A CONCEPTUAL ANALYSIS OF THE

TRANSPORTATION IMPACTS OF B2C E-COMMERCE

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ABSTRACT

This paper discusses, at a conceptual level, a number of issues related to the evaluation of the transportation and spatial impacts of e-shopping. We review the comparative advantages of store shopping and e-shopping, and conclude that neither type uniformly dominates the other. We identify the building blocks of the shopping process, and note that information and communications technologies are making possible the spatial and temporal fragmentation and recombination of those elements. We analyze future shopping-related changes in transportation as the net outcome of four different fundamental causes, that can be viewed hierarchically: (1) changes in shopping mode share (i.e. shifts in the proportion of shopping activities conducted through store shopping, e-shopping and other modes), keeping the volume of goods purchased and per capita consumption spending constant; (2) changes in the volume of goods purchased, keeping per capita consumption spending constant; (3) changes in per capita consumption spending, independent of demographic changes; and (4) demographic changes. Some factors result in reduced travel while others lead to increased travel. The combined outcome of all factors does not appear to support any hope that e-shopping will reduce travel on net; to the contrary there may be negative impacts due to increased travel, even if those impacts are likely to be localized and/or small in magnitude for the most part. Thus, on the whole, we are likely (with some exceptions) to see continued adoption of both store shopping and e-shopping. Consumers will blend both forms as they conduct a sequence of shopping activities, and retailers will blend both in marketing to and serving customers. Assessing the transportation impacts of e-shopping – even in the short term, let alone the long term – presents some formidable measurement challenges. Nevertheless, those challenges are worthy of our most creative efforts at solution.

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1. INTRODUCTION

If one were to rely solely on media reports, electronic commerce has enjoyed a volatile history since erupting on the scene a few short years ago. Initially hailed as a revolution, it attracted thousands of entrepreneurs and investors eager to cash in on its promise. However, as with so many speculation fevers before it, "many are called, but few are chosen" to succeed. With the bursting of the dot.com bubble, "B2B" came to mean "back to basics", and "B2C" became "back to college" for the erstwhile twenty-year-old millionaires. Nevertheless, e-commerce continues to grow. For example, US Department of Commerce figures (http://www.census.gov/mrts/www/ current.html, accessed August 22, 2003), based on a random sample of 11,000 retailers, show that online retail sales in the US totaled about $28 billion in 2000 (0.9% of total retail sales), $35 billion in 2001 (1.1% of total retail sales and an increase of 22% over the previous year, despite the softening economy and the shock of the September 11 terrorist attacks), and $43 billion in 2002 (1.3% of the total and an increase of 26% over the previous year). Couclelis (2001) points out that the DOC figures exclude categories such as travel and event tickets – categories that are certainly relevant to assessing the impact of e-commerce on travel – and hence these figures underestimate total online sales.[1]

Indications are that e-commerce, in some form and at some level, is here to stay – in many contexts it is quite clearly superior to the old way of doing business. To urban planners, then, the impact of e-commerce on transportation is a relevant question. This paper addresses that question, narrowing the focus to the business-to-consumer (B2C) segment of e-commerce. Although the business-to-business (B2B) segment dominates e-commerce in terms of the dollar value of transactions made, B2C remains important for its potential impacts on urban travel and land use patterns.

To date, there is still little empirical data on the transportation impacts of B2C e-commerce. Thus, we are rather short on answers at this stage. The purpose of this paper is more to raise the questions than to provide the answers; specifically to provide a conceptual framework from which to address the questions. Failure to view a broader context may result in studies that fail to ask the right questions, or omit some important questions that would materially alter our understanding of the results. Thus, in the spirit of the proverb that "time spent

sharpening the axe is not wasted", it is hoped that spending some time thinking about the key research issues will bear fruit in the form of more useful information from well-designed studies.

The organization of this paper is as follows. Section 2 explores the potential advantages of electronic shopping "versus" store shopping. Section 3 describes the various elements of the shopping process, and how information and communications technology (ICT) is permitting those elements to be spatially and temporally detached and reassembled in novel ways. Section 4 organizes the potential transportation impacts of e-shopping into four hierarchical levels, and discusses each in turn. Section 5 draws on the previous discussion to present some important issues facing research in this field, and Section 6 offers some concluding remarks.

2. COMPARATIVE ADVANTAGES OF E-SHOPPING AND STORE SHOPPING

Before proceeding further, it is useful to define some terms. *Electronic commerce* generally refers to the use of the Internet (or proprietary intranets) to conduct commercial activities of various kinds, and as mentioned above it can be partitioned into *business-to-business* (B2B) and *business-to-consumer* (B2C, or *electronic retailing*) segments. With respect to the B2C segment, a relevant term that has previously appeared in the academic literature is *teleshopping*. Teleshopping refers to the use of ICT to obtain information about or purchase consumer goods: pre-Internet services such as home-shopping channels on cable television, specialized early computer-based systems such as the Minitel in France, and even telephone orders from a catalog mailed to the home can be placed in this category. In this paper, I will use the term *e-shopping* to refer to the segment of teleshopping that is Internet-based. Thus, e-shopping basically refers to the B2C segment of e-commerce, but with a focus on the set of activities – shopping – that are undertaken by the consumer.

There are two aspects to understanding the extent and nature of the travel (or any other) impacts of e-shopping. Certainly a great deal can be learned from studying the transportation impacts for those who adopt teleshopping. For this purpose, samples of e-shoppers can be obtained and their travel behavior analyzed (specific research issues are discussed further in Section 5). But to scale those impacts up to the urban transportation network level, it is imperative to understand the extent and nature of the *adoption* of e-shopping – for how many people will

[1] For 2001, The Forrester Group (www.forrester.com) indicates that about 29% (or $14 billion) of its estimate of $48 billion in online sales was for airline tickets, car rentals, and hotels. Thus, accounting for differences in what

those transportation impacts apply? Thus, before turning directly to the potential transportation impacts of e-shopping, it is useful to review the comparative advantages of e-shopping and store shopping (based on Underhill, 2000 among others), as a basis for understanding the circumstances under which each might be preferred.

2.1 Potential Advantages of E-shopping

The adjective "potential" should be stressed, since some putative advantages are either not yet fully realized (due to technological constraints or simply to the early stage of diffusion), or apply only in some circumstances. Further, some advantages may accrue at the expense of others. For example, it is suggested (European Commission, 2001) that the personalization a consumer obtains from a particular retailer may raise barriers to switching and hence obviate the benefits of widespread search and price comparisons. With those caveats in mind, some advantages of e-shopping include:

- *Unlimited selection:* A Barnes and Noble superstore stocks 175,000 book titles; Barnesand Noble.com boasts 3 million (*Business Week*, 1998) – and that is just a single Internet seller. Rather than being constrained by the stock on hand at one physical location, the inventories of all Internet retailers are available to the buyer.[2]

- *Lower prices / search costs:* Although reality has sometimes differed (e.g., Palmer, 2000; Lal and Sarvary, 1999), theory suggests that Internet retailers will offer lower prices than their store-based counterparts, due to the lower costs of search for the buyer (the ease of obtaining information will drive prices down), and lower costs of market entry and operations for the seller (Brynjolfsson and Smith, 2000). In some cases the buyer avoids having to pay sales taxes by purchasing through the Web (of course, the added costs of delivery must be balanced against any savings in the purchase price). With respect to search costs in particular, using automated shopbots (Brynjolfsson and Smith, 2001) or even manually, the Internet makes it simple to compare prices on a broad geographical scale. Brynjolfsson and Smith (2000, 2001) and others find that people do not always choose the lowest-priced item from e-tailers, even for "undifferentiated" products such as books and CDs. Rather, they suggest that factors such as brand loyalty, habit, and trust in a given retailer (Jarvenpaa, *et*

each series includes, their numbers seem relatively consistent with those of the Department of Commerce.

al., 2000) continue to be important – arguably (and ironically, in view of claims that the Internet would "level the playing field") even more important in the e-commerce context, where the links among buyer, seller, and product are detached from the physical cues afforded by a bricks-and-mortar store. Nevertheless, price is generally still an important factor informing the purchase decision.

- *Information:* The Internet is a convenient storage medium for voluminous information about a product, information that would not readily be available in stores[3]. Some Web sites are structured to allow ready comparison of a number of specific products along several relevant dimensions, through automatic completion of a matrix (the columns representing the products and the rows the comparison dimensions) as specific products from a given class (e.g., digital cameras) are selected.

- *Personalization:* ICT is enabling the "mass customization" of information and even products (music CDs, computers, automobiles) – tailored to the individual's demographic and preference characteristics, whether offered voluntarily or obtained through unobtrusive tracking of browsing and purchase patterns (Hof, *et al.*, 1998). The individual is often able to design (and in the case of music CDs, create) her own product directly to her own specifications. Greater consumer satisfaction is presumably the result.

- *Convenience:* As various ads have trumpeted, we can e-shop while naked. More prosaically, we can do so while too sick to leave the house, at 3 a.m. when brick-and-mortar stores are closed, during a blizzard, while at work or taking care of the children or traveling. In short, shopping is freed from temporal and spatial constraints, and becomes possible "24/7".

- *Speed:* The Internet allows the shopper to rapidly assemble information from numerous virtual stores, in a negligible fraction of the time it would take to visit real stores in person (Brynjolfsson and Smith, 2000).

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[2] Interestingly, however, it seems to be the norm for online grocery services to stock *fewer* items than their store counterparts (Cairns, 1996; Tanaka, *et al*., 1998).

[3] On the other hand, some authors (Burke, 1997) note that the plentiful information available over the Web nevertheless generally lacks a human interface with whom customers can interact in real time to obtain answers to questions, and others (Manski and Salomon, 1987) suggest that information overload may be an issue.

It is suggested (e.g., European Commission, 2001) that these advantages are combining to place more power in the hands of consumers, resulting in a shift from "supply push" to "demand pull" forms of marketing. On the other hand, retailers will have new tools for advancing their agenda as well. For example, Brynjolfsson and Smith (2001) point out that the Internet enables personalization not only of the product, but also of its pricing, with e-tailers able to charge based on an individual's willingness to pay, predicted from that individual's historical behavior and demographic characteristics. Thus, it is likely that there will continue to be a tug-of-war between retailers and consumers.

2.2 Potential Advantages of Store Shopping

The advantages of e-shopping may appear to be compelling, but they are only one side of the picture. There are a number of dimensions on which store stopping is competitive (Salomon and Koppelman, 1988; Tauber, 1972):

- *Sensory information:* Until virtual reality becomes more sophisticated and more available, there is no good substitute for the ability to see, feel, smell, taste, or manipulate a desired item – try out how it works, feel how much it weighs, see how it looks on you, judge its size or color in a natural environment rather than on a computer monitor. Naturally, this advantage is more salient for some goods than for others, and non-existent for digital or undifferentiated goods, or repetitively-purchased items[4].

- *Tangibility:* A different but related issue is the tangibility, not of the goods themselves, but of the shopping environment. As mentioned in Section 2.1, trust continues to be an important barrier to the adoption of e-shopping. Many people are more comfortable doing business with a physical store that has been in town for years, whose owner is visible in the community, than with an unseen, unknown e-tailer who may be out of business tomorrow (Steinfield and Whitten, 1999).

- *Immediate possession:* With the notable exception of digital goods (a category that is increasingly widening as technology improves, but that will remain limited), store shopping generally has the advantage of instant gratification. As Gould (1998, p. 151) comments, the

[4] Peterson, *et al*. (1997), however, point out that although the Internet is inferior to store shopping on this dimension, it is superior to catalog shopping in the quantity and quality of the "perceptual experience" it can provide.

travel time saved by shopping from home must be balanced against "the offsetting time spent waiting for home delivery."

The remaining advantages of store shopping relate not to the final outcome of acquiring a desired good, but to accompanying components of the shopping process. In many cases these aspects may be incidental to the main purpose of purchasing an item, but in many other cases they may constitute the primary incentive for the shopping activity. Thus, an analysis of shopping behavior that focuses exclusively on the assumed goal of goods acquisition will inevitably underestimate the appeal of store shopping.

- *Social interaction:* "Hanging out at the mall" is a well-known pastime for groups of American teenagers. They are not the only ones for whom shopping serves a social function, however (Vala-Haynes, 2000; Chung, 2002). Going shopping can be a deliberate choice to combat isolation for those who live alone, especially if they also work at home (Gould and Golob, 1997, found that home-based workers spent more time in out-of-home shopping than did conventional workers). Even when isolation is not a factor, many people enjoy the social aspect of store shopping: seeing and being seen, flirting with the cashier, bargaining or simply passing the time of day.

- *Entertainment:* Many researchers have commented that shopping is not purely a maintenance activity, but possesses recreational overtones, to varying degrees for different people and circumstances (e.g. Gould and Golob, 1998; Salomon and Koppelman, 1988, 1992). Retail centers are increasingly combining entertainment with shopping (Kaufman, 1995). The Mall of America in Bloomington, Minnesota (www.mallofamerica.com, accessed August 22, 2003) is an extreme example, but on a smaller scale, any number of malls provide entertainment opportunities such as theme restaurants, virtual reality game arcades, carousel rides for children, or live music performances. Bookstores are redefining themselves as places to buy coffee, sample music, or listen to a children's story hour in addition to their traditional roles. All of these functions add value to the shopping experience (at least for some) beyond the purchase itself.

- *Movement:* Besides serving as an antidote to isolation, store shopping can meet the need for motion. Mall designer Yaromir Steiner has a vested interest in his belief that "people like to get out of the house" (Kaufman, 1995, p. 72), but he is supported by a number of more

detached observers of travel behavior. Contrary to the conventional view that the demand for travel is derived purely from the need to engage in activities that happen to be spatially separated, recent research (e.g., Mokhtarian and Salomon, 2001) is confirming previous observations that travel has a positive utility, and is sometimes desired for its own sake. It is likely that a number of shopping trips are "invented" in order to "justify" (often subconsciously) an urge simply to get out and go *somewhere*.

- *Trip chaining:* Many shopping trips are linked to trips for other purposes. For example, Jou and Mahmassani (1997) found that about a third of commuters studied in Dallas and Austin, Texas made at least one stop on the way home from work, and that nearly one-fifth of those stops were for shopping. This can make the marginal cost of store shopping negligible, and contribute to making store shopping the preferred alternative in many instances (Gould, 1998).

2.3 Implications for the Adoption of E-shopping

The foregoing discussion makes it clear that the choice between store shopping and e-shopping is not unambiguous. The relative advantages presented above will take on different values in diverse situations, and will also be weighted variously by different people and in diverse situations (Handy and Yantis, 1997). Further, Burke (1997) points out that store retailers will not be passively watching the e-tailing phenomenon, but will be actively enhancing and promoting their natural advantages, as well as narrowing the gap on their disadvantages. Of course, he comments, e-tailers will be doing the same things. Thus, an effort to model the adoption of e-shopping should account for all the factors likely to affect the choice, should seek to identify segments of the population that have distinct preferences among those factors, and should be sensitive to differences across shopping contexts and changes across time.

There have been a few studies of the adoption of teleshopping, in most cases based on hypothetical alternatives. Their results are of interest. Koppelman, *et al*. (1991), for example, identified a segment of people who disliked catalog shopping, tended to see teleshopping as a similar form, and thus were unlikely to consider teleshopping, at least in the context of shopping for appliances. A composite of several studies (Tacken, 1990; Gould and Golob, 1997; Gould, *et al.*, 1998; Burke, 1998) indicates that the elderly, disabled, workers in dual-income households, and single parents were most receptive to teleshopping (specifically for groceries, in the Tacken

and Burke studies). To the mobility- and time-limited, Cairns (1996) adds two other segments of the population likely to be early adopters of grocery teleshopping: those who like technology, and those who dislike shopping. These four segments may well be generalizable to many e-shopping contexts. Finally, one recent study of actual online shopping (Eastin, 2002) found its frequency to be significantly and positively influenced by four main factors: prior engagement in shopping by telephone, a measure of self-confidence with respect to e-commerce activities, perceived convenience, and the perceived financial benefit.

3. THE SHOPPING PROCESS AND ITS FRAGMENTATION AND RECOMBINATION

So far, we have for convenience been referring to "shopping" as if it were a single monolithic activity. In reality, of course, shopping is a process, comprising a set of distinct components linked together in a particular sequence that can vary from case to case (Peterson, *et al*., 1997). Knowing the components of the shopping process is important to understanding how e-shopping will be adopted and what its travel impacts will be.

Most introductory textbooks on consumer behavior present a conceptual model of the shopping process. Typical elements of the process include desire, information gathering/receiving, trial/ experience, evaluation, selection, transaction, delivery/possession, display/use, and return (see, e.g., Schiffman and Kanuk, 1987; Salomon and Koppelman, 1988). Not all shopping instances will involve every element; for example, information gathering and trial are negligible to non-existent for many repeat purchases (except to the extent that the purchase and usage itself constitute information gathering and trial for the *next* purchase). Conversely, some elements may be accomplished more than once in a given shopping instance. For example, one may gather information about several members of a category of interest, try several "models" of the item, reject all of those, and return to the information-gathering stage.

In a conventional store shopping scenario, many of these components occur at the same location on a single visit. Specifically, information gathering, trial, evaluation, selection, transaction, and possession often occur at a single place and time. How is the Internet changing this?

Couclelis (2000) notes that a typical outcome of new ICTs is the *fragmentation* of formerly holistic activities, and their *recombination* in new ways. For example, the activity "work" used to occur in a single time window at a single location. "Leisure" used to occur in a

different time window and a different location. Now, telecommuters and mobile workers can detach the work activity both from its traditional time and its traditional place, and reconstitute it as a series of work episodes occurring at a variety of times and places, interspersed and sometimes collocated with leisure activities (checking e-mail on vacation, conducting business by mobile phone while watching one's daughter's soccer game).

We can observe similar changes with the shopping process. Shopping used to occur mainly in stores during well-defined non-work periods (lunch hours, evenings, and weekends); now it can be conducted while at work or at home, in a car or on a plane, interspersed with other activities. Thus, ICT is broadening the options for many of the elements listed above. Consider:

- *Desire:* Underhill (2000, p. 56) wryly (if hyperbolically) notes, "if shoppers suddenly ceased to buy on impulse, believe me, our entire economy would collapse." E-tailers are actively searching for new ways to stimulate desire. Banner ads on web sites were an early approach, although they have not proven to be especially effective (Neuborne and Hof, 1998). Customized e-mail or web-based suggestions and discounts based on one's recent purchase history or stated interests are currently in vogue. One can listen to a new song over an Internet radio service and immediately click to buy the CD. Mobile commerce (m-commerce) applications extend the possibilities even further, to "location-based marketing" (*The Economist*, October 11, 2001): pass near a department store on the way to somewhere else, and receive a mobile phone message that the suit you tried on and registered your interest in last week is now on sale.

- *Information gathering/receiving:* As indicated earlier, an important advantage of Internet-based shopping can be the ability to acquire and filter large quantities of information about a desired item or class of items, in a short time. The consumer may actively acquire information, may initiate a request to automatically receive information meeting certain parameters ("notify me when the price drops below $500"), or may receive unsolicited information.

- *Trial/experience:* This is generally still a limitation of e-shopping compared to store shopping, but technology is always pushing the envelope. Download audio or video samples before buying that CD or DVD. Practice using a simulated version of that digital camera. Give your measurements to a clothing e-tailer, and establish a virtual fitting room, where you

can see how that particular jacket would look on you from any angle. Place your hand in a virtual reality glove, and feel those peaches.

- *Evaluation:* Also as mentioned earlier, a number of web sites have explicit comparison capabilities, permitting the side-by side evaluation of a number of products in a given class, along the same dimensions.

- *Transaction:* The ability to complete transactions between a spatially-separated seller and buyer has been around for a long time. While the two basic transaction modes of debit (subtracting the purchase price from a pre-established account balance) and credit (creating a debt that is repaid later) have not changed, new ways of activating each mode are emerging. Highway tolls are collected electronically when the dashboard-mounted transponder passes under a reader. Cost-effective ways of collecting micropayments (amounts ranging from a few cents to a few dollars) are being developed, such as using the mobile phone to make deductions from a pre-paid account.

- *Delivery/possession:* Goods that primarily contain information are increasingly available in digital form and in these cases can be delivered electronically, requiring no travel whatsoever. Examples are well-known: software, music, photographs, movies, news, books.

- *Display/use:* A physical item is normally displayed or used in the same form in which it was purchased. With information goods, however, ICT has broken apart those two elements: such items are often acquired through ICT but then converted to a physical platform for use. Music may be downloaded to a hard drive but then burned onto a CD for maximum portability. A large technical report may be e-mailed, but then printed off by the recipient.

- *Return:* E-merchants are seeking ways to make returns easier, thereby lowering one barrier to increased e-shopping. Rather than requiring the customer to repackage the item for mailing, make a special trip to a post office, and pay for shipping, e-merchants are partnering with bricks-and-mortar establishments to offer more convenient options (Aoyama, 2001): returning the rented video to the neighborhood Starbucks Coffee (Mount, 2000), returning the ill-fitting garment to the merchant's affiliated store.

Together with the new alternatives for accomplishing each shopping component, ICT is, secondly, permitting the components to be detached and reassembled (especially spatially but also temporally) in new ways. Couclelis (2001) offers a potentially useful typology of shopping patterns, by simplifying the process into three stages – before, purchase, and after – and two shopping mode choices for each stage – local or remote. The result is $2^3 = 8$ possible patterns, and, as she notes (p. 10), "Some of these patterns identify particular kinds of shoppers: the traditional shopper (local/local/local), the cybernaut (remote/remote/remote), the good citizen (remote/local/remote) and the free rider (local/remote/local)."

4. POTENTIAL TRAVEL IMPACTS OF E-SHOPPING

To date, few empirical studies of the transportation impacts of e-shopping – or even older forms of teleshopping, for that matter – have been conducted. Thus, our discussion of the potential impacts must of necessity be speculative. Nevertheless, a number of possible effects can be identified. The possibilities suggested below can be viewed indirectly as a set of research questions that future empirical studies can/should be designed to answer. The discussion below[5] considers not only effects on passenger travel, but also the effects on goods movement due to consumer decisions.

A total future shopping-related change in transportation will be the net outcome of potentially four different fundamental causes. At least at the conceptual level, it is useful to view these four causes hierarchically – arranged in order of decreasing directness of the relationship – and treat them one at a time:

- changes in shopping mode share (i.e. shifts in the proportion of shopping activities conducted through store shopping, e-shopping and other modes), keeping the volume of goods purchased and per capita consumption spending constant;
- changes in the volume of goods purchased, keeping per capita consumption spending constant;
- changes in per capita consumption spending, independent of demographic changes; and
- demographic changes.

It would be valuable to be able to decompose any net change in transportation into these four separate sources, in order to properly understand the nature and specific causes of the observed change. Actually doing so would be difficult in practice. Nevertheless, it is useful to identify these separate effects, to help ensure that they are not overlooked in research design and analysis. For example, it would be easy to focus on the first and most direct source of impact on transportation – a simple substitution of one shopping mode for another – and conclude that e-shopping reduces travel, whereas the deduction could be quite different if the other sources were also taken into account. Below we discuss each category in turn.

4.1 Transportation Impacts of Changing Shares of Shopping "Mode" Given Fixed Volume

For the potential effects mentioned in this subsection, the initial assumption is that the total volume (loosely meant as number and kind) of goods purchased remains constant, even if the specific goods purchased are redistributed in time and/or space. It is precisely the transportation impacts of those redistributions that are of interest here. In succeeding subsections we relax the constant volume assumption.

- To the extent that e-shopping replaces store shopping, travel by the consumer will theoretically decrease. But first of all, in some cases the Internet simply replaces the telephone instead of a trip to the store, as when one books travel over the Internet instead of calling a travel agent, or places a clothing order online rather than phoning it in after browsing through a physical catalog. Even if a store trip does occur, the transportation impact of a shift to e-shopping depends on the extent to which store shopping for the item(s) now purchased electronically was chained to other activities (Handy and Yantis, 1997). In many cases the incremental distance added by the shopping trip is negligible (the stop at the store is made on the way to another location, or the electronic purchase replaces some but not all of the items purchased in the store), in which case the Internet purchase will save virtually no consumer travel (Williams and Tagami, 2003). It should also be kept in mind that when the shopping trip is made by walking, cycling, or public transportation, eliminating the trip will not benefit congestion, energy consumption, or air quality (Keskinen, *et al.*, 2001), and in fact will carry the disbenefit of reduced physical exercise.

[5] This section is much more fully developed from skeletal and less complete lists of impacts appearing in Mokhtarian and Salomon (2002) and Mokhtarian (2000). Also see Siikavirta, *et al.* (2003) for a list of potential environmen-

- Replacing store shopping by e-shopping shifts the travel required to deliver the purchased goods from the consumer to the provider, with an uncertain net impact. Provider-side delivery trips may be more efficiently organized than consumer-supplied deliveries – or they may not be, depending on both the extent to which the consumer trip was chained to other activities, and the provider-side tradeoffs between efficiency and timeliness of delivery. Some researchers (e.g. Niles, 1994) suggest that consumer demand for fast delivery, or for delivery within narrow windows (Lin and Mahmassani, 2002; Siikavirta, *et al.*, 2003), makes it more difficult for the provider to achieve economies in packing and routing trucks, and increases the demand for the more energy-intensive airline delivery mode over truck or rail (Matthews, *et al*., 2001; Murtishaw and Schipper, 2001). On the other hand, ICT is also helping to increase the efficiency of goods movement through information sharing and load consolidation across multiple shippers (Greenleaf, 2000; Marker and Goulias, 2000; Rabah and Mahmassani, 2001; Lin *et al*., 2002).

- E-shopping may change the frequency of shopping. One possibility is that the increased convenience of e-shopping will increase the frequency, resulting in more (possibly smaller) individual deliveries. For example, one weekly trip to a grocery store may be replaced by two or three smaller deliveries during the week. On the other hand the opposite outcome was found in at least one Finnish study (Kärnä, 2001), but it was noted that Finns have an unusually high baseline (without an e-shopping alternative) frequency of 4-5 weekly trips to a grocery store. Currently high delivery charges may discourage increases in frequency for many (Burke, 1998), but it is an important possibility to monitor. Even if the volume of goods demanded by an individual remains constant (as we assume in this section), when it is spread over more deliveries there is a penalty in terms of time, energy consumption, and marginal added travel for each delivery, and hence a greater requirement of resources.

- E-shopping may alter not only the frequency but also the "destination" of the shopping trip (or, from the goods movement perspective, the "origin" of the item being purchased). With the Internet offering global reach even to small providers, manufacturing and delivery travel may increase as consumers and businesses order products and services from more distant providers of whom they would not otherwise have been aware, or to whom they would not have traveled (Salon, *et al.*, 1999; Rabah and Mahmassani, 2001).

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tal impacts of e-commerce that places more emphasis on the seller and less on the buyer than I do here.

- More widespread dissemination of information about physical stores using ICT, e.g. through the Internet, sophisticated in-vehicle navigation devices, or a mobile phone, may prompt trips to more distant stores, or new trips to stores. This can increase transportation, even when the same volume of goods is being purchased.

- As mentioned in Section 3, many information-based goods may now be delivered electronically. To maintain the assumption of fixed volume, here we assume that those goods are all "recon-stituted" or "rematerialized" by the consumer converting them to physical platforms. In that case, the travel associated with the manufacture and purchase/possession of the generic display media (blank CDs, reams of printer paper) should also be accounted for. Presumably the production and distribution of generic media should be more efficient than that of specialized media, all else equal.

- It must not be overlooked that some of the goods purchased electronically will be *travel* – as indicated earlier, perhaps as much as 29% of total online retail sales. Under the assumption of fixed volume, some of those purchases will represent cost savings (or even simply a more convenient alternate means of booking) for a trip that would have been made anyway, while others will in fact displace other trips (which, however, may well have tended to be shorter, as when an intended domestic vacation is replaced by an international one found at a similar price).

4.2 Transportation Impacts of Changing Volumes Given Fixed Per Capita Spending

There are several ways in which the volume of physical goods purchased could change while per capita consumer spending remains constant.

- As has already been mentioned, e-shopping can lead to cost savings, not only due to the ability to comparison-shop, but also due to deeply discounted last-minute sales of "perishable" items. The late sale of otherwise-unused airplane seats is an example of a transaction that was not possible without the Internet as a means for identifying and linking sellers and buyers. In general, to the extent that e-tailers succeed in offering the same goods at lower costs than before, consumers may purchase more goods for the same amount of money (Cohen, 2002). This would result in greater goods movement for deliveries (and/or potentially increased passenger travel for store shopping activities, assuming store retailers respond by cutting prices

as well). And to the extent that travel constitutes a particular product enjoying cost savings, it is likely that purchases of travel will increase. This is certainly the position of a recent European Commission (2001, p. 23) report, which states categorically, "ICT will be a major factor behind the growth of the travel sector, especially increasing demand in air transport."

In Section 4.1 we referred to the electronic delivery of digital goods, but treated the constant volume case in which those goods were physically constituted after delivery, through transference to a tangible platform for more convenient display and use. Here, we observe that electronic delivery can lead to changes in volume, in two ways.

- In the first case, the digital good *remains* virtual. Theoretically this may reduce travel – both the passenger travel of the consumer to the store (to the extent that the trip was *not* chained to other ones), and the goods movement associated with manufacture and distribution of the physical item (to the extent that the electronic version of the item would have been replaced with a physical one if electronic delivery had not been available). In general, the increasing dematerialization of products (referring not only to completely digital products, but to the reduced size and weight of many physical goods as well[6]) may reduce the actual physical volume of the same number (and type) of items purchased.

- On the other hand, if (1) a greater number of digital goods is demanded due to cost reductions (whether through dematerialization as one important mechanism (Bernardini and Galli, 1993; Kärnä, 2001), or through the other factors identified above), and (2) those goods are generally rematerialized by the end user, higher volumes would result. For example, prior to the Internet, a physical report may have been mailed to a relatively small number of people. Now, the same report may be e-mailed to, or accessed on the Web by, a much larger number of people – only a fraction of whom will print it off, but that fraction may be a greater number in absolute terms than the number obtaining it previously. This effect would increase goods movement in total – although, as mentioned earlier, there could be further spatial and temporal redistributions resulting from the detachment of the distribution format (now electronic) from the display/use format (still physical).

[6] Technically, of course, the latter types of dematerialization generally cannot be considered Internet-based. But it is convenient to raise the general issue of the transportation impacts of dematerialization in this context. And Kärnä (2001) identifies several ways in which electronic grocery shopping in particular might facilitate dematerialization for

- However, the Internet could not only support a shift to a higher volume of cheaper goods. The personalization and other customer-service capabilities of e-retailing could also lead to the production of higher-value/cost goods, which are then purchased in lower volumes by the consumer with a fixed budget. Both types of shifts are likely to occur, with an unknown net impact.

- Finally, shifting the allocation of a fixed consumer budget between material products and immaterial services could alter the total physical volume of material products requiring delivery, and total personal transportation required to receive or provide services, in either direction. *A priori*, it is not clear that increased e-shopping favors a shift in either direction, but it is a potential effect to be monitored.

4.3 Will Per Capita Spending Remain Fixed?

It is tempting to focus on substitutions of e-shopping for store shopping in the context of a specific purchase or within a fixed budget. But if in fact there is an increase in consumer spending overall, then substitutions at the margin may be more than counteracted by expansions in the total. Eminent scholars such as Peterson, *et al*. (1997, p. 5 of the online version), endorsed by Burke (1997), assume that "use of the Internet for marketing purposes will not increase overall consumer spending… There is no intuitive reason why the Internet, or any service based thereon, will in and of itself cause consumers to spend more." However, we have already seen a number of ways in which the Internet can stimulate consumers to buy more of some things than they would have otherwise:

- The ease of marketing to consumers (particularly targeted marketing) and conducting transactions over the Internet (see, click, buy) may increase the volume of impulsive or compulsive purchases (Eastin, 2002).

- The convenience of e-shopping and the greater variety available may stimulate purchases that are more deliberate than impulsive, but that simply would not have taken place in stores otherwise. In some cases time and/or mobility constraints may prohibit a counterpart in-store

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physical goods (such as the ability to reduce packaging that is designed to capture the store shopper's eye, and the ability to better manage inventory and hence reduce waste).

experience; in other cases the Internet may draw a directed search for items not expected to be available in local stores.

- As seen in Section 4.1, location-based marketing could increase travel even if total spending remained constant. In some cases it could also increase spending while leaving travel constant (by successfully marketing new goods at locations that were going to be visited anyway). It is quite likely, however, to do both – increase spending and increase travel.

- The appeal of increasingly personalized goods may release some latent demand for products or services that otherwise would have gone unrealized. For example, the ability to customize CDs may increase the music consumption of people who would not purchase a mass-produced CD for the sake of one or two favorite songs.

- As discussed in Section 3, the Internet offers another channel for stimulating desire and for obtaining information about a desired good. The Internet is not just one more channel among many, but has a number of characteristics not shared by other advertising media: its (potential) ubiquity; its capacity to store vast amounts of information; its temporal breadth and depth (not only available 24/7 now, but also offering historical archives); its searchability and linkability; and its multimedia capabilities. These traits are likely to spread information about consumer goods in a way no other medium has done. Again thinking particularly of travel as a consumer good, the ease of obtaining information about people, activities, and destinations through the Internet seems likely to increase the consumption of travel (Couclelis, 2000). But the same mechanism can be at work for other types of goods as well.

The question is whether these mechanisms that increase spending are compensated for by reducing purchases elsewhere in order to leave total per capita spending constant. A common theme of these postulated mechanisms is that, for the most part (with some exceptions), the Internet provides new consumer options without foreclosing on old ones. Although consumers can and will reduce their use of the old options in some cases, it seems likely that e-shopping, to some extent, will augment rather than simply replace consumer spending via store shopping or other modes. Thus, all things considered, I believe it is quite possible for there to be a net increase of consumer spending attributable to ICT generally and the Internet specifically, but this is pure speculation that should be subjected to scientific test when additional data become available.

At least two empirical studies indirectly address the question of whether Internet purchases generate a net increase in consumer spending, but do not provide enough evidence for a firm determination, even one limited to their specific contexts. One early study (Casas, *et al.*, 2001, using 1999 household activity survey data from residents of Sacramento, California) found no statistical differences in the shares of (store) shopping trips conducted by Internet shoppers and non-Internet shoppers, suggesting that Internet purchases were generally supplementing rather than replacing store trips. However, since the focus of the study was on trips rather than spending, it is possible that Internet shoppers could be purchasing less in stores while making the same number of trips as before, leaving total spending constant.

Another study found that 6% of online purchases would not have occurred otherwise (Jupiter Communications, 1999, cited in Rabah and Mahmassani, 2001). But, first, the study apparently did not ask whether any store-based (or other) purchases were foregone to compensate for the increased spending for online goods. Since the information given addresses only one side of the question, it is impossible to determine the net impact due to changes in both directions. Second, even if no other changes occurred so that the reported 6% constituted entirely new purchases, the amount of money spent on them is unknown.

If new spending comprised approximately 6% of online retail revenues, then given the current share of total retail spending that is taking place online (at least 1.3% in the US in 2002, as mentioned in the Introduction), any overall increase in consumer spending due to the Internet would be too small to detect at this early stage. However, with the accumulation of a few more years of aggregate data, it would be of interest to analyze whether incremental changes in per capita consumer spending could in fact be attributed to Internet shopping as well as m-commerce, after more traditional influences are accounted for. At the disaggregate level, it would be of interest to survey consumers about the extent to which they have altered their spending patterns, both in share and in absolute terms, as a consequence of ICT. Respondents' direct self-assessments of those shifts, however, would be subject to considerable recall error. Reporting on the hypothetical "what would you have done with respect to this particular purchase if you had not made it over the Internet" is difficult enough, but it seems far more difficult to identify and report money *not* spent in other ways due to spending it on new Internet purchases. A more reliable approach would be to simply measure the spending of a panel of consumers longitudinally, and track how total amount and distribution among shopping modes changes over time. Ideally, the two disaggregate approaches would be combined in a single study, providing the strengths of both: objective

measurement of all spending in the one case, and useful insight into the perceived availability and utility of alternative shopping modes in the other case.

Conceptually then, the transportation impacts of an increase in per capita consumer spending could take three forms. The more tangible goods that are purchased online, the more freight travel – for the manufacture and delivery of the goods not otherwise demanded – will increase. (Even intangible items are likely to involve some transportation in their production). The more goods that are purchased through location-based marketing, the more personal travel to stores is likely to increase. And obviously, the more money that is spent on travel as a good in itself, the more travel there will be.

4.4 Transportation Impacts of Demographic Changes

Separately from any of the other effects discussed so far, changes in the population size, average household size, employment rate, and other such demographic indicators over time will affect consumer spending in the aggregate. For example, all else equal, the more households there are, the greater the demand for furniture, housewares, automobiles, and so on. Thus, both increases in population and decreases in average household size suggest continued increases in consumer spending overall.[7] While these demographic changes are not due to the Internet, they do have direct implications for forecasting the magnitude of the market for shopping in general, e-shopping in particular, and the transportation impacts of the resulting mix.

[7] Not to mention rising per capita incomes, which will almost inevitably lead to increased per capita spending, but independently of the ICT-based stimuli mentioned in the preceding subsection.

4.5 The Net Effect

Obviously, the potential effects described above do not all operate in the same direction: some will decrease travel but others will increase it. These counteracting effects clearly illustrate the complex nature of the impacts of e-shopping on travel. While the *magnitude* of the net impact is uncertain, in this author's opinion the *direction* of the impact is almost certainly going to be toward increasing travel. The systemwide effects of such an increase will probably be small in view of the proportion of total passenger travel that is devoted to shopping (perhaps at most[8] 14% of local person-distance traveled in the 1995 Nationwide (US) Personal Transportation Survey; Hu and Young, 1999. The share of road distance traveled that is devoted to shopping for "daily goods" in Finland is estimated at 12%; Siikavirta, *et al*., 2003). Those effects are nevertheless worth monitoring and understanding precisely *because* they are uncertain. The effects may well not be small in some localized areas (the impacts of increased delivery traffic on the character of residential neighborhoods, for example). Further, it is important to understand the distribution of various effects across time, mode, and demographic segment as well as space. For example, an outcome of decreases in local auto travel that are counteracted by increases in air travel would be quite different from an outcome of net increases in auto travel.

5. EMPIRICAL RESEARCH ISSUES

The preceding discussion has highlighted some of the complexities of the relationships between e-shopping and transportation. As mentioned, to date there is little empirical evidence with which to calibrate these relationships – not only because the e-shopping phenomenon is so new and still so volatile, but also precisely because the relationships are so complex, and measurement is such a challenge. An exhaustive discussion of these challenges is beyond the scope of this paper, but it is of value to consider at least some major issues with respect to empirical analysis. Following the observation in Section 2, we divide the discussion into two parts: aspects related to modeling the adoption of e-shopping, and aspects related to understanding its transportation impacts.

At least one issue is common to both parts, however: the need to segment the market. Consumer goods (not to mention services) are too varied for one approach to be uniformly

appropriate. Logical bases for segmentation include purchase frequency/price of the item, and (usually roughly corresponding) the size of the area over which a search for the item is normally conducted. For example, we can distinguish goods based on whether the search area is generally regional (e.g., cars), citywide (e.g., electronics and major appliances), or local (groceries, books, CDs). It can be expected that the "typical" shopping process – how the elements described in Section 3 are combined – will vary by category[9]. For example, cycling through information gathering and trial sequences more than once is more likely to characterize higher-value purchases (although successive instances of repetitive shopping can also be viewed as sequential information-gathering and trial episodes).

5.1 Modeling the Adoption of E-Shopping

As mentioned earlier, a number of study approaches are interesting and useful, including aggregate studies of changes in consumer expenditures over time. Here, we take the perspective of trying to understand the adoption of e-shopping at the disaggregate level. That is, how do characteristics of the individual, the choice context, and the shopping alternatives influence the choice to e-shop or not? Obtaining data on these variables can generally not be done through external observation alone, but almost inevitably involves self-reporting of attitudes, behavior, and other characteristics of the shopper, typically on a questionnaire or in an interview.

Obtaining appropriate data for modeling the adoption of e-shopping requires careful specification of the dependent variable and the explanatory variables. With respect to the dependent variable, the following questions present themselves:

- *What is the definition of alternatives?* Whether or not the Internet is used at all in a shopping activity (a binary variable)? The "primary" shopping mode for a given activity (potentially a multinomial variable, with outcomes such as store, Internet, catalog)? Bundles of mode sequences (e.g. Internet for information-gathering, store for trial/evaluation, Internet for transaction, store for return; or Couclelis' 8-bundle typology described in Section 3)?

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[8] This is likely an upper bound, due to trip chaining. If an individual stops at a store on the way home from work, the distance from work to store will presumably be allocated to the "shopping" purpose, even if the store is precisely on the way home from work and the same distance would have been traversed without the shopping stop.

[9] Peterson, *et al.* (1997) suggest classifying products and services as being either search goods (the features of which "can be evaluated from externally provided information") or experience goods (needing "to be personally inspected or tried"). Alternatively, they present three dimensions along which products and services can be classi-

The answer to that question will partly depend on:

- *What is the time frame of interest?* That is, are the alternatives defined with respect to a given single purchase (e.g. the most recent purchase) in the study category? With respect to any purchase made within a certain time period? With respect to a "typical" purchase for frequently-purchased goods such as groceries or pharmaceuticals?

The researcher must further decide:

- *What is the type of construct being studied?* Actual choice? Stated (hypothetical) choice? Preference (which may differ from choice)?

With respect to the explanatory variables, the following seem important to consider, in view of the discussion throughout this paper (also see Salomon and Koppelman, 1988 and Koppelman, *et al.*, 1991):

- mode-specific shopping frequency with respect to the kind of good in question;
- what shopping mode alternatives are perceived to be available for the kind of good in question;
- how each alternative is perceived on a number of dimensions (including, potentially among others, the various pros and cons presented in Section 2) with respect to the kind of good in question;
- distance to store alternatives for the kind of good in question;
- whether trips for such purposes are generally chained to other trips (relevant not only to ascertaining the transportation impacts of various shopping modes, but since it helps determine the travel time and cost of the store alternative, it is relevant to adoption as well);
- general attitudes toward technology; the various shopping modes; time (sensitive to saving it?); prices (bargain-hunter?); and travel (find it desirable under some circumstances?);
- adoption and usage of various ICTs;
- socio-demographic characteristics: employment, education, income, gender, household size/presence of children, auto ownership, and so on.

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fied: cost/frequency of purchase, tangibility/intangibility, and differentiability. Either of these categorization systems can also be a useful basis for market segmentation.

Depending on how heterogeneous the study category is, it may also be important to ask about:

- relevant attributes of the specific product(s) in question (e.g. the most recent purchase): how heavy, bulky, perishable, and so on.

5.2 Estimating the Transportation Impacts of E-Shopping

To discuss research issues with respect to evaluating the transportation impacts of e-shopping, we take the context of a hypothetical study in which it is desired to measure empirically:

- the total (passenger and freight) travel impact of shopping (both store and electronic), compared to some prior (or contemporaneous control) non-electronic state (e.g., vehicle-kilometers traveled, or VKT, "after" compared to "before", or VKT "with e-shopping" compared to VKT "without"); and

- the short-term spatial and temporal redistribution of travel (segmented by passenger and freight).

Again, there are certainly other interesting and important questions to explore related to the transportation impacts of e-shopping (see, e.g., Nagurney, *et al*., 2002 for a network optimization approach to modeling adoption and transportation impacts simultaneously). However, simply understanding the net impacts on travel, and their spatial and temporal distribution, is important to public policymakers and planners, especially if their initial expectation is that e-shopping can be promoted as a strategy for reducing travel.

In exploring this issue, it is critical to consider both categories of travel as well as both types of shopping, because of the interactions between categories. For example, passenger shopping travel may decrease, but we must determine whether that is counteracted by increases in goods movement. E-shopping will almost certainly increase, but store shopping may not decline by a corresponding amount, for the reasons described in Section 4. Thus, we envision

the need for a type of comprehensive "Life Cycle Analysis" (LCA) of the transportation impacts of e-shopping (see, e.g., Fiksel, 1996; Kitou, *et al*., 2001; and Gard and Keoleian, 2003).

With respect to this type of study, there are a number of important challenges relating to data collection. On the consumer side, it is necessary to collect data both on trips and on shopping-related Internet activity. Travel diary data collection techniques are well-known (see, e.g., Axhausen, 1995, 1996), with burdensome traditional paper-based methods currently giving way to more automated processes involving global positioning system (GPS) and hand-held computer technologies (e.g. Doherty, *et al*., 1999; Draijer, *et al*., 2000). Most travel diaries focus on local travel; ascertaining the effect of the Internet on air travel, as discussed in Section 4, would necessitate broadening that scope. Yet it is important to do so, to fully account for all transportation effects.

Internet data collection techniques are less familiar to transportation researchers, and even market researchers are not always sure how to mine the vast databases representing paths through cyberspace, dwell times at various nodes, and so on made by millions of users. In the current context, simply unobtrusively collecting and studying "clicks" does not seem adequate: it is important to query the individual to put otherwise disembodied Internet activity in the proper context. The kinds of questions that seem important to ask include: the sequence of shopping activities around a particular category of goods, how each element of the sequence was conducted (electronically or physically), the availability and utility of alternate shopping modes for conducting each element, and the transportation implications of each activity in the sequence, including what would have taken place if the chosen mode had not been available. Such a questionnaire may well need to be computerized rather than paper-based, to take advantage of the ability to transparently customize the survey to fit each consumer's sequence of activities.

In any case, it ultimately becomes necessary to combine data collected on trips with the data collected on "clicks", in such a way that the net transportation impacts for the consumer can be determined – a challenge in and of itself.

On the retailer side, we need to measure the impacts on goods movement. One approach would be to track changes over time in distance traveled, number of deliveries, volume of deliveries per unit time; distribution of delivery priorities; and so on. Thus, a cooperative retailer/delivery agent is essential. One may ask, "how far back up the supply chain must the

analysis go?" If e-shopping results in deliveries to the consumer from newly-located warehouses, we should account not only for the change in travel from the warehouse to the consumer (compared to different warehouse to store to consumer), but also for the change in travel from the manufacturer to the new warehouse. Thus, the answer to the question theoretically is, "until the point at which there is no difference between store and e-shopping". In practice, of course, this will be quite difficult. Finally, synthesizing the consumer and retailer sides (e.g., assigning the proper incremental increase in delivery travel to balance against a measured decrease in shopper travel) would be non-trivial, requiring data on the same purchases from both sides.

There are some challenges with respect to analysis methodologies as well. One difficulty is to properly assess causality. As has been noted here and elsewhere (e.g., Mokhtarian, 2003), ICTs have the potential to increase travel as well as replace it. Thus, when a study (Casas, *et al*., 2000) finds (even after controlling for income, age, and gender) that Internet shoppers make significantly more daily trips (4.5) than non-Internet shoppers (3.7), is greater travel the cause or the effect of ICT usage? In the short run, the most plausible explanation may be that early adopters of e-shopping include busy people who tend to make more trips even *with* e-shopping – meaning that their greater travel is one *cause* of their choice to e-shop. Taking the longer view, however, there is ample evidence to suggest that more travel will be an *effect* of ICT as well. Calibrating these bi-directional relationships correctly may require tracking the same people across time, and collecting as complete information as possible on all their travel and communication activities – a formidable challenge (Mokhtarian and Meenakshisundaram, 1999).

No single study will be able to provide definitive answers with respect to even the short-term impacts of e-shopping on transportation – even for a single segment of the market, let alone across the board. Rather, as with the study of most complex phenomena, we can expect answers to come through the slow accumulation of findings of multiple studies of partial aspects of the phenomenon, in different contexts – findings that will differ across market segments, and sometimes conflict even within the same segment.

6. CONCLUSIONS

This paper has discussed, at a conceptual level, a number of issues related to the adoption of e-shopping, and to the evaluation of its transportation and spatial impacts. We have reviewed the comparative advantages of store shopping and e-shopping, and concluded that neither type uniformly dominates the other. We have identified the building blocks of the shopping process, and noted that ICT is making possible the spatial and temporal fragmentation and recombination of those elements. We have examined some potential transportation impacts of e-shopping, and noted that some factors result in reduced travel while others lead to increased travel. The combined outcome of all factors does not appear to support any hope that e-shopping will reduce travel on net; to the contrary there may be negative impacts due to increased travel, even if those impacts are likely to be localized and/or small in magnitude for the most part.

With respect to adoption, on the whole, e-shopping seems to have some properties shared by many other technological advances. Specifically, rather than an "either – or" choice between store shopping and e-shopping, we are likely (with some exceptions) to see continued adoption of both forms, "as parallel, coexisting systems that are both complementary and competing" (Peterson, *et al.*, 1997, p. 13 of online version). Consumers will blend both forms as they conduct a sequence of shopping activities, and retailers will blend both in marketing to and serving customers. E-shopping will substitute for store shopping at the margin, but both forms of shopping will probably continue to expand and co-exist. Thus, the dominant relationships between e-shopping and store shopping will not be replacement of the latter by the former, but interactive augmentation and modification of both.

With respect to the transportation impacts of e-shopping, assessing them – even in the short term, let alone the long term – presents some formidable measurement challenges. Nevertheless, those challenges are worthy of our most creative efforts at solution – first for the rewards of discovery and an increased understanding of complex human behavior systems, but also to assist urban planners and decision makers in monitoring this important shift in travel patterns, with an eye to ameliorating deleterious effects to the extent possible.

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