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Evidence from Repeat Cross-Sectional Surveys

Ryan Wilson, Kevin J. Krizek, and Susan L. Handy

Expectations remain high that information communications technology (ICT) might reduce travel. The rapid evolution of technology, combined with a dearth of longitudinal data, has made it extremely difficult to assess the affects of ICT on travel. Results are compared from two independent but similar household surveys in 1995 and 2003 to examine changes in home ICT use and store travel. Multiple analysis of covariance is used to control for differences in sample characteristics, attitudes, and city type and to examine changes in the frequency of out-of-home and at-home shopping and banking between 1995 and 2003. Results indicate that the year of the survey has a main effect in explaining shopping, but not banking frequencies. Respondents in 2003 shop out of home and at home with greater frequency and bank out of home and at home with less frequency, though the latter finding is not statistically significant. Despite reported increases in at-home activities substituting out-of-home shopping trips, the most likely explanation of the results—examining several behaviors—is that people engage in multiple forms of shopping and banking and do so in the ways that are most convenient. Preferences for store shopping and online security concerns may limit observable changes in past growth and the future potential of ICT to replace physical trips.

Expectations remain high that information communications technology (ICT) will reduce physical travel and particularly the negative effects of automobile travel (e.g., traffic congestion and air pollution). For almost a quarter-century, government officials, travel behavior specialists, technology forecasters, and others have been monitoring how ICT might affect travel. Almost 15 years ago, a U.S. Department of Transportation report discussed the long-range implications of ICT on travel patterns, route choice, and congestion. The report identified telecommuting as a potential strategy for managing transportation demand, and other activities (including teleshopping and telebanking) as potential substitutes for auto trips (*1*).

Pinning down the effect of technology on travel is challenging. Almost all work to date has been cross-sectional in nature, examining behaviors at one point in time. It is helpful to consider changes over time, including trends in the use of at-home ICT activities and their relationship to travel. Prospective panel studies are ideal for examining these trends but are expensive, and so far, none have been undertaken. In the absence of panel data, cross-sectional studies can be compared, although different means of data collection as well as the rapid evolution of technology limit this approach. As a result, at-home ICT trends have been difficult to track as new questions and possibilities surface continuously. The approach offered in this paper uses repeat cross-sectional surveys—one conducted in 1995 and the other in 2003—to examine changes in ICT use and related travel behaviors.

The aim of this study is to determine the degree to which at-home ICT use and out-of-home store travel changed from 1995 to 2003 for the selected purposes of shopping and banking. First, relevant literature on the potential impacts of ICT on travel and the nature of common ICT activities provide some overall context for this exercise, and then national trends for computer ownership, Internet access, online shopping, and online banking are detailed. Next, an overview is provided of the methodological approach and statistical techniques used to examine changes in the frequency of out-of-home and at-home shopping and banking between 1995 and 2003. Finally, results are summarized, and the implications are discussed with respect to the relationship between ICT and travel behavior.

LITERATURE ON ICT USE AND TRIP SUBSTITUTION

For many years, transportation agencies have expected that ICT would contribute to an effective strategy for transportation demand management. The ability of ICT to manage short-term travel demand could complement strategies and programs for mitigating congestion in the long term, 10 to 15 years (*2*). ICT use could provoke numerous outcomes on personal travel; two profound possibilities are that ICT will change the type of activity engaged in (at home and out of home) as well as alter the frequency, timing, and destination of travel patterns (*3*). Not without consequence, ICT activities could generate trips if they provided greater flexibility in whether, when, where, and how travel were to occur (*4*).

The ability of ICT to aid in transportation demand management may be limited in several ways. First, ICT trip substitution might be successful only in niche markets, such as high-income and time-constrained groups (*5*). The type of product may limit trip substitution as well. Books, magazines, CDs, DVDs, software, and admission tickets are more popular online purchases than clothing, pharmaceuticals, and food (*6*). Although the content of a CD does not vary across multiple vendors, consumers may be less trusting or unwilling to purchase food or prescription drugs online, preferring to inspect them in person. The percentage of multipurpose trips could also constrain

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the market. One study found that nearly half of shopping trips are multipurpose, implying that substituting one portion of the trip would not eliminate the trip altogether (*7*).

Second, the level of substitution across activities varies. One study, examining 1995 survey data, found that the degree of substitution depends on the activity and attitude. Certain out-of-home activities offer desirable qualities that at-home alternatives cannot replace, such as the social aspect of viewing a movie at a cinema with friends (*3*). Research in Germany found that among computer users, 74% made fewer shopping trips than nonusers, whereas the remaining 26% made more trips (*8*). Another study found that home shopping increases the frequency of store shopping and trip chaining (*9*). Still another found that online shopping reduced short automobile trips by a mere 0.31% (*10*). Other research found that commuters would not be willing to substitute their most frequent home-based trip (*11*). Collectively, these results raise significant doubts about the overall impact of ICT on travel demand.

Third, individual factors that explain trip substitution with ICT are equally unclear. Results of a study of three U.S. cities indicate that Internet availability and attitudinal factors might be as important as, or more important than, spatial attributes (e.g., trip length) in deciding whether to engage in at-home ICT activities (*12*). Reducing travel does not appear to be a primary motivation for using ICT. Results of a review of 65 online shopping studies indicate that the factors affecting online shopping behavior generally are Internet perceptions, vendor information, and user characteristics (e.g., sociodemographics and Internet experience). A desire to avoid trips or reduce travel is an uncommon predictor (*13*).

Prior research thus raises both expectations and doubts about the impact of ICT on travel. Given the rapid expansion in ICT and its use and the potential benefits of even small reductions in automobile travel, further exploration of these questions is warranted.

TRENDS FROM NATIONAL DATA

Technological improvements have increased the rates of computer ownership and Internet access worldwide. Although these changes have been most prominently realized by medium- and high-income households (*14, 15*), low-income households likely realize such upgrades or are able to purchase new products as technology improves and costs decrease. In this section, a snapshot of recent national computer ownership—showing Internet access, online shopping, and online banking trends—is provided for the time period analyzed. This information has two primary purposes: to document how national trends illustrate the emergence of new forms of ICT, and to provide a benchmark for determining how closely the samples reflect the general population.

Computer Ownership and Internet Access

Household computer ownership and Internet access increased steadily from 1995 to 2003. Figure 1 displays national trend data from the U.S. Census (*14*) and the Pew Internet & American Life Project, a nonprofit research center examining the impact of Internet on Americans (*16*). The gap between computer ownership and Internet access shrunk, suggesting that the Internet became more valuable and possibly more affordable to computer owners. Data from the Center for Digital Future mirrors that of Pew Internet, estimating that 65.1% of households had Internet access in 2003 compared with 46.9% in 2000 (*17*). The average 2003 user spent 12.5 h per week online, up from 9.4 in 2000. These results suggest greater at-home opportunities for ICT use.

Online Shopping

Online shopping has grown at rates similar to Internet access since 2000. The Economics and Statistics Administration reports that 40.1% of Americans shopped online in 2000, compared with 52.1% in 2003 (*15*). Pew Internet estimates a change from 41% to 61% during the same period (*16*). However, the percentage of adults who purchased online remained near 45% between 2000 and 2003 (*17*).

The portion of total retail sales attributed to online shopping increased from 0.9% in 2000 to 2.3% in 2003 (*18*). As consumers realize technological innovations and become more trusting of online purchases, market share is likely to increase. At current rates, online shopping gains are likely to outpace total retail shopping over

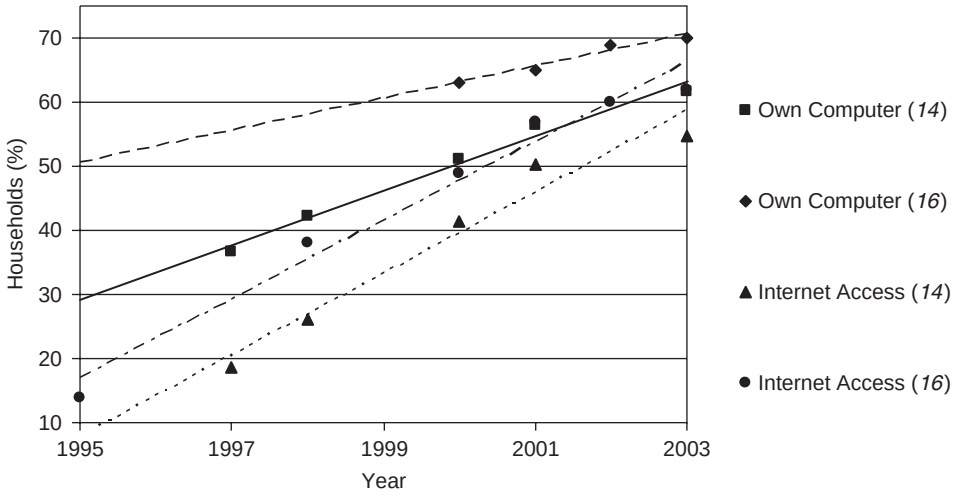

FIGURE 1 Percentage of American households with computers and Internet access (*14, 16*).

the next several years (*19*). The frequency of online shopping probably is increasing with sales, although these trends fail to differentiate this possibility from higher dollar purchases or simply more shopping overall.

Online Banking

Online banking trends tend to mirror those of online shopping. The Economics and Statistics Administration (*15*) estimates an increase of 17.4% to 27.8% in online banking between 2000 and 2003, whereas Pew Internet reports a change of 18% to 34% (*16*). Another poll found that 38% of Americans used online banking in 2005 and that, despite security considerations, 81% believe it is improving overall service and will remain a banking alternative (*20*). Using an ATM is an out-of-home, ICT-based banking activity that allows users to deposit checks and withdraw money from a primary bank. The convenience of ATM cards is greater than ever; a 2002 study estimates that 60% of U.S. ATMs were not at banks (*21*).

HYPOTHESIS

Using the data from two repeat cross-sectional surveys (conducted in 1995 and 2003), two broad research questions were posed. First, to what degree has at-home ICT use and out-of-home store travel changed from 1995 to 2003? Multiple analysis of covariance (MANCOVA) is used to determine the interaction effects, controlling for sample differences. Because congestion has worsened and technology has become more accessible over this period, higher at-home and lower out-of-home frequencies are hypothesized. Second, how much do at-home alternatives substitute for out-of-home trips, and to what degree has this amount changed between 1995 and 2003? Given travel demand expectations, greater substitution is hypothesized.

DATA AND METHOD

Survey Instruments

The 1995 and 2003 surveys queried ICT use; access to technology; and attitudes toward substitution, technology, and congestion. Both were administered by mail and sent randomly to 1,000 individuals in three U.S. metropolitan areas. The 1995 survey focused on San Jose, California; Austin, Texas; and Oklahoma City, Oklahoma. The 2003 survey used Seattle, Washington; Kansas City, Missouri; and Pittsburgh, Pennsylvania. The cities were chosen to test (and control) for ICT influence in areas that represent varying degrees of technology and congestion: low technology and low congestion in Oklahoma City and Pittsburgh, high technology and low congestion in Austin and Kansas City, and high technology and high congestion in San Jose and Seattle. The overall response rate was 16% in 1995 and 31% in 2003. Additional details regarding the individual instruments and select analysis results are available elsewhere (*3, 11*).

The only difference between the survey instruments was in the form of at-home shopping and banking: respondents reported the frequency of catalog shopping and phone banking in 1995 and Internet shopping and banking in 2000. Each represents the common at-home activities that individuals might have used as substitutes for out-of-home physical store trips at the time.

Statistical Analyses

The first research question was posed to determine whether the year of the survey (1995 or 2003) had an effect on the frequency of out-of-home and at-home shopping and banking. MANCOVA emerges as an appropriate multivariate technique to do this because it examines the difference in means of two or more dependent variables across categorical independent variables. The dependent variables should share a theoretical relationship because each measures a separate influence of the independent variables, but their outcomes should be discrete. MANCOVA differs from multiple analysis of variance (MANOVA) in that it considers the interaction effects of continuous and interval-level covariates, which act as controls for the independent variables (*22*). It is more appropriate in this application because both types of independent variables exist.

Changes in the rates of at-home and out-of-home shopping and banking are defined as the dependent variables and survey year as the independent variable of interest. The multivariate *F*-statistic (Hotelling's Trace) tests whether the independent variable survey year and each covariate has an effect on at-home and out-of-home activities. MANCOVA also generates univariate *F*-statistics to describe the interaction between each category of survey year (1995 and 2003) and both dependent variables.

The nine covariates control for differences in sample characteristics, attitudes, and city type. The characteristics of the sample populations (i.e., age, household income, household size, and number of household vehicles) are coded as continuous variables. City type is coded as an interval-level variable, assuming the increasing likelihood to use at-home activities in the following order: low technology–low congestion, high technology–low congestion, and high technology–high congestion. Four attitudinal questions related to technology and congestion are included. A Likert scale measures the extent to which each respondent agrees or disagrees with each statement. The scale ranges from 1 (strongly disagree) to 5 (strongly agree).

To determine whether differences between the 1995 and 2003 survey respondents are statistically significant and to answer the second broad research question, three significance tests for independent samples are used: the independent sample *t*-test (to compare means of two independent continuous variables), the chi-squared test (to compare means of nominal-level tabular data), and the Mann–Whitney *U*-test (to compare mean ranks of ordinal or higher data).

RESULTS

Tables 1 and 2 compare characteristics of the survey respondents, adjusting household income for inflation. The national measure of the average change in price (the consumer price index) was used to adjust for inflation: 20.01% for the entire period (*23*). The means of four differences are significant. On average, the 2003 respondents are 9.4 years older, whereas the 1995 respondents have a higher education level. The 2003 respondents have a smaller average household size and own fewer vehicles per household. The cumulative effect of these differences is difficult to predict. The 2003 sample is older and slightly less educated, characteristics typical of less frequent at-home ICT users. The 2003 respondents also have fewer vehicles and persons per household, which may lead to greater disposable income.

TABLE 1 Respondent Characteristics, 1995 and 2003, Part 1

	Survey Year				Comparing Survey Year	
	1995		2003		1995 $N = 475$	2003 $N = 738$
Characteristic	%	*n*	%	*n*	Statistic	
Gender					0.022[a]	
Female	42.3	195	43.0	311		
Male	57.7	264	57.0	414		
Education					–3.072[b,c]	
Less than high school	2.0	10	3.3	25		
High school	27.0	123	34.7	249		
Technical college	13.7	61	15.0	109		
College degree	37.3	169	28.3	206		
Master's or professional	17.3	77	16.0	116		
PhD	2.7	16	2.0	14		
Other	0.0	0	0.7	3		

[a]Reporting likelihood ratio from chi-squared test (2-tailed significance).
[b]Reporting *Z*-statistic from Mann–Whitney *u*-test (2-tailed significance).
[c]$p < 0.01$.

Comparing the Sample with National Trends

Contrasting the respondents with national trends establishes benchmarks for internal and general comparisons. Of all respondents, 73% owned a computer and 43% had home Internet access in 1995 versus 78.5% and 73.9%, respectively, in 2003. Each value is above the national trends outlined earlier. In terms of at-home ICT activities, 46.6% of 2003 respondents had purchased online and 41% had banked online, both slightly above national averages. Consequently, the 1995 and 2003 respondents may have had a greater affinity toward at-home ICT alternatives and associated higher frequency of use.

Changing Frequency of At-Home and Out-of-Home Shopping

The second strategy uses a MANCOVA model (Table 3). The multivariate *F*-statistic for variable survey year (equal to 64.450) is significant—as were age, household income, and three attitudes—in controlling for differences in the survey year, indicating that the survey year has an effect on out-of-home and at-home shopping frequency. The overall *F*-statistic of the model is significant for both dependents. The adjusted *R*-squared is 0.141 for out-of-home shopping and 0.172 for at-home shopping.

The univariate *F*-statistics explain the interaction effect of each category of variable survey year (1995 and 2003) and the dependent variables. For out-of-home shopping, the 2003 beta parameter is 0.654 compared with base year 1995, indicating that the mean frequency of out-of-home shopping was significantly greater in 2003. Interpreting the covariate parameters, adding this value to the intercept estimates out-of-home shopping when the covariate is zero. Household income, household size, and concerns about privacy with computers have a positive effect on out-of-home shopping frequency.

The 2003 respondents also were more likely to engage in at-home shopping; the beta parameter for 2003 at-home shopping is 0.145 compared with base year 1995. At-home shopping frequency is

TABLE 2 Respondent Characteristics, 1995 and 2003, Part 2

	Survey Year				Comparing Survey Year	
	1995		2003		1995 $N = 475$	2003 $N = 738$
Characteristic	Average	*n*	Average	*n*	Statistic	
Age	45.0	466	54.4	707	9.902[a,b]	
Household income	61,016.0	457	59,299.0	669	–0.883[a,b]	
Household size	2.6	454	2.4	723	–2.454[a,b]	
Vehicles/household	2.2	456	2.0	726	–2.637[a,c]	

[a]Reporting *t*-statistic from independent sample *t*-test (2-tailed significance).
[b]$p < 0.01$.
[c]$p < 0.05$.

TABLE 3 At-Home and Out-of-Home Shopping Frequency, 1995 and 2003

Variable	Statistic	Out-of-Home	At-Home
Survey year			
(Hotelling's trace $F = 64.450^a$)			
2003 $n = 592$	Beta	0.654^a	0.145^b
1995 $n = 394$		0	0
	F	132.237^a	4.904^b
Age			
(Hotelling's trace $F = 20.740^a$)	Beta	0.000	-0.014^a
	F	0.039	40.640^a
Household income			
(Hotelling's trace $F = 15.309^a$)	Beta	0.041^b	0.127^a
	F	3.942^b	28.756^a
Household size			
(Hotelling's trace $F = 2.8022$)	Beta	0.050^b	−0.022
	F	4.483^b	0.657
Household vehicles			
(Hotelling's trace $F = 1.596$)	Beta	0.042	0.049
	F	1.772	1.792
City type			
(Hotelling's trace $F = 2.843$)	Beta	−0.009	0.090^b
	F	0.071	5.401^b
Technology helps save me time			
(Hotelling's trace $F = 19.198^a$)	Beta	0.010	0.181^a
	F	0.145	38.322^a
I worry about my privacy with computers			
(Hotelling's trace $F = 4.418^b$)	Beta	0.047^b	−0.044
	F	4.730^b	3.112
Traffic drives me crazy			
(Hotelling's trace $F = 0.878$)	Beta	−0.025	0.015
	F	1.238	0.345
I prefer to spend free time with other people	Beta	−0.007	-0.107^a
(Hotelling's trace $F = 5.398^a$)	F	0.065	10.792^a
Intercept			
(Hotelling's trace $F = 75.\ 144^a$)	Beta	2.799^a	1.947^a
	F	115.969^a	50.042^a
Corrected model	F	17.105^a	21.488^a
R^2 (adjusted)		0.141	0.172

$^a p < 0.01$.
$^b p < 0.05$.

greater in high-income households, among respondents who believe that technology helps them save time, and in high-technology–high-congestion cities. Older respondents and those who prefer to spend free time with friends spend less time shopping at home. However, the primary finding from this line of analysis is that the independent variable of interest (survey year) has an effect on out-of-home and at-home shopping frequency.

Changing Frequency of At-Home and Out-of-Home Banking

The variable measuring survey year does not explain changes in out-of-home and at-home banking. The model in Table 4 shows an insignificant multivariate *F*-statistic equal to 2.537, although this statistic would be significant at a 0.90 confidence level. The covariates that have an effect in the model are age, household income, the number of household vehicles, one attitude, and city type. The overall *F*-statistic is significant for both dependents. The adjusted *R*-squared is 0.075 for out-of-home banking and 0.137 for at-home banking. Although the out-of-home *R*-squared is relatively low, the parameter estimates make sense and have the expected sign, suggesting a practical model with numerous unobserved effects.

The univariate *F*-statistics explain the interaction effects of the independent and dependent variables. Regarding out-of-home banking, the 2003 beta parameter (equal to −0.161) indicates that the 2003 respondents banked out of home less frequently than respondents in 1995. Interpretation of the covariates indicates that out-of-home banking frequency increases as the number of household vehicles and concerns about privacy while using computers increase. Conversely, household income, a pro-technology attitude, and a high-technology–high-congestion city have a negative effect.

The variable measuring survey year fails to explain changes in at-home banking. The 2003 beta parameter is negative, indicating that respondents in 2003 banked less often at home than respondents in 1995, but the result is not significant. At-home banking frequency decreases with age and privacy concerns while using computers. Respondents who live in a high-technology–high-congestion city and believe that computers help them save time have a positive effect on at-home banking frequency.

TABLE 4 At-Home and Out-of-Home Banking Frequency, 1995 and 2003

Variable	Statistic	Out-of-Home	At-Home
Survey year			
(Hotelling's trace $F = 2.537$)	Beta	−0.161[a]	−0.120
2003 $n = 468$		0	0
1995 $n = 269$	F	3.810[a]	1.327
Age			
(Hotelling's trace $F = 11.628$[b])	Beta	0.001	−0.018[b]
	F	0.276	22.944[b]
Household income			
(Hotelling's trace $F = 4.212$[a])	Beta	−0.077[b]	0.046
	F	6.847[b]	1.505
Household size			
(Hotelling's trace $F = 1$ .824)	Beta	0.036	0.067
	F	1.165	2.531
Household vehicles			
(Hotelling's trace $F = 7.879$[b])	Beta	0.175[b]	−0.050
	F	14.947[b]	0.746
City type			
(Hotelling's trace $F = 14.152$[b])	Beta	−0.201[b]	0.190[b]
	F	18.313[b]	9.685[b]
Technology helps save me time			
(Hotelling's trace $F = 22.915$[b])	Beta	−0.078[a]	0.190[b]
	F	4.454[a]	41.0856[b]
I worry about my privacy with computers			
(Hotelling's trace $F = 8.452$[b])	Beta	0.099[b]	−0.102[b]
	F	10.015[b]	6.700[b]
Traffic drives me crazy			
(Hotelling's trace $F = 1.534$)	Beta	−0.051	−0.034
	F	2.422	0.682
I prefer to spend free time with other people			
(Hotelling's trace $F = 0.131$)	Beta	0.007	−0.025
	F	0.027	0.234
Intercept			
(Hotelling's trace $F = 58.982$[b])	Beta	3.062[b]	1.831[b]
	F	93.992[b]	21.253[b]
Corrected model	F	7.001[b]	12.650[b]
R^2 (adjusted)		0.075	0.137

[a] $p < 0.05$.
[b] $p < 0.01$.
NOTES: Wilks' lambda F-statistic is for DV among IV. F-statistic is between subjects. Household income from 1995 adjusted for inflation.

Changing Substitution or Inducement of Shopping and Banking Activities

Further examination of the two surveys reveals the effects of at-home ICT activities on trip substitution and inducement. The degree to which respondents substituted at-home shopping and banking for out-of-home alternatives is reported in Table 5. In 2003, 79% of at-home users said they would have visited a store had an at-home option been unavailable; this response is in sharp contrast to 20% of respondents who would have made that trip in 1995. Approximately 56% of at-home users in 1995 and 2003 reported that an at-home activity induced an in-store trip.

Unlike with shopping, respondents in 2003 were less likely to substitute at-home banking for out-of-home trips; nearly 40% of the 1995 respondents reported that at-home banking substituted for a trip compared with 27.6% in 2003. As a point of comparison, respondents have not changed in the degree of substitution of out-of-home ATM transactions for out-of-home bank trips. Roughly 56% of respondents in both 1995 and 2003 would have made a trip to the bank had their last ATM use not been possible. The relationship between using an ATM and visiting a bank—both out-of-home forms of banking—are discussed in more detail below.

DISCUSSION

The multivariate models paint a distinct picture of out-of-home and at-home shopping and banking; they suggest that activities are changing in both frequency and form of technology. The variable that measures survey year has an effect on out-of-home and at-home shopping after controlling for sample characteristics, attitudes, and city type. Survey year is notable but does not significantly explain banking frequencies. These findings are not particularly surprising, because shopping and banking patterns might be expected to evolve in terms of frequency of use and form of at-home activity.

Respondents were more likely to shop both out of home and at home in 2003 than in 1995. In terms of travel demand management, as at-home technologies improve and congestion worsens, the expectation is that at-home shopping will grow and out-of-home shopping

TABLE 5 Shopping and Banking Substitution and Inducement, 1995 and 2003

	Yes				No				Comparing 1995 and 2003
	1995		2003		1995		2003		
	%	*n*	%	*n*	%	*n*	%	*n*	Statistic[a]
Shopping									
Would have made out-of-home trip had last at-home purchase been unavailable (among at-home users)	20.2	73	79.0	271	79.8	288	21.2	73	257.824[b]
Ever made an out-of-home trip because of something seen at-home (among at-home users)	56.4	264	55.5	208	43.6	204	44.5	167	0.075
Banking									
Would have made out-of-home trip had last at-home transaction been unavailable (among at-home users)	39.5	98	27.6	64	60.5	150	72.4	168	7.675[c]
Would have made out-of-home trip had last ATM transaction been unavailable (among ATM users)	48.9	160	49.8	258	51.1	167	50.2	260	0.062

[a]Reporting likelihood ratio from chi-squared test (2-tailed significance).
[b]$p < 0.01$.
[c]$p < 0.05$.

will decline. Instead, respondents engaged in multiple forms of shopping with greater frequency. Several factors may explain this behavior. Respondents may

- Continue to prize store shopping to view a product in person, ask questions, acquire a product immediately, or engage in social activities (e.g., get out of the house);
- Chain multiple trips;
- Maximize convenience, browse, or shop for certain goods at home and continue to buy other goods out of home; and
- Take more frequent trips with shorter durations because of changing time constraints.

Respondents reported a greater degree of substitution of out-of-home shopping for at-home alternatives in 2003. Given that both out-of-home and at-home shopping increased between 1995 and 2003, this finding seems contradictory. One possible explanation is that because respondents shopped stores more frequently, they were more willing to make a store trip if the product was unavailable at home. Another possibility is that the greater frequency of at-home shopping reflected general increases in product needs and desires that respondents would satisfy with either at-home or out-of-home purchases.

The extent of store shopping inducement remains unchanged. More than one-half of respondents in 1995 and 2003 had ever made a store trip to purchase an item seen at home. This result likely reflects several behaviors. The first is price comparison, which may be conducted at home (e.g., by browsing multiple catalogs or Internet sites) to discover the best deal for their product of interest. The second is a reluctance to buy without viewing, so people may analyze products at home, then travel to a store to view the product in person. This moves toward a third explanation, which is the desire to view a product in person before purchasing.

Respondents were less likely to bank out of home in 2003 than in 1995. The decrease in at-home banking frequency between survey years is not significant, despite changes in the form of at-home banking technology. In contrast to shopping, the results indicate less banking overall. One possible explanation is online paycheck deposits and automatic bill payment, which respondents may not count toward total banking activity. Respondents in 2003 were less likely to indicate that at-home banking substituted for out-of-home physical trips. The desire to conduct certain transactions at banks (e.g., obtaining loans and cashier's checks) may continue the need for store banking.

The proximity of banks and ATMs could explain the decrease in at-home banking and limit future at-home banking growth. Table 6 displays bank and ATM proximity to respondents' homes and places of work. A greater number of respondents reported having a bank within walking distance of their home in 2003. Although the difference in ATM proximity is not significant, results indicate that roughly 40% of respondents are within walking access of an ATM at one of two key locations. The ease of accessing these locations, in addition to a seemingly increasing number of banks and ATMs at other

TABLE 6 Bank and ATM Proximity to Respondent Home and Work Locations, 1995 and 2003

	Yes				No				Comparing 1995 and 2003
	1995		2003		1995		2003		
	%	*n*	%	*n*	%	*n*	%	*n*	Statistic[a]
Bank or ATM proximity									
Bank within walking distance of home	15.8	73	27.5	202	84.2	389	72.5	533	22.722[b]
Bank within walking distance of work	22.1	92	18.3	123	77.9	325	81.7	549	2.272
ATM within walking distance of home	35.4	161	40.9	291	64.6	294	59.1	421	3.537
ATM within walking distance of work	43.7	180	42.9	285	56.3	232	57.1	379	0.061

[a]Reporting likelihood ratio from chi-squared test (2-tailed significance).
[b]$p < 0.01$.

locations—supermarkets, bookstores, and gas stations—may limit the need to engage in at-home banking and slow future growth. The various banking alternatives also may reduce the observed effect of any individual at-home banking activity on trip substitution.

The characteristics of people willing to engage in at-home activities, their attitudes, and city characteristics explain changes in the frequency and form of shopping and banking activity. The models confirm some of the expected variable effects; however, the influence is not always consistent and varies depending on the type of at-home technology. For instance, respondent age was significant in at-home models but insignificant in out-of-home models. Increasing household income has a positive effect in shopping models, a negative effect in the out-of-home banking model, and an insignificant effect in the at-home banking model. Respondents from high-technology–high-congestion cities were more likely to increase their at-home frequency in both activities but varied in out-of-home frequency. Attitudes toward technology and congestion generally had the expected signs but were not always significant. Unexpectedly, the attitude "traffic drives me crazy" was not significant in any of the models. Together, the results indicate that expectations that certain populations or specific locations will engage in at-home shopping and banking alternatives may be overstated. Instead, evolving use patterns depend of the activity (shopping or banking) and the form of the at-home activity (catalog, phone, or online).

CONCLUSION

ICT use and its potential to reduce travel have been discussed enthusiastically for many years. The longitudinal approach used herein analyzed the differences from two similar surveys to examine the evolving relationship between store travel and at-home ICT alternatives. This analysis compared typical at-home activities during two survey years: catalog shopping and phone banking in 1995, and online shopping and online banking in 2003. The variable measuring the year of the survey had a main effect in explaining changes in the frequency of at-home and out-of-home shopping but not banking.

In 2003, respondents engaged in greater amounts of at-home and out-of-home shopping. They also were more likely to substitute at-home activities for store trips; however, the overall increase in shopping seemed to override this change. Examining banking activities, a decrease in out-of-home banking and a notable, but insignificant, decrease in at-home banking were observed from 1995 to 2003. Examining multiple behaviors, the most likely explanation for the results is that with the growth in ICT use, people engage in multiple forms of shopping and banking and do so in the ways most convenient to them. ICT has expanded the number of means available for carrying out activities but has not significantly replaced the earlier means. The desire to shop in a physical store, for social or other reasons, and to touch and examine products before buying is a possible explanation, although this analysis fails to fully capture this effect. Similarly, people may be unwilling to conduct certain transactions away from banks. The proximity of banks and ATMs to home and work locations and the convenience of ATMs in other stores may not warrant online banking for many individuals.

The approach presented in this paper offers insights that pure cross-sectional studies on their own cannot. MANCOVA is a useful technique to control for differences in similar sample populations and examine longitudinal changes. The surveys were limited in scope, and this analysis was limited to the portions of the two surveys that provided sufficient and consistent data. This study echoes the difficulty in capturing the effect of evolving at-home technologies. Future studies can work toward this goal by testing the frequency of at-home ICT use before and after receiving access to the newest technologies using panel data. Notwithstanding such shortcomings, the approach presented in this paper offers a viable alternative to surmising results from a series of unrelated cross-sectional studies.

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