E-Shopping, Spatial Attributes, and Personal Travel: A Review of Empirical Studies

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Abstract

In an era of the unprecedented proliferation of e-shopping, retailers and planners are interested in the changes that it will bring about. Recently, a number of empirical studies have explored the influence of spatial attributes on e-shopping and the impacts of e-shopping on individuals’ activity-travel patterns. This study evaluates the progress that has been made, critiques previous research, and discusses the improvements in research methodology needed to enhance understanding of the connections among e-shopping, spatial attitudes and travel behavior. In particular, this review highlights the importance of (1) controlling for shopping preferences and household shopping responsibility, (2) exploring multiple dimensions of travel behavior, (3) testing the connections that depend on time scale, (4) deconstructing the shopping process, (5) differentiating product types, (6) demonstrating the “oomph” of coefficient estimates, (7) integrating shopping surveys and activity diaries, and (8) identifying shopping accessibility based on the search area for products when testing its impacts on e-shopping.

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1. Introduction
E-shopping has the potential to replace traditional in-store shopping. E-shopping as used in this paper refers to the business-to-consumer (B2C) segment of e-commerce (Mokhtarian, 2004), i.e. product information search (online searching) and product transactions (online buying/purchasing) via internet, unless otherwise indicated. It is well perceived that information and communication technologies (ICTs) have had pervasive impacts on modern society - they are changing how and where we work, shop, and in other ways live our lives. Significant research has been conducted to understand the impact of ICTs on where work is done and how this affects travel. Recently, e-shopping has become a centerpiece of ICTs because of its unprecedented proliferation. In the Netherlands, online sales have increased from less than €200 million in 1999 to more than €1.6 billion in 2004, as reported by Farag (2006). In the U.S., online retail spending grew by 19% a year to $136.4 billion in 2007, which accounted for 4% of total retail sales (InternetRetailer.com, 2008). The growth of e-shopping has reshaped consumers’ shopping behavior. Online buying could be a substitute for traditional shopping media, and may well dominate the exchange of certain products (e.g., digital assets) in the future (Cao and Mokhtarian, 2005).

With the rise of e-shopping and its long-term potential in the retail industry, many players are interested in the changes that it will bring about. To promote e-shopping, marketing agents are eager to identify its advantages and limitations compared to traditional shopping, the characteristics of e-shoppers, and the factors affecting the adoption and usage of e-shopping. Since the late 1990s, a growing number of empirical studies have addressed these questions. For example, Chang et al. (2005) classified the determinants of e-shopping behavior into three categories: perceived characteristics of the web as a sales channel, online consumer characteristics, and vendor and product characteristics.

E-stores both compete with and complement retail stores. Retailers, real estate developers, and urban planners are interested in the geographic distribution of online buyers and the impacts of online buying on land use development. This knowledge is critical because the proliferation of e-shopping may change the operation of retail businesses and land use patterns over time, and
hence shopping behavior in the long run (Anderson et al., 2003; Dixon and Marston, 2002; Gould, 1998; Marker and Goulias, 2000; Weltevreden et al., 2008).

Transportation planners focus on the effects of e-shopping on individuals’ activity-travel patterns and on patterns of freight transport. Changes in freight transport can result from the growth of delivery trips to consumers and the bypass of wholesalers and retailers in the network from manufacturers to consumers (Anderson et al., 2003). The potential of e-shopping to substitute for traditional shopping and reduce personal shopping travel has important implications for travel demand management and congestion mitigation. According to the 2001 National Household Transportation Survey (NHTS), on average shopping travel accounted for 14.4% of annual VMT per household and 21.1% of annual vehicle trips per household (Hu and Reuscher, 2004). Therefore, the rise of e-shopping could have the potential to reduce traffic if it does replace physical shopping. On the other hand, if e-shopping induces new shopping trips, e-shopping is likely to generate more personal travel to existing transportation systems.

Little empirical work has been conducted to relate e-shopping to spatial attributes and travel behavior, however. In particular, how does the adoption and usage of e-shopping differ by geographical areas (such as urban and exurban areas) or shopping accessibility? How (and to what extent) does e-shopping impact individuals’ physical shopping and activity participation? What are the implications for land use and transportation planning? Recently, a number of geographers and planners have paid attention to these issues. Among other studies, two Ph.D. dissertations from Utrecht University, the Netherlands are notable. From a consumer perspective, Farag (2006) addressed the impacts of geography on e-shopping and the interactions between e-shopping and traditional shopping. Weltevreden (2006) focused on both consumers and retailers, and examined the connections between e-shopping and city center shopping.

As the number of e-shopping studies grows, it is appropriate to evaluate the progress that has been made, and to consider the improvements in research methodology needed for a better understanding about the influence of spatial attributes on e-shopping and the impacts of e-shopping on individuals’ activity-travel patterns. The focus of this review is on recent empirical studies regarding the interactions among e-shopping, spatial attributes, and personal activity-
travel pattern in the English language literature. The studies were identified based on my knowledge and connections with worldwide scholars, but I do not claim that they are exhaustive.

There are scenario analyses (or simulation studies) in the field (e.g. Lenz, 2003). These studies did not aim to explore how e-shopping influenced travel but assumed certain relationships between e-shopping and travel. They used the assumed connections to predict what can happen in the population and then discuss the implications of e-shopping for travel. Because the studies reviewed here aim to test what is assumed in these scenario analyses, the latter are not included.

The paper is organized as follows. The next section summarizes studies on the relationships between spatial attributes and online buying. Section 3 reviews and critiques studies on the interactions between e-shopping and activity-travel patterns. The last section recapitulates the findings and makes recommendations for future research.

2. Effect of Spatial Attributes
Although numerous studies have explored the determinants of e-shopping adoption and/or usage, few focused on the influence of spatial attributes, which is critical to evaluate the impacts of e-shopping on future land use patterns. Anderson et al. (2003) proposed two competing assertions: innovation-diffusion hypothesis and efficiency hypothesis. First, urban areas facilitate creative thinking and innovation. People in urban areas are more open to new technologies and ideas than those in remote areas. Knowledge spillovers in urban areas accelerate the penetration of new technologies. Therefore, with online buying being an innovative shopping channel, the innovation-diffusion hypothesis states that urban residents are more likely to be online buyers. Further, the well-connected internet services in urban areas also provide support for this hypothesis. In contrast, one of the benefits of online buying is that it removes the location barrier/spatial constraint – low shopping accessibility (Mokhtarian, 2004). Therefore, the efficiency hypothesis postulates that people with low shopping accessibility tend to participate in online buying. These two hypotheses are equivalent to the contradictory assertions regarding the diffusion of internet technology in industry: global village theory (“firms in small cities and rural areas adopt the Internet more quickly than urban firms because the marginal returns from the use of the communications capabilities of the Internet are higher in remote locations”, Forman et al., 2005a, p. 391) and urban density theory (the Internet diffuses “first through urban
areas with complementary technical and knowledge resources that lower the costs of investing in new frontier technology” Forman et al., 2005b, p. 1). Empirically, several studies have tested the innovation-diffusion and efficiency hypotheses for e-shopping (Table 1). Generally, spatial attributes have been operationalized in two ways: types of geographical areas and shopping accessibility.

[Insert Table 1 here]

Krizek et al. (2005) explored this issue using a sample of about 740 adults from three cities in the U.S. Through chi-square tests, they found that people living away from the CBD were more likely to adopt online buying. Chi-square tests also showed inter-metropolitan differences in online buying adoption. However, these bivariate differences disappeared in a multivariate logistic model for online buying frequency (frequent vs. infrequent buyers). Krizek and colleagues concluded that spatial attributes did not have a significant influence on online buying, and the intra-metropolitan and inter-metropolitan differences were attributable to confounding factors.

In contrast, Farag et al. (2006a) found different results in the context of the Netherlands. They used the data of 2,190 internet users collected in 2001 (and 1,172 users in 1996 for comparison) by Multiscop. Spatial variables included shopping accessibility (the number of shops within the driving distance of a specified time period) and a group of dummy variables differentiated by street address density (from very strongly urbanized to nonurbanized). The adoption of online searching, the adoption of online buying, and the frequency of online buying were used to measure e-shopping behavior. They developed binary logit models for the adoption variables and a linear regression model for the frequency variable. They found that “[p]eople living in a (very) strongly urbanised area have a higher likelihood of buying online, but people with a low shop accessibility buy more often online” (p. 59). The former finding supports the innovation-diffusion hypothesis but the latter supports the efficiency hypothesis.

Ren and Kwan (2008) examined the impact of shopping accessibility on the adoption of online buying, using 392 internet users in Columbus, OH. Shopping accessibility was measured by the
number (and area) of shopping opportunities within the driving distance of specified time periods. The binary logistic regression showed that the area of shopping opportunities within 6.25-minute driving is negatively associated with the adoption of online buying. This result supports the efficiency hypothesis.

Some studies shed light on the impacts of spatial attributes on the adoption and usage of online buying although they did not explicitly aim to test the hypotheses. When investigating the impact of city center attractiveness on e-shopping, Weltevreden and van Rietbergen (2007) controlled for shopping accessibility. Accessibility was measured as the numbers of shops within specified time periods by car and by bike, respectively. They developed a multinomial logit model to predict the adoption of online buying by different mode users (car and alternative modes). Their results indicate that shopping accessibility did not have an influence on the adoption of online buying.

When comparing online buying behavior of American and Dutch, Farag et al. (2006b) examined the relationship between shopping accessibility (measured as travel time to shops for the Dutch sample and as shops within the walking distance or within a short driving distance from home for the U.S. sample) and online buying adoption (and frequency). They developed binary logit models for two independent samples. The U.S. sample consisted of 360 respondents from the Minneapolis-St. Paul, MN, metropolitan area and the Netherlands sample included 634 individuals from Utrecht. They found that shopping accessibility was not significant in the frequency model for both samples, and that the Dutch who had shorter travel times to stores were more likely to buy online than those with longer travel times. Since urban areas tend to have a higher shopping accessibility, the latter finding seems to support the innovation-diffusion hypothesis. For Americans, shopping accessibility did not have a significant influence. However, the insignificance of accessibility for Americans may result from the geographic scale of measurement – walking distance and short driving distance are hardly sufficient to represent regional shopping accessibility.

As reviewed in detail later, Farag et al. (2005) found that residential environment (urban vs. suburban) did not have a direct effect on the frequency of online buying (but the total effect was
positive and significant at the 0.10 level). Farag et al. (2007) concluded the positive impact of shopping accessibility on online buying frequency. They also found that urban residents bought online more often because faster internet connections were more prevalent in urban areas, an indirect effect. Ferrell (2005) found that retail employment accessibility was positively associated with time spent on home teleshopping, which supports the innovation-diffusion hypothesis.

3. E-Shopping and Travel Behavior
Conceptual and empirical studies in the field of ICT and transportation suggest that e-shopping may interact with travel behavior in four ways: substitution, complementarity, modification, and neutrality (Choo et al., 2007; Mokhtarian, 1990; Pendyala et al., 1991; Salomon, 1986). (In fact, e-shopping’s interactions with travel can be far more complex than other applications of ICT as Mokhtarian (2004) discussed.) *Substitution* denotes that a physical trip to traditional stores is replaced by an online transaction. *Complementarity* means that e-shopping generate new demands for trips to stores. Complementary effects can take at least four forms based on different shopping processes. An individual finds a product online, and travels to a store to experience it, and then buys it online; an individual finds a product online and then buys it in a store; a product purchased online makes an individual travel to a store for accessories or related products; an individual orders a product online and picks it up at a satellite store (e.g. Walmart’s shipping to store). Distinguishing specific forms of complementarity requires tracking individuals’ shopping processes. *Modification* denotes that e-shopping does not affect the amount of physical travel to stores but changes the characteristics of trips such as mode choice, timing, and chaining. *Neutrality* means that e-shopping is independent of traditional shopping. If an individual would have not bought a product if it were not available online, the online purchase represents an induced demand because of online information. In this case, the online purchase does not have any influence on personal physical shopping activities. Among these effects, substitution carries important positive implications for transportation. Planners are eager to disentangle the complex connections between e-shopping and travel behavior, and to measure the degree of substitution. Generally, previous studies on the connections fall into two categories: direct questioning and multivariate analysis.
3.1 Direct questioning
To assess the effects of e-shopping on individuals’ travel, why not just ask them? Although this approach may appear simplistic next to multivariate approaches, it can provide direct insights. Most studies using direct questioning can further be classified into two groups as shown below.

By directly asking for substitution effects, several studies have come to relatively consistent conclusions across many countries. Overall, they point to the substitution of online buying for trips to traditional stores. However, it seems that the magnitude of the substitution effect is not large. Specifically, in a three-year UCLA internet project, Cole et al. (2003) found that about 65% of U.S. internet buyers reported a reduction of their purchasing in traditional stores somewhat or a lot in 2000 and 2002, when they were asked if online buying affected their buying in retail stores. In contrast, Sim and Koi (2002) stated that 12% of 175 Singapore online buyers had reduced their travel to stores but the remainder did not feel any influence. The difference between purchases and travel may explain the large disparity between the results: fewer purchases do not necessarily reduce shopping trips (Mokhtarian, 2004).

In other studies, Tonn and Hemrick (2004) found that some internet users in the Knoxville metropolitan region (TN, U.S.) have reduced trips to stores although a smaller percent indicated generating new trips. Cairns et al. (2004) reported that 427 (or 80%) of 538 U.K. internet users polled by British Telecom have saved at least one car trip because of online buying, and that 82% of the 427 respondents had not made a replacement trip. Weltervreden and van Rietbergen (2007) found that more than 20% of Dutch respondents reported fewer visits and fewer purchases in city center stores. Using a different dataset, Weltervreden (2007) found that online buying had reduced some Dutch people’s visits to city center stores for some types of products (such as books, CDs, and travel) although the majority of Dutch people (ranging from 83% to 98%) perceived no influence and even more visits to stores. Dixon and Marston (2002) found that “[j]ust under two-thirds of the online shoppers in our Cyberton survey [U.K.] said that some or all of their online purchases made during the last year had replaced a purchase that otherwise would have been made in the town center” (p. 19).
Some studies adopted a different questioning strategy. Handy and Yantis (1997) asked respondents in three cities in the U.S. what they would have done if they had not found the last purchase in a catalog. They found that about 20% of respondents would have made a special trip to a store for that item; that is, catalog shopping reduced 20% of shopping trips. On the other hand, about a third of catalog shopping would not have happened, which was the demand induced by the catalog channel. Further, forty-six percent of respondents have ever made a trip to a store due to something they saw on a catalog; that is, the information obtained from catalogs also induces new demands. Although this study focuses on catalog shopping, these questions offered important insights and have been adapted in other studies. Wilson et al. (2007) asked respondents in three cities in the U.S., finding that online buying for the last purchase substituted for 79% of shopping trips and 21% were induced demand. They also found that 55.5% of respondents generated new trips because of information obtained online. Corpuz and Peachman (2003) showed that 35% of respondents in Sydney would have made a trip if online buying were not available (among which, 55.4% are special trips), and that 14% would have not made the purchase. Note a special trip does not necessarily mean an increase in vehicle miles traveled and the mode choice of special trips matters for transportation planners. Overall, these studies yielded mixed information. Online buying replaces some shopping trips. The opportunity for online buying also induces online transactions. Although these purchases may not require personal travel, they require a home delivery. More importantly, online information also generates new trips to retail stores. Given these interactions of substitution and induced demand, the net outcome of e-shopping on personal shopping travel remains unclear.

Direct questioning provides succinct and insightful information on the connections between e-shopping and travel behavior. However, it has its own limitations. Direct questioning is likely to suffer from a number of biases such as memory bias and social desirability bias (respondents may anticipate the objective of the study and hence conform their expressed choices either to what they think the researcher wants to hear, or to established social norms). Sometimes, studies asked respondents’ choice under hypothetical circumstances, which can be substantially different from actual behavior.
3.2 Multivariate analysis
A number of studies have applied multivariate models to reveal the relationships between e-shopping and travel behavior (Table 2). The modeling approaches range from simple descriptive analysis to sophisticated structure equations model (SEM). Some studies explored unidirectional influence from e-shopping to activity participation and travel behavior; and some considered multiple interactions among them. Based on the nature of data, these studies can be classified into two groups: studies using shopping surveys and those using activity/travel diaries.

[Insert Table 2 here]

Studies using shopping surveys
A typical shopping survey includes the following components: sociodemographic characteristics, internet-related variables, attitudes toward shopping and related factors, e-shopping behavior (adoption and/or frequency), in-store shopping behavior, or some combination of these elements. Both shopping behaviors are not measured at the daily level but aggregated at a longer term such as three months or half a year. The applications here used two separate data from the surrounding areas of Utrecht, the Netherlands, and concentrated on the impacts of e-shopping on traditional shopping frequency.

Using 826 respondents to a shopping survey randomly sent to one urban municipality (Utrecht) and three suburban municipalities in the Netherlands, Farag et al. (2005) applied path analysis to examine the connections between e-shopping and in-store shopping. The model contained six endogenous variables: online buying frequency, online searching frequency, in-store shopping frequency, internet use frequency, and two attitudes toward online buying and in-store shopping, respectively. Exogenous variables included sociodemographics, a dummy variable for residential environment, and two cognitive attitudes. This study assumed a unidirectional influence from e-shopping to in-store shopping. They found that online searching frequency had a positive impact on in-store shopping frequency although the influence of online buying frequency was insignificant. Therefore, the online information seemed to generate new traditional shopping trips. This result is not surprising given the cross-channel complementarity as shown in Handy and Yantis (1997) and Wilson et al. (2007).
Using the same dataset, Farag et al. (2007) augmented the path analysis to a SEM, in which traditional shopping and e-shopping were assumed to influence each other (the SEM also contained measurement models for attitudinal factors). In terms of direct effects, they found again the positive association between online searching and in-store shopping. Further, people who shop often in stores tend to purchase often online (but not vice versa), after controlling for shopping attitudes. In general, they concluded the complementary relationship between e-shopping and in-store shopping.

Using the Dutch sample described previously, Farag et al. (2006b) employed linear regression to explore the impacts of online buying frequency on durations and trip frequencies of daily in-store shopping and non-daily in-store shopping, controlling for sociodemographics, spatial attributes, internet experience, and attitudes. They found that frequent online buyers were more likely to make shopping trips (daily and non-daily) and that online buyers tended to spend less time for non-daily in-store shopping. They concluded that “the relationship between online buying and in-store shopping is not one of substitution but of complementarity” (p. 43).

Shopping surveys have advantages in studying the specific activity. Shopping surveys have a clear orientation. We can capture detailed information regarding shopping behavior and disentangle the whole shopping process; we can differentiate product types; we can also capture various shopping-related attitudes and thus their roles in the interactions between shopping behaviors; and so forth. However, because (online and traditional) shopping behavior is often measured at the aggregate level, it is difficult to show day-to-day variation in shopping behavior from shopping surveys. Therefore, shopping surveys are less likely to address such questions as: How does online buying affect shopping trip chaining in everyday life? How are time savings of online buying allocated to in-home and out-of-home activities and other travels? How does e-shopping interact with other activities? These questions can be addressed through activity diary surveys.

**Studies using activity/travel diaries**

Although many studies have used activity/travel dairy to explore the implications of ICT for travel, few explicitly focused on online buying. Zmud et al. (2001) is one of the earliest studies that explored the impact of online buying on travel behavior. Based on a supplementary survey,
they classified respondents to the 1999 household travel survey in Sacramento, CA into two groups: internet shopper and non-internet shopper. They found that internet shoppers had a higher overall trip rates than non-internet shoppers and hence concluded that online buying may generate new trips. However, this finding was not based on statistical analysis but descriptive analysis. More importantly, they did not control for any third-party variables such as income. Therefore, this observed difference can be attributable to confounding factors.

Ferrell (2004) used the 2000 San Francisco Bay Area Travel Survey (BATS 2000) – an activity diary – to explore the relationships between home-based teleshopping (by internet, catalog, and television) and travel behavior. He assumed that household travel behavior is affected by sociodemographics, teleshopping frequency, out-of-home shopping duration, and non-shopping activity duration. Because out-of-home shopping duration and non-shopping activity duration are also influenced by travel behavior (called travel time budget effects in Golob, 1996), Ferrell adopted a two-step model to address the endogeneity bias. He first developed two models to predict out-of-home shopping duration and non-shopping activity duration (with sociodemographics being explanatory variables) and then inserted predicted values into the equations of travel behavior. With respect to shopping travel, Ferrell found that the number of teleshopping activities has positive influences on shopping trip frequency and trip chaining frequency, but its influence on shopping trip distance is insignificant. He concluded a complementary effect. However, this study has a few concerns. First, the second-step equations in the two-step model are influenced by the efficacy of the first-step equation. The low $R^2$ for out-of-home shopping duration (0.031) is a concern, similar to the problem of weak instruments in instrument variables regression (as Mokhtarian and Cao, 2008 summarized). Second, Ferrell chose activity durations as predictors for travel behavior, but it is unclear why he used the frequency of teleshopping rather than its duration as a predictor. More importantly, this study does not control for shopping attitudes: it can be shopping preference that causes teleshopping and traditional shopping, and hence the relationship between the latter two may be spurious.

Following the activity-based travel choice model system proposed by Golob (1996), Ferrell (2005) applied a SEM approach to the BATS 2000 to investigate the connections between teleshopping duration and shopping travel. In the model, he distinguished in-home and out-of-
home activities for work, maintenance, and discretionary purposes. The shopping-related endogenous variables included teleshopping duration, out-of-home shopping duration, travel time, travel distance, trip frequency, and chaining frequency. He found that “people substitute home teleshopping time for shopping travel time and that teleshoppers take fewer shopping trips and travel shorter total distances for shopping purposes” (p. 212). Specifically, every 100-minute teleshopping is associated with a 5-minute reduction in shopping travel time, with a 1-mile reduction in travel distance, and with 0.2-trip reduction in frequency, although teleshopping did not have a significant influence on traditional shopping duration and trip chaining. With a fixed time budget, the participation of teleshopping may also affect the participation of other activities and associated travel (if any). Ferrell concluded that teleshopping is primarily a discretionary activity because of its connections with in-home discretionary activities. This is consistent with the argument of Mokhtarian et al. (2006) – teleshopping replaces traditional leisure activity. However, his model did not include travel behavior for other purposes as endogenous variables and hence was unable to evaluate the influences of teleshopping on travel behavior in general.

Using the same data, Ferrell (2004, 2005) yielded contradictory relationships between teleshopping and shopping travel. Ferrell (2004) concluded complementarity – teleshopping frequency was positively associated with shopping trip frequency and trip chaining, while Ferrell (2005) concluded substitution – teleshopping duration had negative associations with shopping travel time, distance, and frequency. Ferrell attributed this critical difference to the limitations of the dataset and different units of analysis: household vs. person. This difference may also result from different variables used in these two studies. The inclusion of teleshopping frequency is more or less ad hoc, while teleshopping duration is embedded in an activity-based analysis framework.

The activity-based analysis provided clues for the interactions between teleshopping and other activities. Teleshopping substitutes for shopping travel and in-home discretionary activities (Ferrell, 2005). However, it is still unclear how individuals would rearrange their time allocation (for in-home activities or for out-of-home activities) if teleshopping saves time for shopping travel. Ideally, a panel analysis will provide strong insights on changes in time uses resulting
from e-shopping. Alternatively, Gould and Golob (1997) addressed the changes in activity patterns if individuals would have participated in teleshopping. In particular, they assumed that time savings for shopping travel would be used for out-of-home maintenance activities and associated travel, out-of-home discretionary activities and associated travel, and shopping activity. They estimated a SEM using 1,810 women (with out-of-home work activities) in the 1994 activity and travel survey in the Portland metropolitan area. Only the link between shopping travel and maintenance activities was statistically significant; every 100-minute reduction in shopping travel time is associated with an 11-minute increase in the duration for out-of-home maintenance activity and associated travel. This study suggests that a small proportion of time savings resulting from the substitution of teleshopping for traditional shopping is likely to be relocated to new trips. However, teleshopping activities were not measured in this study. Instead, Gould and Golob explored what would have taken place if shopping travel could be replaced by teleshopping. An implicit assumption is that all relationships in the model would have remained the same should the substitution have happened.

Activity diaries offer detailed measurements for different activities, which embeds e-shopping study in an activity-based analysis framework. Various measurements for travel behavior (such as frequency, distance, duration, and chaining) can be derived from activity diaries. This enables the evaluation of multidimensional travel impacts of e-shopping. Activity/travel diary surveys have limitations, too. These surveys are generally conducted for the purpose of transportation planning, especially regional travel demand forecasting. Transportation-related activities are the main focus of the surveys; we cannot expect detailed information regarding shopping activities (although activity diaries designed for time-use analysis may contain more information). Therefore, it is less likely that we can distinguish e-shopping from other home-shopping channels. This is why Ferrell (2005) chose to investigate teleshopping (an aggregation of online, catalog, and television shopping). Further, there is a temporal mismatch between surveys and shopping activity. Disproportionate shopping activities occur on weekends, but most activity/travel surveys are conducted during weekdays (such as the Sacramento survey). This mismatch is likely to bias the connections between e-shopping and traditional shopping.
4. Toward Improved Knowledge

Previous studies have made certain progress on the relationships among e-shopping, spatial attributes, and travel behavior. However, there are no consistent findings regarding the impacts of spatial attributes on online buying (Table 1). In terms of online buying frequency, Farag et al. (2006a) supports the efficiency hypothesis; Farag et al. (2007) support the innovation-diffusion hypothesis; Farag et al. (2005, 2006b) and Krizek et al. (2005) did not find a statistically significant influence. For online buying adoption, the results are also mixed: two for the innovation-diffusion hypothesis, one for the efficiency hypothesis, and two for no effects. In addition, Ferrell (2005) supports the innovation-diffusion hypothesis for teleshopping duration.

Regarding the interactions between e-shopping and personal travel, the studies using the direct questioning approach tend to show mixed effects of substitution and complementarity. On the other hand, all three studies by Farag and colleagues (2005; 2006b; 2007) using shopping surveys support net complementary effects of e-shopping on traditional shopping frequency, and studies using activity/travel diaries produced mixed findings on substitution and complementarity. There is also evidence that e-shopping interacts with other activities, particularly leisure. However, this generalization should be interpreted with caution because (1) each study has its own weaknesses and (2) there are a limited number of studies in limited geographic areas. More importantly, the findings of existing multivariate analyses indicate only the association between e-shopping and personal travel but not the causality.

This review suggests that the relationships among e-shopping, spatial attributes, and travel behavior are more complex than it first appear, and point to various issues that future research should address:

(1) Future research must account for the influences of antecedent factors on both e-shopping and traditional shopping, especially individuals’ shopping responsibility in the household. Do the positive associations found in Farag et al. (2005, 2006b, 2007) mean that e-shopping has a complementary effect on in-store shopping (and hence implicitly on shopping travel)? The answer is not straightforward, however. The positive association can be attributed to at least three mechanisms (Mokhtarian and Circella, 2007). First, online buying induces the need for
additional related goods such as accessories (a direct causal influence). Second, time savings from online buying are reallocated to other shopping activities and travel (an indirect causal influence). Moreover, the association may result from factors antecedent to both shopping behaviors. For example, affluent individuals are likely to have a higher demand for online buying and traditional shopping than the poor; other sociodemographics (such as household size and age) can cause the demand for both shopping activities in the same way. Shopping enjoyment may also increase the demand for shopping through multiple channels. Because all three studies controlled for sociodemographics and shopping attitudes in the model, it seems that these studies point to the complementarity.

However, household shopping responsibility is another important antecedent factor. Shopping can be a maintenance or leisure activity. That is, shopping is motivated by enjoyment but also by household responsibility. Failure to control for the responsibility may produce spurious relationships between online buying and traditional shopping at the individual level. Consider two extreme cases: individuals in group A shoulder all shopping activities in the household and have a high frequency for online buying and in-store shopping; those in Group B carry few shopping responsibility and have a low frequency for both behaviors. A model of these two groups of people without controlling for the share of responsibility tends to yield an erroneous complementary effect. One way to address this issue is to model shopping activities at the household level (and hence the share of responsibility within the household does not matter), as Ferrell (2004) did. Another way is to include sociodemographics (such as gender, age, and children) in the model, but these variables are not likely to fully capture the explanatory power of household responsibility. None of the studies reviewed here explicitly measured individuals’ share of household shopping responsibility, however.

(2) Future research should integrate multiple dimensions of travel behavior into the relationships between e-shopping and personal travel. First, planners are interested in the impacts of e-shopping on trip generation (frequency). The following questions are also intriguing: Does e-shopping reduce shopping-related vehicle miles traveled? Does the information obtained online reduce time spent on shopping travel? Does e-shopping facilitate or discourage trip chaining of shopping activities? Does e-shopping reduce shopping trips that occur during rush hours? All
studies reviewed here chose trip frequency as dependent variables and a couple considered other dimensions of shopping travel. Second, the mode choice of shopping trips is directly related to the implications of the relationships. A driving trip induced by e-shopping carries social costs whereas an induced walking/biking trip may have health benefits instead. Although automobile dominates the mode choice of shopping activities in the U.S., an exploration of mode choice may provide insights for other countries such as European countries. It is worth noting that Corpuz and Peachman (2003) have made some attempts in Sydney. Third, previous studies extensively focused on the impacts of e-shopping on shopping travel. As presented earlier, time savings from e-shopping can be reallocated to other travel activities. However, few studies have examined how e-shopping influences travel behavior as a whole. Because these questions require ample information on activity-travel pattern, it is desirable to exploit an activity diary with detailed information on internet use and shopping activities.

(3) Future research should test the connections between e-shopping and traditional shopping at different time scales. Using different types of surveys, Farrell (2005) concluded substitution effects but Farag et al. (2005; 2006b, 2007) concluded complementary effects. The results appear to be contradictory. On the other hand, these findings may reflect the real influences of e-shopping on traditional shopping at different time scales. Activity diaries measure activity participation and travel behavior in one or two days. The induced demand of e-shopping may not occur within such a short period, especially when online purchases require physical delivery. In contrast, the span of shopping behavior over a certain period may be long enough to capture this inducement, and hence studies using shopping surveys concluded complementarity. However, this hypothesis has yet to be tested. In general, these two possible connections can be simultaneously tested by measuring an individual’s behaviors using both a shopping survey and an activity diary.

(4) Future research should examine shopping process and its implications for transportation. A shopping process can include, but is not limited to, information search, product trial, transaction, distribution, and return (as Mokhtarian (2004) summarized). E-shopping and traditional shopping may interact with each other at many stages of the shopping process (Mokhtarian 2004; Peterson et al., 1997). More importantly, their relationships can be distinct at different stages.
For instance, an individual orders a product online and picks it up at an outlet store later. In this case, an online transaction substitutes for a physical transaction at stores but it may also generate a special trip to the store. Further, the findings from the studies using the direct questioning approach also demonstrate the complex relationships between e-shopping and traditional shopping. To accurately measure the impacts of e-shopping on traditional shopping, it is necessary for future studies to quantify the interactions at all stages of the shopping process.

(5) Future research should differentiate product types when investigating the connections between e-shopping and traditional shopping (Cao and Mokhtarian, 2005). The characteristics of products greatly determine the degree to which they are suitable for marketing online and hence their potential for the substitution effect (Peterson et al., 1997). Conceptually, Peterson et al. (1997) concluded that low-cost, frequently-purchased, and tangible or physical products are more likely to be purchased in traditional stores; low-cost, frequently-purchased, and intangible or informational products are more likely to be purchased over the internet; and both channels are suitable for high-cost, infrequently purchased products. Further, different products may have different needs for information gathering, price comparisons, etc. Empirically, Tonn and Hemrick (2004) found the size of substitution effects differ by product types; so did Weltervreden (2007).

(6) Future research should discuss the magnitude of the influence of e-shopping on travel behavior. Previous studies have reported statistical significance of the influence; they have answered the question: “does e-shopping have a statistically significant influence on travel behavior?” However, it is arguable that the magnitude of an effect is at least as important as statistical significance of the effect, especially as statistical significance is affected by sample size (Ziliak and McCloskey, 2004). With the size of the influence, we can ascertain how big it is, not just whether it occurs or not. Further, it is desirable to compare the roles of e-shopping, sociodemographics, shopping attitudes, and other related factors in explaining travel behavior. This knowledge will enable us to evaluate the contribution of e-shopping in a relative sense, and hence to evaluate its potential as a travel demand management strategy or to factor in increased VMT in future.
(7) Future research should integrate shopping surveys and activity diaries. As discussed in Section 3.2, the weaknesses of the research are at least partly attributed to the limitations of the data. Consequently, an integration of shopping surveys and activity diaries could exploit the advantages of each and address their limitations. Through shopping surveys, we can obtain attitudinal measurements but cannot capture day-to-day interactions among different activities and travel. In contrast, activity diaries seldom capture attitudinal measurements but contain ample information on activity-travel patterns (although detailed information on shopping-related activities is desirable). With respect to survey content, the shopping survey should measure shopping-related attitudes, household shopping responsibility, sociodemographics, internet experience, and so on; and the activity diary should focus on shopping activities and travel as well as (in home and out of home) subsistence, maintenance, and leisure activities and associated travel. In addition, we can measure shopping behaviors over a long period (such as a quarter of a year) in the shopping survey. Combining quarterly measures and daily measures, we can test the hypothesis that the impact of e-shopping on travel changes depends on time scale.

(8) When we test the impacts of shopping accessibility on e-shopping behavior, it is desirable to measure the accessibility based on the areas over which consumers search information for different types of products. Generally, the search area for products differs by product type: it can be regional (specialty products, cars), citywide (clothes and electronics), and neighborhoodwide (books, CDs) (Mokhtarian, 2004). Farag et al. (2005) found that those living in highly urbanized areas were more likely to buy travel tickets online whereas those in low and moderately urbanized areas were more likely to buy digital products and clothes online. Previous studies tested different geographic scales, ranging from neighborhood (Farag et al., 2006b), to region (Ferrell, 2005), and to nation (Farag et al., 2006a; Krizek et al., 2005). However, these studies seldom explored the influences of different geographical scales on e-shopping with respect to product types. If product types are not differentiated, citywide and regional scales are attractive because the innovation-diffusion and efficiency hypotheses are formulated based on regional characteristics.

The proliferation of e-shopping during the past decade has attracted substantial attention from a variety of fields. The impacts of e-shopping on personal travel and hence the whole
transportation system are intriguing, especially when many claim that e-shopping can substitute for physical trips to traditional stores and reduce travel. However, these impacts are apparently understudied compared to the impacts of ICTs on commuting. As a result, the relationships between e-shopping and travel behavior remain unclear. More empirical research is needed to improve our fundamental knowledge on the connections.

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References


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Notes
1. In the conclusions column, ID represents that findings support the innovation-diffusion hypothesis; E denotes that results favor the efficiency hypothesis; N means that no effects were found.
2. Farag et al. (2006a), Krizek et al. (2005), and Ren and Kwan (2008) were explicitly designed to test the hypotheses.
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Notes:
1. For path analysis and SEM, dependent variables indicate endogenous variables and independent variables indicate exogenous variables.
2. Demographics may contain variables regarding internet usage.
3. In the Conclusions column, C means complementarity; S stands for substitution; N indicates that no effects were found.