Reexamining ICT Impact on Travel Using the 2001 NHTS Data for Baltimore Metropolitan Area

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ABSTRACT

This paper presents an empirical examination of the relationship between information and communications technology (ICT) and travel. The primary research objective is to examine the effects of several indicators of ICT usage on three measures of travel outcomes. The ICT indicators include the frequency of Internet use, the number of mobile phones, and the presence of a telephone at home for business purposes. The travel outcomes examined are vehicle miles traveled (VMT), total daily trips, and daily walking trips. Using the 2001 national household travel survey (NHTS) data for Baltimore metropolitan area, a linear regression model is estimated for VMT and two Poisson regression models are estimated for, respectively, total daily trips and daily walking trips. The empirical results suggest simultaneous existence of substitution and complementarity interactions between ICT and travel, with complementarity as the dominant form. Implications of the research findings are discussed.

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INTRODUCTION

Information and communications technology (ICT) creates rich opportunities for individuals to reduce economic and social costs associated with their spatial interaction with others. The potential effects on travel behavior, however small individually, can aggregate substantially because ICT is rapidly permeating all aspects of our daily lives (Golob and Regan 2001). Given that ICT usage necessarily involves reallocation of time and resources, it is conceivable that public policy could play an important role in facilitating desirable changes in travel outcomes by influencing the spatial and temporal reorganization of individuals' activities (Shen 2004).

The last decade has witnessed a growing number of empirical studies on the relationship between ICT and travel (see, for example, Handy and Yantis 1997, Johansson 1999, Mokhtarian and Meenakshisundaram 1999, Harvey and Taylor 2000, Hjorthol 2002, Farag *et al* 2003, Fadare and Salami 2004, Nobis and Lenz 2004, Srinivasan and Athuru, 2004). These research efforts have undoubtedly broadened and deepened our understanding of the multidimensional, multidirectional, and complex ICT-travel connection. However, due to data and methodological limitations, such as small sample size, inadequate measurement of ICT usage, and lack of experimental design, there are many gaps in the existing knowledge about the actual and potential impacts of ICT on travel. The knowledge base must be strengthened in order to effectively support transportation planning and policy making for achieving the full benefits of ICT.

This empirical study aims to gain additional insights into the relationship between ICT and travel using the 2001 National Household Travel Survey (NHTS) data, which contain a large sample of households and individual members and serves as an important data source for travel behavior research. The specific research objective is to examine the impact of several indicators of ICT on three measures of travel. The ICT indicators include the frequency of Internet use, the number of mobile phones, and the presence of a telephone at home for business purposes. The travel outcomes examined are vehicle miles traveled (VMT), total daily trips, and daily walking trips. These ICT indicators and travel outcomes are all measured at the individual level. We ask two basic research questions. First, what are the individual effects of the ICT indicators on the travel outcomes? And second, what is the overall relationship between ICT and travel as seen in the empirical data?

The findings contribute to the growing body of work in the area of ICT and travel behavior by demonstrating the differential effect that the various indicators of ICT have on the range of travel outcomes examined. Furthermore, because the NHTS is expected to be a continual data collection effort, studies such as ours can help identify desirable modifications to the existing questionnaire and, subsequently, improvements for future surveys. As Golob and Regan (2001) point out, household activity and travel surveys should and can be improved to collect richer data that are essential for better understanding the profound changes induced by ICT.

LITERATURE REVIEW

Scholars (de Sola Pool 1979, Salomon 1986, and Mokhtarian 2002) have theorized that the interaction between telecommunication and travel can take several different forms. These include substitution (alternatives replacing each other), complementarity (use of one generating additional use of the other), modification (use of one changing the way in which the other is used), and neutrality (use of one having no effect on the use of the other). This general framework has provided a useful conceptual basis for empirical investigations.

Mohktarian and Salomon (2002) reviewed a considerable number of empirical studies on the ICT-travel relationship. They concluded that, although short-term studies that focus on a single activity (such as telecommuting) have often found substitution effects of ICT, in more comprehensive, long-term empirical studies, complementarity effects are often observed. The reader is cautioned, however, that the question remains as to how much the simultaneous increases observed in telecommunications and travel reflect true causal complementarity, and how much they are due to spurious third-party correlation with other variables (Mohktarian 2002).

An example of the studies that found a positive association between ICT and travel was a report by Johansson (1999). Using data from the 1997 Swedish National Communication Survey in which a sample of about 2,000 respondents completed a diary to record information on all trips and contacts, Johansson observed that the number of trips is positively correlated with the number of telecommunication contacts. However, the data analysis did not control for some obvious confounding factors, such as income. Therefore, the results told us little about causality.

Similarly, using data collected from a survey of 3,500 individuals in Germany, Nobis and Lenz (2004) showed that the heavy ICT users also tend to be heavy car users. Again, while the data analysis showed a clear pattern of positive statistical association, it did not use multivariate methods to explore possible causality. Such an effort will likely be undertaken in the future by these researchers, however, because the survey, conducted in 2003, was intended to be only the first data collection effort of a long-term panel study of ICT applications and daily activities.

Stronger evidence of complementarity was provided by Hjorthol (2002). Based on the Norwegian national personal travel survey 1997/98 and a connected mail back survey of the use of ICT at home, Hjorthol examined the relationship between transportation mobility and use of home computer. In this study, use of home computer was divided into four categories: (1) private tasks without need of an Internet connection, (2) private tasks with need of an Internet connection, (3) work tasks without need of an Internet connection, and (4) work tasks with need of an Internet connection. Linear regression models were estimated for a sample of almost 800 individuals. The models showed that—after controlling for gender, age, household income, and number of cars—using a home computer for work with or without Internet connection both have a small but statistically significant positive effect on daily distance traveled.

Understanding the complementarity effect of ICT and recognizing the substantial empirical evidence of an overall net travel generation outcome is certainly important, especially from the standpoint of forecasting short-term change in travel demand. However, it is equally important to recognize that recent empirical studies have also identified the variety of ways in which ICT generates effects on travel, revealed the dynamic nature of ICT-travel interactions, and suggested potential roles of public policy in influencing the outcomes of these interactions.

In a study of the impacts of ICT on nonwork travel, Handy and Yantis (1997) examined the relationship between in-home and out-of-home versions of the same activities. Three specific activities were selected, and the sets of potentially substitutable versions of those activities were examined: movies (theater vs. VCR vs. television), shopping (store vs. catalog vs. television), and banking (bank vs. ATM vs. phone vs. on-line). A household survey was conducted to characterize the use of the different versions of the three case study activities and explore the trade-offs between them. The results suggested that the degree to which in-home versions substitute for out-of-home versions of an activity depends on the nature of the activity—with in-home entertainment generating additional travel, whereas online maintenance activities reduced travel—and the characteristics of the individuals.

Similar insights about the complex and dynamic nature of ICT-travel interactions have been obtained by other researchers who undertook empirical research in different contexts. In a study of travel behavior implications of ICT in Puget Sound region, Viswanathan and Goulias (2001) found that Internet use was correlated negatively, whereas mobile phone use was correlated positively, with time spent on travel. In the aforementioned study by Hjorthol (2002), it was found that users of home computer tend to make somewhat less work trips but more chauffeuring and total trips after the effects of income, gender, age, and car availability have been controlled for.

Srinivasan and Athuru (2004) conducted probably the most extensive statistical analysis of interaction between Internet communication and travel activities to date. Using a series of statistical models, they investigated three dimensions of the interaction: (1) factors affecting the propensity to perform virtual activities using the Internet, (2) the relationship between activity participation and ICT use, and (3) interaction between ICT use, activity attributes, and observed travel behavior. The models were estimated based on the 2000 activity-diary data from the San Francisco Bay Area. The results indicated the presence of both substitution and generation of trips due to Internet use. Furthermore, they showed the influence of a wide range of technological and socioeconomic factors on the interactions between ICT and travel.

Several studies focused on the impact of telephone on travel. One early study was reported by Claisse and Rowe (1993), who surveyed the residential telephone use of 663 respondents in the Lyon, France metropolitan area in 1984. The respondents recorded a one-week diary of all calls made and received at home. Claisse and Rowe found that residential phone use generated trips 3-5% of the time, and replaced trips 21-27% of the time, for a net substitution of 17-22%. Contrary evidence was presented in a more recent study, however (Fadare and Salami 2004). Focusing on the effect of telephone use on travel behavior in Nigeria, the researchers found that telephone usage tends to increase the number of trips. In particular, most business-related calls tend to induce travel rather than substitute for it.

Sociological studies of the impact of the Internet on individuals' time use and social participation also suggest great complexity in the ICT-travel relationship. Sociologists (Nie and Hillygus 2002, Robinson *et al* 2002) tend to agree that the Internet has changed people's use of time and consequently relationships with various communities (including the residential community), but they disagree on the nature and extent of the substitution effect of the technology. Therefore, impact on social interaction and travel is expected, but the direction of the impact is unclear.

Taken together, these empirical studies not only have painted a general picture of the ICT-travel relationship in which complementarity appears most prominent, but also have uncovered aspects of the dynamics and complexity of this relationship. As the outcome is not always certain and seems to be influenced by a wide range of factors, it begs the question of what potential roles can public policy play in exerting desirable influence on the outcome (Shen 2004).

The existing knowledge is insufficient for answering the question raised above. The empirical basis needs to be expanded and strengthened, with causal-effective mechanisms more clearly understood and their connections with policy instruments established. This will require a great volume of empirical research that employs appropriate data and methodology.

RESEARCH METHODOLOGY

This research is intended to gain additional insights about the impact of ICT, in the forms of Internet and conventional and mobile telephones, on individuals' travel behavior. The research design is a cross-sectional study that tests the associations of various indicators of ICT usage with three different measures of travel. Using the 2001 National Household Travel Survey (NHTS) Add On for the Baltimore metropolitan area, complemented with local land use data, three statistical models of travel are estimated at the individual level. The NHTS data were collected through a household-based, random digit–dialed telephone survey, administered under the guidance of the Baltimore Regional Transportation Board (BRTB), the Metropolitan Planning Organization (MPO) for the region. The data include information about individuals and their households, and detail information about all trips made in one day for a sample of residents in the six-county region surrounding Baltimore City. The sample of this survey consisted of 7,825 respondents from 3,519 households residing in the study area. Because respondents aged under 16 appropriately skipped the question about "the frequency of Internet usage", the sample used in this study was restricted to the adult population aged 16 years and older, resulting in a total of 5,429 individuals in the models.

The dependent or outcome variables capturing individual travel patterns include the vehicle miles traveled (VMT) in the travel day by personal vehicle, the total number of trips made in the travel day, and number of walking trips made in the travel day. For the VMT, the ordinary least squares (OLS) is employed to estimate the coefficients of the linear regression model, expressed in the following equation:

$$Y= \beta_0 + \beta_1 X_1 + ... + \beta_j X + \varepsilon \quad (1)$$

Where

$X_1, \ldots, X_j$ are independent variables;
$\beta_1, \ldots, \beta_j$ are the corresponding coefficients to be estimated;
β_0 is the intercept;

ε is random error.

Poisson regression is used to estimate the two trip variables given that these data are counts of trips. In a Poisson regression model, the probability of occurrence of exactly *k* trips made by individual *i* is given by the following equation:

$$\Pr(Y_i = k) = \frac{e^{-\lambda_i} \lambda_i^{\,k}}{k!} \qquad (2)$$

Where

$\lambda_i = \exp(\beta_0 + \beta_1 X_{i1} + ... + \beta_j X_{ij})$ is the mean number of trips for individual *i*;
$X_1, \dots, X_j$ are independent variables;
$\beta_1, \dots, \beta_j$ are the corresponding coefficients to be estimated;
β_0 is the intercept.

Independent variables include measures of individual ICT usage, individual or household socioeconomic characteristics, and land use characteristics. These variables are briefly described below. Descriptive statistics of all dependent and independent variables are illustrated in Table 1.

[Table 1 approximately here]

The three measures of ICT usage. The first consists of categorical measures of the frequency of Internet usage ("Web use frequency: High", "Web use frequency: Medium", and "Web use frequency: Low"). There are four groups of self reported Internet users - high, medium, and low frequency users, and people have no access to Internet. High frequency stands for "almost every day"; medium frequency is equivalent to "several times a week" and "once a week"; and low frequency corresponds to "once a month" or less. The first three groups have access to Internet at home and/or work. The fourth level of Internet use is "no access to Internet", which means that one has no access to Internet neither at home nor at work.

The second measure of ICT is the number of mobile phones per adult member of household, which proxies for both access to and use of the cell phone. If the value is between 0 and 1, it represents the probability of sharing a cellular phone with other household members. If the value is greater than 1, which means that an individual has more than one mobile phone, it will be assigned a value of 1 because the extra phones serve no practical purpose.

The third measure of ICT is the presence of a land line exclusive for business/fax purposes, which can to a certain extent capture the probability that one conducts business at home.

One limitation of these aggregate indicators of ICT use is that there is no information about the specific activities performed on the Internet or the purpose of accessing the web. Another limitation is that the ownership of mobile or conventional phones provides no indication of the extent or purpose of their use. Nonetheless, this information allows us to distinguish between several types of ICT technologies and estimate their separate effects on travel.

Socioeconomic characteristics. Age, gender, race, foreign born, driver status, worker status, and occupation are included in models as individual-level covariates. Because age often does not have a linear relation to travel outcomes, both age and its square are included to fit the curvilinear relationship. The reference groups for socioeconomic variables are female, non-white, those who were born in US, non-driver, non-worker, and people whose occupations are other than the four listed in Table 1. Variables that describe household characteristics are annual income per household member, vehicles per household driver, number of children in household, and tenure of housing unit.

Land use characteristics. To control for the influence that the urban environment may have on travel behavior (Dieleman *et al* 2002), several land use variables are incorporated into the models. These include population density (persons/square mile), employment density (jobs/square mile), regional accessibility to commercial activities, and entropy of land use balance, all measured from the residential location of the individual. Population density and employment density are calculated at the census tract level. Regional accessibility is defined in terms of the accessibility to retailing activities at traffic analysis zone (TAZ) level. In this study the measure of regional accessibility is calculated based on the cumulative opportunities, measured by the number of retailing jobs, located within 30 minutes of travel from home. The land use balance entropy is computed through the formula as follows:

$$Entropy = -\sum_j \frac{P_j \times \ln(P_j)}{\ln(J)} \qquad (3)$$

Where,

P_j is the proportion of developed land in the *j*th use type;

J is the number of land use categories considered. In this study, J = 4: residential, commercial, industrial, and institutional.

The entropy index for individual household is computed at the 800-meter radius circle.

Finally, one-way distance to work is included in the VMT model to control for the residential and regular workplace locations, which are considered exogenous in this study. ICT increases location flexibility, which may cause households to move further away from workplace in the long term (Janelle 1995, Shen 2000). However, recent empirical research found little evidence that the increased location flexibility has led to changes in the residential patterns of households (Ellen and Hempstead 2002).

RESULTS

The specification and estimation results for the three models are illustrated in Table 2.

[Table 2 approximately here]

VMT outcomes

As has been found in previous research, VMT is greater for white than other races/ethnicities, for drivers than non-drivers. The age and square of age are both significantly associated with VMT in different directions which represent a parabola curve. Two household variables have significantly positive effect on VMT. The result can be interpreted that a person in a household which has more private vehicles and ownership of housing unit will generates more VMT.

Interestingly, after controlling for the effect of one-way distance to work, none of the land use variables has a statistically significant association with VMT even though the coefficients are all negative. It seems to show that, consistent with previous findings, the local population or employment density, land use mixture, and regional accessibility have very weak, if any, effect on individual VMT. The one-way distance to work variable has a highly significantly positive effect on personal VMT.

Controlling for these covariates, the high frequency of Internet use is significantly and positively associated with VMT (t=2.741). All else equal, persons with relatively higher frequency of Internet usage will travel about 5 or 6 more miles than people with low frequency or no access to Internet. The standardized coefficient (not shown in Table 2) is 0.059 for high frequency. In comparison with other coefficients in the model, this one is not small, which means that the magnitude of Internet effect is not negligible. Although not conclusive, these results indicate an overall complementarity effect of Internet usage on vehicle miles traveled.

Use of mobile phones is also positively associated with VMT, and the levels of statistical and practical significance of the association are similar to those characterized the relationship between VMT and high frequency Internet use. Again, the result also suggests an overall complementarity effect—between mobile phone usage and travel.

Number of trips outcomes

Similar to what is found in the VMT models, the number of trips is higher for females than males, for white than other races, and for drivers than non-drivers. And people whose occupations are sale/service or professional generate more trips than others. Likewise, the curvilinear relationship between age and number of trips can be clearly demonstrated through the signs and significance of age and its square.

Three household variables – household income per household member, number of children in household, and tenure of housing unit – are positively associated with number of trips the individual in the household makes. It is the variable of "vehicle per household driver" shows insignificant effect on number of trips. The problem of multicollinearity is suspected to function here.

Only one of the four urban environment variables, land use mix entropy, is found significantly related to number of trips. It suggests that a person with more mixed land use around his or her household tends to generate more daily trips, regardless of the mode of travel. Another finding is that the regional accessibility variable is highly correlated with land use mix measure (correlation=0.505). If we estimate a model without the land use mix measure, the accessibility variable shows a significantly positive effect on dependent variable. A problem of multicollinearity between these two measures of urban environment may be concluded here. Generally speaking, higher land use mixture and regional accessibility tend to be positively associated with increased number of trips.

After controlling for these covariates, the high and medium frequency of Internet use are positively related to total number of trips at a highly significant level ($t = 4.92$, $p < 0.001$; $t = 5.06$, $p<0.001$). The marginal effect of high frequency of Internet use is (3.67)(0.116)=0.426, suggesting that high frequency of Internet use will increase the expected number of trips generated by the individual by approximately 0.426, other things being equal. In other words, the difference between high frequency Internet users and people with no access to Internet is approximately half a trip. Likewise, medium frequency will increase expected number of trips by approximately 0.466.

This evidence indicates that frequent Internet users generates a greater number of total trips than less frequent users or people who have no access to Internet, all else equal. Coupled with the results from VMT model, it is clear that frequent Internet usage is associated with higher number of trips as well as higher VMT, which suggests a complementarity relationship between Internet use and travel.

Use of mobile phones does not show a statistically significantly relationship with number of trips made. The business telephone variable is negatively associated with the number of trips at the 0.05 level of significance. This suggests a small but significant substitution effect of business telephone use at home on travel behavior.

Number of walking trips outcomes

Consistent with common sense and expectation, the number of walking trips is higher for white than other races, for non-drivers than drivers. Also, people whose occupations are sale/service or manufacturing/construction/farming have less walking trips in comparison with others.

Vehicles per household member show a significantly negative effect on number of walking trips, which makes sense because usually people with more personal vehicles walk less. Interestingly, household income per household member is positively related to number of walking trips at a highly significant level ($z = 6.01$). It seems to suggest that higher income people walk more.

The track level employment density at household place is significantly positively related to number of walking trips. It is consistent with findings in previous pedestrian behavior research. A higher employment density represents higher intensity of various activities in an area, and possibly attracts local residents who may reach the place through walking mostly. The regional accessibility to retailing activities is also found to be positively related to number of walking trips. In addition, the entropy index of local land use balance has significantly positive effect on number of walking trips. These evidences seem to reiterate recent research findings that desirable local urban environment characteristics will stimulate people's walking activities.

The only ICT variable statistically linked to number of walking trips is the number of cellular phones per household adult ($z = -6.64$, $p < 0.001$). The result suggests that an additional cellular phone per household adult will decrease the number of daily walking trips made by each adult in this household by approximately 0.205. Evidences show that persons with access to cellular phones are less likely to walk, all else equal. This may suggest a substitution effect of mobile phone usage for personal walks. However, the impact of this relationship cannot be discerned from this analysis. The three Internet usage variables don't have statistically significant effect on number of walking trips.

CONCLUSION

This study reveals that Internet and telephone usage are significantly associated with some forms of individual travel behavior. After controlling for covariates including socioeconomic characteristics of individuals, household characteristics, and urban environment, high and medium frequency of Internet use have significant association with both number of trips and VMT. These findings seem to attest to an overall complementarity impact of telecommunication on travel, which has been found in most of comprehensive empirical studies at disaggregate level.

Although extremely important, Internet is but only one component of ICT. Our research demonstrates that other measures of ICT usage cannot be overlooked. In particular, the empirical results indicate that presence of telephone for conducting business at home is associated with decreased number of total daily trips. Only by including multiple measures of ICT could we have identified the complementarity and substitution effects simultaneously.

Note that the magnitude of the complementarity effect of Internet usage observed in this study is relatively large in comparison with that of the substitution effect of business telephone. In fact, the substitution effect is observed in the model of total daily trips but not in the more fundamentally important model of daily VMT. The results, taken as a whole, seem to suggest that the net effect of ICT on travel is to generate additional travel. But before we take this conclusion too far, we must qualify the empirical results in light of several limitations of this study that have become clear through the research process:

First, because this study is cross-sectional in nature, the relationships between ICT usages and travel it has identified are essentially statistical associations, not causations. The empirical results basically indicate that certain ICT usages are associated with certain travel behavior changes, most of which are in the direction of complementarity. Research incorporating more rigorous experimental controls will be required to tackle the more difficult problem of establishing causality.

Second, the models are simplistic in that they ignore some likely simultaneous relationships among variables. For example, our exploratory data analyses revealed that some forms of ICT usage may be simultaneously determined with some outcomes of travel. More sophisticated statistical tools need to be explored to sort out these complexities.

Third, our measures of ICT usage are still too aggregate and do not allow for separated indicators of how and why Internet and telephones are used. More detailed information about ICT use can potentially shed additional light on the ways in which various technologies create different effects on travel. A survey that collects information on the purpose for accessing the Internet or making a telephone call would help to understand the impacts on travel. For example, was the Internet used to access information about congestion in order to better time a trip or select a route, suggesting a modification effect on travel? Or was it used to place an order for goods or services, substituting for a trip? In the case of complementarily, perhaps an individual seeks out information about various restaurants before choosing which one to visit. Traditional travel diary data is not adequate to meet the ICT research needs. Time use and activity surveys provide more detailed information but if they are not designed with ICT in mind, they cannot advance our understanding of these complex relationships.

Finally, the estimated models have rather limited explanatory power, and we have little knowledge of the nature of the large amount of unexplained variation. Are there explanatory variables that show more powerful influence on the dependent variables in certain contexts? Are the differences, if exist, in some way connected with public policy?

These limitations provide important hints for desirable improvements in the future, which include serious efforts in data collection, research design, statistical modeling, and policy analysis. None of these efforts will be trivial.

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Table 1. Descriptive Statistics of the Variables

	N	Min	Max	Mean	S.D.
Travel Behavior (dependent variables)					
VMT	5,429	0	3001	34.35	68.390
Number of trips	5,429	0	15	3.67	2.463
Number of walk trips in travel day	5,429	0	12	0.43	1.128
ICT usage					
Web use frequency: High	5,429	0	1	0.42	0.493
Web use frequency: Medium	5,429	0	1	0.19	0.395
Web use frequency: Low	5,429	0	1	0.11	0.307
Cell numbers per HH adult	5,429	0.00	1.00	0.54	0.420
HH has telephone exclusive for business/fax	5,429	0	1	0.16	0.371
Socioeconomic Characteristics					
Age	5,429	16	95	47.57	17.143
Age squared	5,429	256	9025	2557	1718
Sex: male	5,429	0	1	0.45	0.498
Race: white	5,429	0	1	0.77	0.422
Foreign born	5,429	0	1	0.06	0.231
Driver status	5,429	0	1	0.85	0.359
Worker status	5,429	0	1	0.66	0.473
Occupation: sale	5,429	0	1	0.16	0.368
Occupation: clerical	5,429	0	1	0.08	0.273
Occupation: manufacturing/construction/farming	5,429	0	1	0.07	0.257
Occupation: professional	5,429	0	1	0.33	0.470
Income per HH member (thousand dollars)	5,429	1	100	25.12	16.922
Vehicles per HH driver	5,429	0.00	9.00	0.97	0.516
Number of children in HH	5,429	0	8	0.59	0.990
Tenure of housing unit: owner	5,429	0	1	0.78	0.415
Land Use Characteristics					
Population density at HH location (track level)	5,429	0.05	30	7.82	8.257
Employment density at HH location (track level)	5,429	11.04	16.99	3.50	3.867
Accessibility to commercial activities (TAZ level)	5,429	0	19.77	10.63	6.683
Land-use mix entropy	5,429	0	1.00	0.551	0.318
One-way distance to work	4,910	0	210	9.26	14.200

Table 2. Estimated Models of VMT, Walking Trips, and Total Trips

	VMT		# Walking Trips		# Trips	
	Coefficient.	t	Coefficient	z	Coefficient	z
Constant	-7.451	-1.187	**-1.530**	**-7.80**	**0.397**	**6.17**
ICT usage						
Web use frequency: High	**6.489**	**2.741**	0.107	1.55	**0.116**	**4.92**
Web use frequency: Medium	4.896	1.918	-0.031	-0.39	**0.127**	**5.06**
Web use frequency: Low	1.914	0.697	-0.101	-1.14	-0.020	-0.68
Cell numbers per HH adult	**4.740**	**2.377**	**-0.380**	**-6.64**	-0.028	-1.43
HH has telephone exclusive for business/fax	1.606	0.763	-0.081	-1.30	**-0.049**	**-2.46**
Socioeconomic Characteristics						
Age	**0.469**	**1.970**	**0.016**	**2.17**	**0.015**	**6.08**
Age squared	**-0.005**	**-2.090**	**-.0003**	**-4.15**	**-.0002**	**-6.07**
Sex: male	2.414	1.573	-0.032	-0.72	**-0.029**	**-1.94**
Race: white	**5.779**	**2.877**	**0.386**	**6.96**	**0.056**	**2.74**
Foreign born	-0.475	-0.151	0.098	1.19	-0.034	-1.08
Driver status	**9.321**	**3.662**	**-0.347**	**-5.44**	**0.306**	**10.78**
Worker status	-6.583	-1.576	-0.091	-1.06	-0.033	-1.08
Occupation: sale	2.870	0.664	**-0.287**	**-3.01**	**0.090**	**2.75**
Occupation: clerical	3.746	0.771	-0.109	-0.98	0.057	1.51
Occupation: manufacturing/construction/farming	5.857	1.213	**-0.404**	**-3.16**	0.013	0.33
Occupation: professional	1.428	0.329	0.143	1.59	**0.084**	**2.66**
Income per HH member (thousand dollars)	0.055	0.962	**0.008**	**6.01**	**0.001**	**2.57**
Vehicles per HH driver	**4.959**	**2.856**	**-0.550**	**-9.90**	0.024	1.41
Number of children in HH	1.305	1.468	0.017	0.66	**0.044**	**5.19**
Tenure of housing unit: owner	**4.900**	**2.460**	-0.070	-1.39	**0.046**	**2.28**
Land Use Characteristics						
Population density at HH location (track level)	-0.052	-0.219	0.004	0.72	-0.0002	-0.07
Employment density at HH location (track level)	-0.484	-0.999	**0.042**	**4.06**	0.006	1.13
Accessibility to commercial activities (TAZ level)	-0.063	-0.466	**0.062**	**9.68**	0.002	1.34
Land-use mix entropy	-3.510	-1.331	**0.214**	**2.55**	**0.083**	**3.19**
One-way distance to work	**0.882**	**14.443**				
Number of observations	4910		5429		5429	
R square or Pseudo R square	0.130		0.123		0.028	