and Venkatesh (2004) only measured the reasons households used computers at one point in time, we measured the change in usage behavior between the time of adoption and the time of survey.

[3] Negative use diffusion is reflective of use contraction behavior, similar to the limited use pattern in Shih and Venkatesh (2004).

Table 2. Antecedents and Outcomes of Dynamic Use Diffusion

Variable	Measurement	
Household communication intensity	$HCI_h = \Sigma \lambda_{ij}/H_h$ λ_{ij} = frequency of communication between users i and j (2 = frequently, 1 = sometimes, 0 = never) H_h = number of users in the household	
External communication intensity	Sum of frequency of communication with friends, coworkers, and others on computer use (2 = frequently, 1 = sometimes, 0 = never).	
Technological structure	Which of the following technologies do you currently use at home? • PDA or handheld computer • Fax or telex machine • Cell/mobile phone • Video game console • Digital camera • DVD player/VCR	 • Stereo system • Satellite TV/cable TV • Video camera • Voice mail/answering machine
Use innovativeness 1 = Strongly disagree 5 = Strongly agree α = .81, .84, .76*	• I am creative with computers. • I am very curious about how computers work. • I am comfortable working on computer projects that are different from what I am used to. • I often try to do projects on my computer without exact directions. • I use a computer in more ways than most people do.	
Impact of technology 1 = Strongly disagree 5 = Strongly agree α = .73, .77, .73*	• The computer has saved us time at home. • The computer has changed the way we do things at home. • The computer has replaced the telephone as a major communication device in our home. • We have more contact with friends and relatives now that we have email. • My family watches less TV as a result of using the computer or the Internet. • Households with a computer are run more efficiently than those without a computer.	
Indispensability of technology 1 = Strongly disagree 5 = Strongly agree α = .79, .74, .72*	• The computer is as essential as any other household appliance. • It would be difficult to imagine life without a computer in the home. • The computer has become part of the daily routine in the home.	
Social status outcome 1 = Strongly disagree 5 = Strongly agree α = .79, .71, .71*	• Computers give status to their owners. • Those who are not knowledgeable about computers are falling behind.	
Satisfaction with technology 1 = Not at all satisfied 5 = Very satisfied	• What is your experience with computers at home in general?	

* Cronbach's alphas are listed in the order of the United States, Sweden, and India.

with people outside of the household, technology structure, and use innovativeness. Household communications intensity (HCI) for respondent h was measured as the frequency of computer-related communication with other users in the home and computed as:

$$HCI_h = \sum \lambda_{ij} / H_h,$$

where λ_{ij} is the frequency of communication between users i and j (2 = frequently, 1 = sometimes, and 0 = never), and H_h is the number of users in the household.

This index makes an upward adjustment when communication about computers between two users is more frequent. To avoid biases toward larger household sizes, HCI was normalized by the number of computer users in the household. External communication intensity (ECI) measured the extent to which members of the household communicate with friends, co-workers, or a company helpline from which they seek assistance with computer usage. For each of the above parameters, a score was given where 2 = frequently, 1 = sometimes, and 0 = never. Scores were summed to form an index. Technology structure was defined as the extent of cognate or complementary information and media technology use within the household other than computers.

Respondents were read a list of technologies (see Table 2) and asked to indicate whether any of those technologies were used in the home. Finally, use innovativeness was measured by modifying the scale developed by Ridgeway and Price (1994). The items were selected from each of the four reported factors and were reworded to fit the context of the study. The items were randomized and measured with a Likert-type scale, where respon-

Table 3. Computer Use at Home by Country

	United States		Sweden		India	
	Reasons for Adoption	Reasons for Current Use	Reasons for Adoption	Reasons for Current Use	Reasons for Adoption	Reasons for Current Use
Education	72.4%	59.0%	66.7%	53.4%	70.5%	42.0%
Financial management	46.8%	61.2%	21.7%	50.1%	26.4%	29.1%
Job/employment	62.7%	70.9%	56.7%	64.6%	64.0%	72.7%
Games/entertainment	68.0%	92.5%	57.6%	87.4%	59.4%	88.6%
Communications	35.2%	73.6%	41.5%	72.2%	42.5%	39.9%
Web surfing	39.2%	76.6%	42.1%	73.3%	45.2%	39.8%
Shop/home management	35.6%	59.8%	39.4%	58.8%	9.6%	17.2%
Average total reasons for use	3.3	4.9	2.9	4.6	3.1	3.3

dents indicated on a 5-point scale (1 = not at all, 5 = very much) how well the personality statements described themselves (see Table 2).

Dynamic use diffusion outcomes were determined by measuring the impact of technology use, indispensability of technology in the home, and social impression of technology use with multiple items on a 5-point scale (1 = strongly disagree, 5 = strongly agree). Table 3 lists the items included in our survey. Satisfaction with technology was measured with a single question—"What is your experience with computers at home in general?"—on a 5-point scale (1 = not at all satisfied, 5 = very satisfied). While the use of single-item scales is generally discouraged, research in psychology, management, and marketing has argued that a one-item measure of constructs can be both accurate and reliable under certain conditions (Bergkvist and Rossiter, 2007; Rossiter, 2002; Sackett and Larson, 1990; Scarpello and Campbell, 1993; Wanous, Reichers, and Hudy, 1997). In general, a single-item measure may suffice when the construct being measured is sufficiently narrow or is unambiguous to the respondent; satisfaction has been suggested as such a construct (Sackett and Larson, 1990; Wanous et al., 1997).

Sample Descriptive Statistics

Before presenting the analysis of our conceptual model, we present sample descriptive statistics and some initial results of our survey examining computer usage behavior in the home. Table 4 presents the sample statistics. As expected, we found that households in the United States generally have a much longer history of home computer adoption than do those in Sweden and India (see Table 4). Based on our data, at the time of data collection, the average length of Internet use in Sweden is 5.10 years compared with 7.02 years in the United States and 1.92 years in India. In the case of India, however, 75% of the household computers had been acquired within the 2 years immediately prior to data collection. Higher degrees of penetration in Sweden and the United States were also indicated by the fact that households in these two countries exhibited a greater incidence of multiple computer ownership (20% of the computer-owning households in Sweden and 28% in the United States compared with only .7% in India).

We next examine our dynamic use diffusion measure, the difference between reasons for adoption of household computers and how computers are being used (see Table 3). Overall, there has been significant growth in dynamic use diffusion across all three countries, but the United States (3.3–4.9) and Sweden (2.9–4.6) experienced greater dynamic use diffusion growth than India (3.1–3.3). This makes intuitive sense given

Table 4. Sample Statistics

	United States	Sweden	India
Sample size (number of households)	910	906	996
Years of computer ownership	7.02	5.10	1.92
Number of computers at home	1.40	1.38	1.01
Number of users per household	2.53	2.41	2.57
Number of adult users per household	1.81	1.70	2.14
Number of children users per household	.68	.71	.43
% of households in the sample with Internet	83%	78%	42%
Ratio of male to female users in the sample	50/50	57/43	75/25
Mean household size	2.95	2.83	4.10

that respondents in the United States and Sweden have longer histories of home computer ownership and thus more opportunities to experiment with using computers in diverse areas of family life. Interestingly, educational use of computers was claimed as the primary reason for computer adoption in homes across all countries.

However, across all countries, education was not the primary reason that respondents were using computers in the home. In fact, the percentage of computer use for educational purposes was significantly lower in all three countries compared with the original reason computers were adopted. Communications is an area in which home computers experienced the most growth between adoption and current use in the United States (+38.4%) and Sweden (+30.7%). Communication use actually declined in India (−2.6%), suggesting that perhaps the proliferation of mobile phones and text messaging has shifted the intended use of home computers for communications to mobile technology. Instead, the largest area of growth in computer use for India was in games and entertainment (+29.2%).

Hypotheses Testing

We first assessed the measurement models in terms of fit for each of the three countries. The measurement models provided a good fit across all three countries, and the model fit indexes were within the recommended range (goodness-of-fit index [GFI] = .97, .96, .95; comparative fit index [CFI] = .96, .96, .95; and root mean square error of approximation [RMSEA] = .03, .04, .04 for the United States, Sweden, and India, respectively) (Kline, 2005). All constructs achieved reliability above the recommended cutoff of .7 (Cronbach's alpha ranged from .71 to .84), and all items demonstrated adequate convergent validity with significant loading on the constructs with values exceeding .54 (all $p < .05$). Overall, the analysis suggested satisfactory reliability of the measures used in the analysis.

We then assessed the structural model for different countries. In all analyses, we used years of experience with computers in the home as a control variable for dynamic use diffusion and its outcome variables. This was done because dynamic use diffusion and its consequences may be influenced by length of time computer has been adopted, which would obscure the expected effects. For example, it takes time for households to increase dynamic use diffusion. Further, social status outcome may be influenced by stages of diffusion process because at early stages of diffusion process, the technology is still novel, and usage perhaps can signal membership in a technological elite class. Using time since adoption as control variable, the structural paths we observed in our analysis are interpreted as effects on dynamic use diffusion and consequences of dynamic use diffusion controlling for experience with technology.

Figure 2 shows the results of the structural equation model and path between constructs for each of the three countries. Although the χ^2 statistics were significant for all three countries ($\chi^2 = 279.56, 218.36, 267.82$, degrees of freedom = 196, $p < .001$ for the United States, Sweden, and India, respectively), the model suggested a good level of fit for the corresponding data given all fit indices in the appropriate range for each of the samples (GFI = .93, .91, .90; CFI = .95, .95, .94; RMSEA = .04, .04, .05 for the United States, Sweden, and India, respectively). In addition, most of the hypothesized relationships for each sample were significant, which provided initial support for our conceptual model.

Regarding the antecedents of dynamic use diffusion, results suggested that household communication, external communication, technology structure, and use innovativeness were all significantly related to dynamic use diffusion for all three countries, as predicted. Thus, H1–H4 were supported.

Hypothesis 5a predicts a positive effect of dynamic use diffusion on perceived impact of technology use. This was true for the United States and Swedish samples, but not for the Indian sample. Similarly, H5b predicts a positive effect of dynamic use diffusion on feelings of indispensability of technology in the home. Again, we only found a positive relationship for the United States and Sweden, but not for India. H6a and H6b predict positive effects between feelings of impact and indispensability of technology use on satisfaction with technology in the home. The results supported this contention as we observed positive significant effects for both factors for all three countries.

H7 predicts that for countries with high social class distinctions, there will be a stronger effect of dynamic use diffusion on the social status outcome of technology use. This was supported in that we observed a positive effect of dynamic use diffusion on social status outcome only in the Indian sample. Finally, H8 predicts a stronger relationship between social status outcome of technology and satisfaction with technology for a high social status conscious country (i.e., India). This was supported in that there was a positive effect for India, but no significant effect for the United States and Swedish samples.

Discussion

Across the three countries, technology structure appears to have the most relative impact on dynamic use diffusion while innate individual differences and use innovativeness have weaker but still significant impacts. Further, this pattern of relative strength appears to be the same across all three countries. This would suggest that while individual differences can impact how technology usage evolves, the manner in which people communicate with one another and the technological environment of the household play bigger roles in the process. Given the consistent effects of antecedents across different countries, it would appear that factors driving increasing technology usage in the home are universal, even if reasons for initial adoptions may differ.

In examining the outcome of dynamic use diffusion as it varies across countries, we found that increasing dynamic use diffusion led to feelings of greater impact of technology use and essentialness of technology only for the United States and Swedish samples. A higher social status outcome of technology use was found only in the Indian sample. This is consistent with our hypothesis that respondents from India tend to be more concerned about the social status implications of product usage. With regard to the final outcome variable, satisfaction with technology, all three impacts, and essentialness of technology use led to satisfaction for all three countries. Social status outcome of technology use only led to higher satisfaction for Indian respondents.

However, we also note that the effect of impact and essentialness of technology use exerted a greater effect on satisfaction rather than social status outcome in India. The takeaway message would appear to be that while Indian computer users are consuming technology symbolically and as a way to distinguish themselves and claim membership in a more technologically advanced class, it is also important for them to feel that the technology use is having a significant influence in their lives. On the contrary, in the United States, technology use is more democratic and less likely to be a result of the desire to assert and reflect a user's hierarchy in society. In this regard, satisfaction is primarily derived from users' perceptions of how the technology has changed their day-to-day lives at home.

Contributions and Implications

The research presented here is one of the first efforts toward understanding how technology is being accepted and integrated into households across some parts of the globe. By identifying the dimensions that influence the extent of computer integration in the home, we have extended traditional diffusion research, which, until now, has focused primarily on adoption, by emphasizing usage and integration into home environments. Our research findings suggest that, although there may be some cultural variations in terms of the reasons computers are adopted and how they are used, the determinants of technology integration into households are similar across cultures.

For those interested in developing new information technologies in the home, our study shows a strong relationship between the use of computers and the use of other technology products in the home. In particular, the use of related technologies influences the extent of the dynamic use diffusion of computers, which in turn leads to a more positive impression of the impact and essentialness of computer use and, ultimately, satisfaction with computers. The way in which technology usage in one area can influence usage in another suggests some possibilities for integrating multiple functions into a single technology. For future technology design, attention should be paid to how existing technologies are currently being used by adopters and how users interact with other technologies in the home. For example, Apple has taken such design steps by bundling different consumer technologies, particularly in their iPhone and iPad designs, with multiple functions that cut across various usage scenarios at home and can seamlessly integrate work and home life. Such designs may have great potential for extensive dynamic use diffusion into different distinct household environments and promote general satisfaction with particular technologies.

Given that a computer is a general-purpose technological tool that is difficult to use but has limitless applications, the diffusion of use, and ultimately satisfaction with the computer, rely on how adopters learn to use it for new and different purposes. While it is commonly acknowledged that the word-of-mouth effect is critical in promoting technology adoption, we found that beyond adoption, the word-of-mouth effect, whether with other household members or users outside of the home, continues to be a key driver of dynamic use diffusion. It would then stand to reason that to promote dynamic use diffusion, firms need to encourage other users to disseminate usage information. Such dissemination can be accomplished through the use of key informants in users' social networks, such as the information technology professionals at work or online discussion groups.

We believe that one of our key contributions is articulating the relationship between dynamic use diffusion and technology satisfaction. The relationship between satisfaction and technology adoption is a tenuous one with no clear patterns (Mick and Fournier, 1998; Wood and Moreau, 2006). Much of the home technology that was adopted with great enthusiasm is eventually disadopted, left abandoned and discarded in the garage or storage (Shih and Venkatesh, 2004). Our paper showed that adoption in and of itself does not lead to higher satisfaction, rather it is the continuous and increasing use of technology that leads to perceived impact and indispensability of technology, social status outcome of use (at least for high power distance cultures) that in turn leads to high satisfaction. Thus, one of our implications is that for firms to increase satisfaction with their technology, after the adoption process has been completed, they still need to motivate the adopters to increase how the technology has been used.

Finally, in our study, we found that impact and utilitarian outcomes are strong factors in determining the level of technology use in the home, but social and symbolic aspects of technology also matter under certain cultural conditions. However, if technology does not provide observable utilitarian outcomes, the level of use may not be sustained. That said, our findings also suggest that highlighting the symbolic aspects of technology is of value for technology producers in certain high power distance countries when marketing their products. While most marketing communications pertaining to technological products emphasize the key features and benefits relative to other products, an alternative could place more emphasis on how the use of the technology makes the user stand out, signaling membership in a technologically sophisticated class. This would subtly shift the marketing message away from the product and put the focus on the user and how usage makes the user unique in some way, akin to how advertising differentiated Apple from other companies by presenting its users as "cool" and the antithesis of Windows users.

References

Angell, I. O., and J. Ezer. 2006. New barbarians at the gate: The new spirit emerging in India. *Information Society* 22 (2): 20–33.

Bajwa, D. S., F. L. Lewis, G. Pervan, and V. S. Lai. 2005. The adoption and use of collaboration information technologies: International comparisons. *Journal of Information Technology* 20 (2): 130–40.

Bergkvist, L., and J. R. Rossiter. 2007. The predictive validity of multiple-item versus single-item measures of the same constructs. *Journal of Marketing Research* 44: 175–84.

Burt, R. S., and G. A. Janicik. 1996. Social contagion and social structure. In *Networks in marketing*, ed. D. Iacobucci, 32–49. Thousand Oaks, CA: Sage.

Castells, M. 2001. *The internal galaxy: Reflections on the Internet, business and society*. New York: Oxford University Press.

Chandrasekaran, D., and G. J. Tellis. 2008. Global takeoff of new product: Culture, wealth, or vanishing difference. *Marketing Science* 27 (5): 844–60.

Chaudhuri, A. 1998. Product class effects on perceived risk: The role of emotion. *International Journal of Research in Marketing* 15 (2): 157–68.

Childers, T. L., and A. R. Rao. 1992. The influence of familial and peer-based reference groups on consumer decisions. *Journal of Consumer Research* 19 (2): 198–211.

Corracher, N., and A. Ordanini. 2002. Measuring the digital divide: A framework for the analysis of cross-country differences. *Journal of Information Technology* 17: 9–19.

Cotte, J., and S. L. Wood. 2004. Families and innovative consumer behavior: A triadic analysis of sibling and parental influence. *Journal of Consumer Research* 25 (1): 78–86.

Deuze, M. 2006. Participation, remediation, bricolage: Considering principal components of a digital culture. *Information Society* 22 (2): 63–75.

Dobers, P., and J. Schroeder. 2001. Representing IT: Embodying the electronic economy—Swedish experience. *Digital Communities Conference*. Chicago, IL, November.

Friedman, T. L. 2005. *The world is flat: A brief history of the twenty-first century*. New York: Farrar, Straus, and Giroux.

Ganesh, J., V. Kumar, and V. Subramaniam. 1997. Learning effect in multinational diffusion of consumer durables: An exploratory investigation. *Journal of Academy of Marketing Science* 25: 214–28.

Golder, P. N., and G. J. Tellis. 1998. Beyond diffusion: An affordability model of the growth of new consumer durables. *Journal of Forecasting* 17: 259–80.

Granovetter, M. 1973. The strength of weak ties. *American Journal of Sociology* 78: 1360–61.

Heitzman, J. 2004. *Network city: Planning the information society in Bangalore*. New Delhi: Oxford University Press.

Hoffman, D. L., T. Novak, and A. Venkatesh. 2004. Has the Internet become indispensable. *Communications of the ACM* 47 (7): 37–42.

IMRB. 2004. *Report on Internet in India*. Available at http://www.acronymfinder.com/Indian-Market-Research-Bureau-%28IMRB%29.html, accessed July 2008.

ITU. 2007. *Trends in telecommunication reform 2007: The road to next-generation networks (NGN)*. Geneva: International Telecommunications Union.

Johnson, J., and G. J. Tellis. 2008. Drivers of success for entry into China and India. *Journal of Marketing* 72: 1–13.

Jung, H. S., and S. Y. Yeoum. 2010. The effects of use patterns and service quality on performance and use satisfaction on library information system. *Journal of Global Academy of Marketing Science* 18 (4): 217–44.

Kim, C. S., J. Shin, M. Lee, and J. Lee. 2009. Correlation among ownership of home appliances using multivariate probit model. *Journal of Global Academy of Marketing Science* 19 (2): 19–28.

Kline, R. B. 2005. *Principles and practice of structural equation modeling*. New York: Guilford.

Kruse, E., and A. S. Carlsson. 2005. *A journey to the third place: Making sense of the early adopters of communication technology*. Stockholm: Ericsson.

Lim, K. H., K. Leung, L. S. Choon, and M. K. O. Lee. 2004. Is ecommerce boundary-less? Effects of individualism–collectivism and uncertainty avoidance on Internet shopping. *Journal of International Business Studies* 35 (6): 545–59.

Lindolf, T. R. 1992. Computing tales: Parents' discourse about technology and family. *Social Science Computer Review* 10 (3): 291–309.

Mick, D. G., and S. Fournier. 1998. Paradoxes of technology: Consumer cognizance, emotions, and coping strategies. *Journal of Consumer Research* 25 (2): 123–43.

Nguyen, H. V., G. Moschis, R. Shannon, and K. Gotthelf. 2009. The effects of family structure and socialization influence on compulsive buying. *Journal of Global Academy of Marketing Science* 19 (2): 27–39.

Oliver, R. L. 1980. A cognitive model of the antecedents and consequences of satisfaction decisions. *Journal of Marketing Research* 27: 460–69.

Ridgeway, N. M., and L. L. Price. 1994. Exploration in product usage: A model of use innovativeness. *Psychology and Marketing* 11: 69–84.

Robertson, T. S., and H. Gatignon. 1986. Competitive effects on technology diffusion. *Journal of Marketing* 50 (3): 1–12.

Rode, J. A., E. F. Toye, and A. F. Blackwell. 2004. The fuzzy felt ethnography—Understanding the programming patterns of domestic appliances. *Personal and Ubiquitous Computing* 8 (3–4): 167–76.

Rogers, E. M. 1995. *Diffusion of Innovations*. New York: Free Press.

Rossiter, J. R. 2002. The C-OAR-SE procedure for scale development in marketing. *International Journal of Research in Marketing* 19: 305–35.

Roth, M. S. 1995. The effects of culture and socioeconomics on the performance of global brand image strategies. *Journal of Marketing Research* 32: 163–75.

Sackett, P. R., and J. R. Larson, Jr. 1990. Research strategies and tactics in industrial psychology. In *Handbook of industrial and organizational psychology volume 1*, ed. M. D. Dunnette and L. M. Hough, 419–89. Palo Alta, CA: U.S. Consulting Psychologist Press.

Scarpello, V., and J. Campbell. 1993. Job satisfaction: Are the parts there? *Personnel Psychology* 36 (3): 577–600.

Shih, C. F., and A. Venkatesh. 2004. Beyond adoption: Development and application of a use-diffusion model. *Journal of Marketing* 68: 59–72.

Shugan, S. M. 1980. The cost of thinking. *Journal of Consumer Research* 7: 99–111.

Spencer, J. W. 2003. Global gate keeping, representation, and network structure: A longitudinal analysis of regional and global knowledge-diffusion networks. *Journal of International Business Studies* 34 (5): 428–42.

Stremersch, S., and G. J. Tellis. 2004. Understanding and managing international growth of new products. *International Journal of Research in Marketing* 21: 421–38.

van Everdingen, Y. M., W. B. Aghina, and D. Fok. 2005. Forecasting cross-population innovation diffusion: A Bayesian approach. *International Journal of Research in Marketing* 22 (3): 293–308.

Venkatesh, A. 1995. Ethnoconsumerism: A new paradigm to study cultural and cross-cultural consumer behavior. In *Marketing in a multicultural world*, ed. J. A. Costa and G. Bamossy, 26–67. Thousand Oaks, CA: Sage.

Vitalari, N., A. Venkatesh, and K. Gronhaug. 1985. Computing in the home: Shifts in the time allocation patterns of the household. *Communications of the ACM* 28: 512–22.

von Hippel, E. 1995. *The sources of innovation*. New York: Oxford Univ. Press.

Wanous, J. P., A. E. Reichers, and M. J. Hudy. 1997. Overall job satisfaction: How good are single-item measures? *Journal of Applied Psychology* 82 (2): 247–52.

Warlop, L., and S. Ratneshwar. 1993. The role of usage context in consumer choice: A problem solving approach. In *Advances in consumer research volume 20*, ed. L. McAlister and M. L. Rothschild, 377–82. Provo, UT: Association for Consumer Research.

Wolcott, P., and S. Goodman. 2003. Global diffusion of the Internet 1: India: Is the elephant learning to dance? *Communications of the Association for Information Systems* 11: 540–646.

Wood, S. L., and P. Moreau. 2006. From fear to loathing: How emotion influences the evaluation and early use of innovations. *Journal of Marketing* 70 (3): 44–57.

Ziamou, P., and S. Ratneshwar. 2002. Promoting consumer adoption of high-technology products: Is more information always better? *Journal of Consumer Psychology* 12 (4): 341–51.