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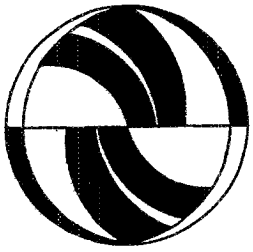

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Shopping without travel or travel without shopping? An investigation of electronic home shopping

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This study explores the growth of electronic home shopping in terms of likely transportation and communication interactions Although opportunities exist to shop from home today most consumers initiate travel trips to stores or markets Widespread use of automobiles has facilitated the retailing configurations we know today but the development of new electronic networks could change this This study establishes a baseline to explore shopping activities using two-day travel activity data from a large U S metropolitan area It is found that people who telework from home today spend more time engaged in shopping activities than other workers Potentially, their saved work travel is converted into new trips In the future, saved shopping travel might be converted into other types of travel, and modelling results show that for busy working women there is a latent demand for maintenance-related activities The study results suggest that electronic home shopping will bring into play complex interactions between communications and transportation

1. Introduction

Historically, convergences in transportation and communications have led to changes in how goods are bought and sold The railway and telegraph were catalysts for the growth of both downtown department stores and catalogue sales More recently, the automobile encouraged stores to disperse spatially, and increased the travel distance for shopping Today, electronic home shopping could counter this trend, if consumers come to substitute network-based transactions for shopping trips in their cars However, if consumers adopt new broadband communication technologies, they may also have more opportunity to participate in other 'teleservices', and work from home Under these circumstances, the need for electronic home shopping might dwindle, since the focus of outside shopping activities might be more local

Electronic home shopping is an inquiry or transaction for consumer goods or services that takes place through an interactive media with video capability The inclusion of the terms interactive and video is made to distinguish electronic home shopping from services provided today over broadcast television and through catalogue sales Future electronic home shopping is likely to take place over broadband communications networks, accessed through either computers or television sets, or a hybrid of both Although we focus on interactions initiated

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from home, shopping for home consumption can also take place through kiosks located at sites such as libraries and transport stations (e g airports, railway terminals or bus depots), or from computer terminals at work sites

The idea of electronic home shopping is not new, and over the past 15 years there have been many highly publicized failures (Talarzyk and Widing 1994) An interest in electronic home shopping began in the 1970s with early videotext systems, but the outcomes often failed to meet high expectations for digital shopping (e g Hiller 1983) However, teletext over TV channels did spawn a large holiday-booking industry, which continues to grow in the U K (*Connected* 1996) Across Western countries, there is a renewed spate of interest in home shopping due to the recent growth of the Internet, improvements in the speed and quality of video graphics, and new encryption techniques to secure digital transactions

As electronic home shopping begins a second wave of diffusion, transportation planners may find that it raises a number of important issues about transportation / communication interactions If the ability to use electronic home shopping increases, a naive forecast would predict a net decrease in the use of personal vehicles for shopping trips, and a net increase in the number of trips undertaken by commercial delivery services Similar forecasts were made when the telephone was introduced (Pool 1983) There are several paradoxes that make it difficult to predict the impact of teleshopping on travel The first is that people do not necessarily minimize the distance they travel to shop, and in the United States there has been a movement to locate large warehouse stores and factory outlets at a great distance from urban centres, and people appear willing to travel to them to benefit from the availability of high-quality discounted goods However, as the growth in car ownership has made it more feasible to shop at greater distances there has, conversely, been a growth in 'convenience' stores that carry a small selection of food and household items that cater to 'last minute' or impulse shopping desires

Another paradox has been the accessibility of transport among those who use catalogue and mail-order shopping Although catalogues originally served customers who were geographically remote from trading centres, their function has changed over time Today, the people who use them most frequently seem to be cost-sensitive and careful shoppers There is little indication that mail-order and catalogue shopping is used by them as a substitute for travel to stores (Handy and Yantis 1997) Shoppers who use mail-order seem to visit retail stores as frequently as non-users It is likely that some of the products available through catalogues are 'hard to find' items, such as clothing in special sizes or craft items Sales advertising in catalogues also exposes the consumer to attractive price discounting

Some forecasts expect that future teleshopping will become another channel for reaching consumers, much like TV or radio Other forecasts indicate that teleshopping will bring far more profound change since, unlike TV or radio, teleshopping is interactive The growth of teleshopping has to be examined in conjunction with the growth of other 'teleservices', like telework and telebanking, since the technology that enables one is also likely to facilitate adoption of the others

Future home shopping impacts the transportation system in important ways The first is at the level of individual or household travel activity The growth of electronic shopping might induce new travel activity, reduce some types of trips, or lead to different travel patterns Shopping travel is more discretionary than work-related travel and can be more readily allocated to different times of the day, new locations, different modes of travel or the substitution of personal travel by home delivery

However, an increase in commercial delivery could change the number and amount of commercial vehicle activity, pollution levels and local neighbourhood traffic (Jones and Salomon 1993)

At a broader level, we can study the factors that both encourage and discourage the growth of electronic home shopping to learn more about communication and transportation interactions The convergence of transportation and communication in home shopping brings to the surface fundamental issues Renewed understanding of communication and transportation interactions may also help to explain the lacklustre growth of home shopping over the past 20 years, and help to illuminate arguments about the expectation that it will now flourish

In this paper, we begin with an examination of electronic home shopping at this broad organizational level We ask whether it may lead to new ways of organizing buyers and sellers, and whether the market-place—and the goods which are sold in it—are likely to change Historically, convergences of transportation and communication have produced macro-level changes We do not predict a particular outcome, but try to raise likely issues associated with this development

Our discussion of home shopping then narrows its focus to an examination of communication/transportation interactions at the household and individual level of travel activity First, we pose, at a conceptual level, possible impacts of electronic home shopping on time use spatial patterns and in-home/out-of-home activities We then follow this discussion with an activity analysis of shopping travel data

Empirically, we investigate

(*a*) *Predictors of shopping activity* Can shopping activity be predicted by individual factors, like gender age and employment status, as well as by the accessibility of travel?
(*b*) *Interaction with other telecommunication activities* Will the adoption of telework interact with the decision to teleshop? Do people who work from home today show a similar level of shopping activity as office workers?
(*c*) *Saved time and travel relationships* Will a reduction in travel time be converted to home-based activities, or create a latent demand for new discretionary activities?

We preface this study on electronic home shopping with (i) a brief overview of the literature, and (ii) a definition of home shopping which links its growth to available levels of communication and transport technology

2. Related literature

Investigation of future home shopping is interdisciplinary—ranging from institutional and policy issues (Deighton 1996), marketing and communication factors (Alba *et al* 1996) and the geography of time and space (Golledge and Stimson 1987) Within the transportation field, a foundation, which precedes the current wave of popular interest in teleshopping, is provided by Salomon (1985), Salomon and Koppelman (1988) and Koppelman, Salomon and Proussaloglou (1991)

Salomon and Koppelman (1988) were among the first to draw attention to the cross-disciplinary nature of teleshopping studies In their framework, they observe that 'shopping' is not a single activity, like purchasing a good They describe shopping as a series of interrelated stages, including entry into the market, choice

among shopping modes, information gathering, evaluation of information and product selection They distinguish shopping from purchase, and they also identify that it has both in-store and non-store components They indicate that shopping fulfils two main functions first, it provides an economic function in which the consumer expends time and money to learn about products to reduce the risk or increase the utility of a planned purchase Secondly, shopping is undertaken because of its psychological benefits

Citing Manski and Salomon, they describe the demand for telecommunications as a 'derived demand based on information that is located elsewhere' If the quality and quantity of information is deemed useful, consumers might substitute home shopping for travel trips However, because people enjoy some types of travel, and they shop for other than economic purposes electronic home shopping could also generate additional travel and new types of in-store shopping activity

There are a few empirical studies on home shopping These include a stated preference study by Koppelman *et al* (1991), in which they examined the utility and choice of catalogue shopping *vis-à-vis* other types of in-store shopping Another study by Tacken (1990) examined the travel activities of households that participated in a Dutch teleshopping service, and used a combination of catalogue and telephone for order-placement More recently, Handy and Yantis (1997) examined whether out-of-home travel trips were changed, given current opportunities to bank by machine or phone, rent movies in lieu of cinema visits and shop from catalogues or TV

Although it would seem to be a prerequisite for further study, there is limited travel data about how often people shop, and the distances they travel In the U K about 12% of all mileage and 20% of personal trips are undertaken for shopping (U K Department of Transport 1996) Results for the U S A are similar, where 19% of all personal trips are made for shopping (this includes mass transit), and it represents 12% of the annual vehicle-miles travelled (U S Department of Transportation 1994) There are many problems reporting an annual vehicle miles travelled (VMT) for shopping shopping trips are chained with other out-of-home activities, they tend to involve many short stops and people tend to under-report shopping trips that did not result in a purchase or transaction Golledge and Stimson (1987) cite several studies including one by Looman in Newark, Ohio, showing that 42% of all shopping trips were multipurpose Further analysis by Recker and Pas found that of the remaining 58% single-purpose trips, 16% of these involved multi-stops A more recent study by Bhat (1996) used hazard modelling to study the evening work-to-home commute, and observed that about 18% of his sample participated in shopping activities on the way home Socio-demographic factors that facilitated shopping stops were gender (females) absence of young children at home, age (older) and household size (larger)

3. Home shopping: definition and evolution

Home shopping is not new, but its past growth has depended upon advances in transportation Rail and telegraph made possible the development of catalogue sales (Tedlow 1996), and the diffusion of household telephones further expanded its growth New electronic shopping extends the opportunities for consumers to engage in travel-less shopping

Some people believe that electronic home shopping is equivalent to putting a catalogue on-line This overlooks, however, electronic capabilities of new software,

like the potential to screen thousands of selections, the ability of intelligent agents to compare choice sets and find best buys, and 'stored memory of past 'shopping' transactions Electronic home shopping also differs from catalogue shopping because on-line digital products, like software CD music or games, can be 'experientially' tested Table 1 compares dimensions of three different shopping formats physical stores, current home shopping like to door-to-door and catalogue sales, and future electronic home shopping The social interaction and entertainment values of shopping are also cited as a reminder that the shopping activity is not always utilitarian, and it is undertaken with varying motivations (for a discussion of this, see Salomon and Koppelman 1988, Tauber 1972)

4. Future home shopping and transport / communication interactions

This section has two aims first, it suggests that the growth of home shopping will depend upon the resolution of many key transport outcomes, and it focuses upon the facilitation and constraints of telecommunication channels Secondly, as the discussion moves from a broad focus on transport and distribution issues to those more specific to household travel, it sets an agenda for the empirical analysis in section 5

4 1 *Would electronic home shopping change the organization of the market-place?*

The cost and time to transport goods has always been a key factor in how buyers and sellers come together and, more generally, in the organization of markets Before the invention of steam rail, goods were transported by boats or on foot, and this limited most trading to person-to-person sales and open-air markets With the invention of the railway and telegraph, information could be sent in advance of shipping goods, and this facilitated growth of larger, centralized markets and stores An illustrative story which depicts fundamental relationships between the form of markets, products and available transport is reported by the business historian R Tedlow (1996) With the invention of the railway, cattle in the U S A were shipped live on rail instead of being herded to market However, this was highly inefficient because only about 40% of the animal was edible and large numbers of them died *en route* Gustavus Swift realized the advantage of refrigerated rail cars for meat carcasses, since live cattle would not have to be shipped This change in distribution (using rail) fundamentally changed the market

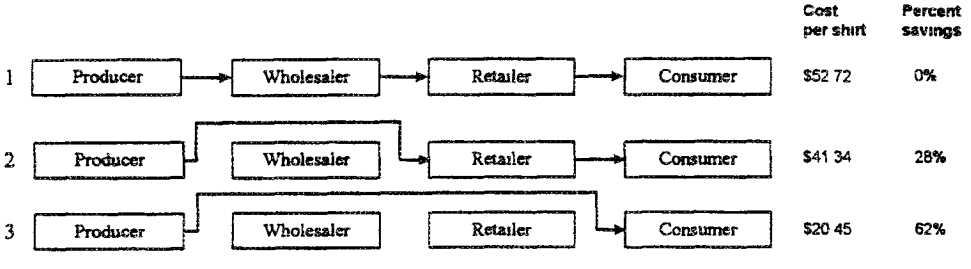
Table 1 A comparison of dimensions across three shopping formats

	Physical stores	Home shopping	Electronic home shopping
'Experience' goods (touch, smell or trial)	High	High (door to door) Low (catalogue)	High (digital goods) Low (physical goods)
Compare choices	Medium	Low	Medium/High
Information from past transactions	Low	Low	High
Social interaction	Varies	Medium (door to door) Low (catalogue)	Low
Entertainment	Depends	Depends	Depends

Electronic home shopping brings a new convergence of transport and communications, but it is not clear if this will change the organization of shopping markets to take advantage of new efficiencies and new modes of distribution Today, in a few businesses that sell to consumers (e g Virtual Vineyards and Amazon Books), on-line consumers are showing a preference for placing orders electronically instead of buying similar items at retail stores

This trend could accelerate if consumers perceive new benefits from on-line markets In the business literature it has been suggested that efficiencies might be achieved if retail stores developed purpose-built warehouses for home distribution It is estimated that about 20% of a clothing retailer's costs come from the overhead and maintenance of store fronts (see, for example, Benjamin and Wigand 1995) Figure 1 is based on an analysis of the retail clothing industry, and traces a distribution chain for goods Fewer steps in the chain from manufacturer to consumer eliminate some travel trips and could reduce the cost of goods (but not necessarily the final selling price)

This example indicates that electronic shopping could lead to new market organization, reduce the level of physical distribution and bring cost efficiencies There is even more compelling evidence of these trends from the growing market for 'digital' products (Negroponte 1995) Products which can be represented in digital bits, like CDs or software, no longer require physical manufacturing, physical inventory or distribution by air or surface travel Increasingly, they can be sold to customers and distributed using high-speed broadband networks Microsoft Corporation, for example, anticipates that 10% of its software will be sold this way over the next 18 months and that the level will increase to 50% by the turn of the century (Judge 1996) Increasingly, the availability of new communication channels may replace the transportation of goods, and reorganize how many goods are bought and sold



Growth in Value Added and Selling Price

	Producer	Wholesaler	Retailer
Value Added	$20 45	$11 36	$20 91
Selling Price	$20 45	$31 81	$52 72

Figure 1 A value chain of consumer goods [*Sources* the prices for high-quality shirts are derived from Thornton (1994), the figure is taken, in part, from Benjamin and Wigand (1995)]

4 2 *Would electronic home shopping change products and in-store shopping?*

If electronic shopping merely replaces transactions made from catalogues or current TV shopping channels, then the distribution process will come to rely more on telecommunications The products or services would basically remain the same We need to relax this assumption, however, because it is characteristic of communication and transport interactions to induce deeper levels of change

The emergence of new, digital-based products, which we cited above, are early indicators of this For example, software purchased on-line today offers about the same features as comparable software purchased from a retail store In the future, electronically bought software could offer new advantages it could regularly update itself with new versions, electronically read and tailor settings for users The growth of telecommunications is likely to change the products that we shop for, as well as their distribution

It appears that electronic home shopping will facilitate the growth of these electronic products, but also lead to entirely new markets — for example, consumer-to-consumer exchanges and auctions Broadband communications like the Internet may accelerate transactions that were once too travel intensive In the past, certain markets did not grow because of travel/time relationships For example consumer-to-consumer sales through classified advertising often involved 'wasteful' trips to screen choices and gather information These trips were 'wasteful' because they did not always culminate in a purchase, and they took time to transact Expectation of a growing consumer-to-consumer market can be found in Sheth and Sisodia (1993) A similar type of electronic market is expanding for on-line auctions, where neither the buyer, seller or the goods initially travel

Expansion of these new electronic markets may provide consumers with an incentive to shop on-line, and encourage new product ranges and categories to develop If household shopping budgets and time to shop remain relatively constant, then other types of shopping activity may decline For example, if consumer-to-consumer sales grow in number, then reliance on commercial shopping malls might fall

It is unlikely that retail stores will become obsolete, but there may be a need for fewer of them, if electronic shopping gains in popularity and frequency of use The location of physical stores, their proximity to other stores and their hours of

Table 2 Possible interactions of on-line shopping and shopping-related travel

Increase in amount of on-line shopping or consumer-to-consumer transactions	Physical stores	Possible travel impact
	(a) Fewer physical stores, or	Increase in VMT (longer distances) or decrease in VMT (fewer trips)
	(b) Change in retail stores	
	(b1) Proximity to other stores	As above
	(b2) Change in operating hours	As above
	(b3) Change in stock, in-store inventory	Generate new travel to other stores, new on-line activity, or both

operation may also change, resulting in new travel activity on the part of consumers, in Table 2 we speculate on the interrelationships

4.3 *Would home shopping provide time saving to consumers?*

In this section, we begin to narrow our discussion of electronic home shopping to consumer issues, and we ask whether there are advantages or disadvantages for them

One aspect of consumer demand for electronic home shopping is thought to be related to time savings (Rosenberg and Hirschman 1980) Time-busy consumers are often targeted as an initial market for electronic home shopping because it is believed that they would choose to reallocate shopping time to other activities, and because they are often from dual income households that could pay a premium for this service

In the transport literature, the value of time has been a subject of extensive research (e g Gunn and Bates 1982) Salomon and Koppelman (1988) caution that time use has to be carefully interpreted, since shopping activities also serve a number of personal and social motives

There has not been a great deal of measurement of how much time is spent on shopping, and we address this need in our empirical analysis One element is the explicit time to travel, and the second element is the actual time spent in stores We currently do not know if ordering on-line would reduce the latter, since there is a time cost to bringing a computer on-line, selecting a site, and so forth There is also an explicit time cost to waiting for home delivery, which we consider below

Measuring actual time spent in shopping activities is complex, since many shopping trips are undertaken in conjunction with other travel, like the drive-home from work Other shopping activities are 'aspatial'—they involve no travel, since people browse for information or consume ads With future home shopping, a reallocation of time might occur—shoppers might reduce the number of physical trips to gather information, but the information search might induce new travel if their range of possibilities is expanded (Salomon 1986) Or shoppers might use electronic transactions to reduce the time spent for shopping activities that they consider to be a chore (e g groceries), but might increase in-store visits for 'hedonic' shopping (see Babin *et al* 1994)

4.4 *Is electronic home shopping an in-home activity?*

Closely related to the issues above is consideration of how electronic shopping might change the balance of in-home/out-of-home activities By definition, electronic home shopping places emphasis on activities conducted from the home The time–activity patterns of households are important, since either someone must be home to take delivery of goods or other arrangements must be made Somewhat related is the future issue of how the household allocates its time as a complement of other future 'teleactivities', like telework and telebanking

Today, home delivery is a fairly small component of retail sales, since shoppers in Western countries use their cars to transport items that they purchase Home delivery is used primarily for delivering gifts, items purchased through catalogue or mail order, and the delivery of bulky appliances or furniture For a very thorough review of alternative home delivery schemes see Cairns (1996)

One of the reasons that home delivery services have contracted over this century is the reduction in the availability of consumers at home There are fewer people

home during the daytime as the number of working women has increased, and the family unit size has decreased The absence of at-home neighbours to accept deliveries and increases in crime are additional factors that have deterred home delivery

Parcel delivery firms, like Parcel Force and UPS, have taken steps to expedite service, and derive improvements from telecommunications, like consumer-initiated checks of parcel location and en-route, mobile phone calls to sites These methods improve the odds that people are home for delivery, but they do not assure it Accordingly, more radical approaches to home delivery are mentioned As in old days when homes had exterior iceboxes, some have proposed retrofitting the exterior of homes with large, secure delivery receptacles and refrigerated cubicles (McNair and May 1978) A centralized post office box is another variation of 'home' delivery Shoppers would collect their prepacked groceries and parcels at the office or from neighbourhood centres and local stores Most hybrid collection points are still likely to rely upon use of the car, since shoppers need to carry their packages or bags home Transport issues associated with the use of pick-up centres have not been addressed—for example, the availability and ease of driving to them and securing a parking place, the time savings if they initiate short, separate trips and the pollution generated by vehicle trips nearby the home

The availability of household members for home delivery ties into a second issue Increasingly, many people work from home (telework) and the expansion of broadband communication networks will accelerate this trend This raises something of a paradox On the one hand, people are more likely to be at home during the day to accept delivery of packages, and might even welcome this break in their routine On the other hand, teleworkers may favour physical activity outside their home and diversions which provide a contrast to computer usage Baer (1985) depicts one possible scenario for the future, where the computerized home could become an electronic isolation chamber Under such circumstances, home-bound populations might choose to travel, and shopping-related trips might increase in distance or frequency Future shopping could serve many functions, including social contact (Tauber 1972, Forman and Srivam 1991) Or teleworkers might choose to engage in new types of out-of-home activity

5. An activity analysis of shopping behaviour

In the previous section, we conceptually developed the issue of electronic home shopping, and pointed to the intersection of new transport and communication concerns We began at a broad, market-wide level of analysis, and then narrowed our focus to the shopping activities of consumers In this section, we provide some initial empirical data to investigate individual and household shopping activity

First, we establish baseline results, and describe current levels of shopping activity and travel Next we explore whether (i) time to travel is a major component of the shopping trip, and (ii) whether time to travel varies across workers and non-workers and other groups Then, applying insights gained about potential communication and travel interactions we examine evidence about the future role of shopping when telework is available, and the reallocation of saved travel time

5 1 *The empirical investigation*

We chose to study current shopping and travel activities for the Portland Metropolitan Area in north-west Oregon and south-west Washington states

(U S A) The spatial distribution of stores and households in metropolitan Portland resembles other large metropolitan areas, and it is the only area with a large and representative sample from a recent multiday activity diary An activity and travel survey was conducted by the local metropolitan planning organization, Metro Regional Services, in the spring and autumn of 1994, with some data collection extending into early 1995 The survey was designed to record all activities involving travel and all in-home activities with a duration of at least 30 minutes, for all individuals in the household, over a 48-hour period The importance of a multiday diary for this type of analysis is demonstrated by Pas (1986), Pas (1995) and Pas and Koppelman (1987) A full range of household and person data were also collected in the survey The survey data are augmented by comprehensive land-use and transport network data of the type used in urban transport planning in the U S A and Western Europe

The sample used here consisted of 6919 persons aged 16 and older, representing 3891 households These 6919 persons recorded 13 838 days of observation, but these days were not equally distributed across the week, because the starting days-for the two-day activity diary in the Portland survey were not equally distributed, due to logistical problems in the interviewing and the need to over-represent work days in the sample for transport planning reasons As activity participation varies by day of the week, it was necessary to weight statistics computed from the person–day sample, so that all days were equally represented The day weights, centred at unity to preserve the original sample size in statistical tests, varied from 0 82 (Thursday) to 1 30 (Sunday)

Activities were recorded into 28 categories in the telephone retrieval of the two-day activity diaries in the Portland survey (Lu and Pas 1997) There were two categories of shopping, 'general' and 'major', which we combined as a single 'shopping' activity We analysed this activity within a hierarchy of all other activities that has been used in many time-use studies (e g Chapin 1974)

5 2 *Individual differences in shopping participation*

We first investigated how shopping varies across individuals Several studies have investigated interpersonal differences in activity participation (e g Damm 1983, Lu and Pas 1997, Pas 1984, Pas *et al* 1995), but we deviate from previous general studies by focusing on shopping activities First of all, we found three socio-demographic characteristics to be the most effective in explaining differences in shopping participation rates gender, employment status and age As shown in table 3, females perform an average of 3 7 shopping activities per week, involving

Table 3 Shopping activities, by gender, in the Portland (U S A) Metropolitan Area (statistics based on two days of observations per person)

		Average per week			Average per activity (min)	
Segment	Sample size	No of activities	Activity duration (min)	Travel to shop (min)	Average duration	Average trip time
Male	3346	2 64	118	36	44 8	13 5
Female	3573	3 70	183	48	49 6	13 1
Total sample	6919	3 19	152	42	47 7	13 3

approximately 3 hours (183 min of shopping and 48 min of travelling to the activity sites Males, on the other hand, engage in an average of 2 64 shopping activities per week, spending a little less than 2 hours shopping and 36 min travelling to shopping sites (All of these differences in average statistics are statistically significant at the $p = 0\ 01$ level) The average duration of each shopping activity is greater for females (50 versus 45 min), but the average travel times to activity sites are almost identical for males and females (being a little over 13 min for both genders)

Non-workers are also more likely to shop than workers (table 4), although the differences between non-workers and workers are not as pronounced as those between males and females We can contribute the high rate of shopping for non-workers to more available time and to household role structures

We found that gender differences are preserved across employment status Female workers and non-workers participated more in shopping than their male counterparts (table 5) In fact, female workers spend about as much average total time shopping per week as male non-workers, but they make more shopping trips (3 6 per week versus 3 3), so the average duration of their shopping activities is less (48 min versus 52 min) Female workers conduct approximately one fewer shopping activity per week than do female non-workers Presumably, they either have to forgo some recreational shopping activities, or they conduct recurrent shopping activities with lower frequency To the extent that female workers face time pressures in carrying out traditional household roles, the option of in-home shopping might be attractive to such busy people We test for this empirically in section 5 4

Shopping activities vary across age in a non-linear pattern: as demonstrated in figure 2, where average weekly shopping activity duration is plotted, together with shopping as a percentage of the total duration of all out-of-home activities We see

Table 4 Shopping activities, by employment status in the Portland Metropolitan Area (statistics based on two days of observation per person)

		Average per week			Average per activity (min)	
Segment	Sample size	No of activities	Activity duration (min)	Travel to shop (min)	Average duration	Average trip time
Workers	4 793	2 95	134	39	45 3	13 2
Non-workers	2 126	3 71	193	50	52 1	13 4

Table 5 Shopping activities, by gender and employment status, in the Portland Metropolitan Area (statistics based on two days of observations per person)

		Average per week			Average per activity (min)	
Segment	Sample size	No of activities	Activity duration (min)	Travel to shop (min)	Average duration	Average trip time
Working males	2 553	2 43	102	32	41 9	13 2
Non-working males	793	3 33	172	48	51 6	14 3
Working females	2 240	3 55	170	47	47 9	13 2
Non-working females	1 333	3 95	206	51	52 1	13 0

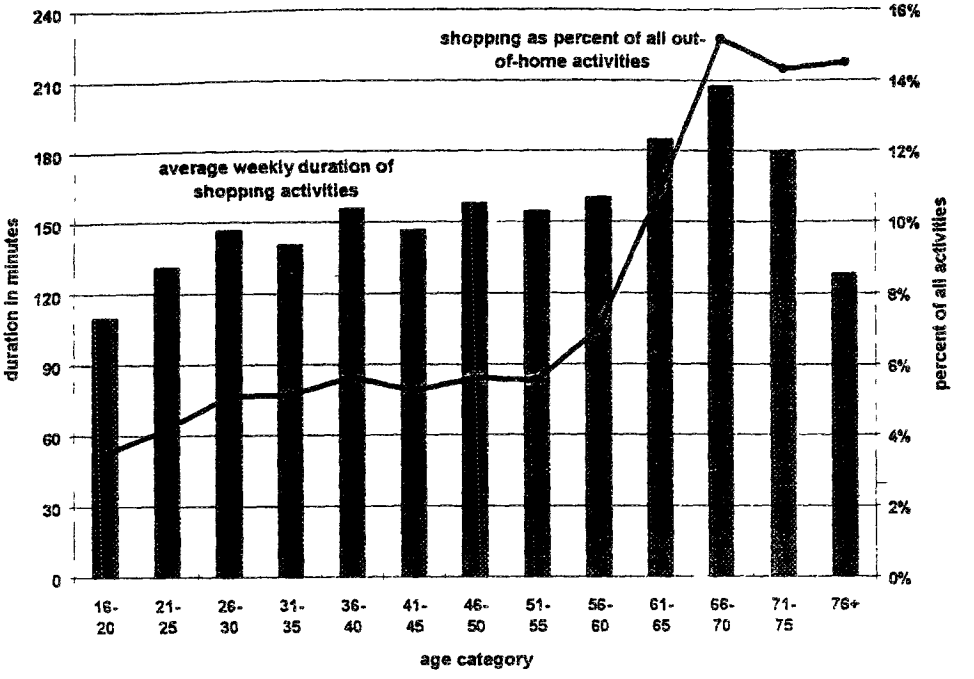


Figure 2 Shopping activities, by age in the Portland Metropolitan Area (statistics based on two days of observation per person)

that shopping time increases with age until the age category 66 to 70 but the increase is relatively slight between the ages of 26 and 60 Persons aged 66 to 70 spend the most time shopping, followed by persons in the adjacent age categories of 61 to 65 and 71 to 75 The shopping share of all out-of-home activities is relatively constant between the ages of 26 and 55, but from ages 56 and 70 shopping becomes an increasingly bigger part of activity schedules

Age and employment status are obviously related, so, in order to develop a composite picture of shopping activities, we estimated a linear regression of shopping activity duration as a function of a variety of socio-demographic characteristics We found seven explanatory variables to be significant at the $p = 0.05$ level They are, in order of absolute value of their standardized regression coefficient (i) employment status, (ii) gender, (iii) driving licence status, (iv) number of children over 11 years of age in the household, (v) the interaction of gender and working status, (vi) total household size and (vii) high household income dummy Drivers and persons from high-income households shop more, *ceteris paribus* Persons from bigger households, and from households with older children, shop less, *ceteris paribus*, presumably due to the sharing of shopping responsibilities among more household members The interaction term means that female workers shop more than predicted by the sum of the working status and gender effects

5.3 *Effects of working at home on shopping activity patterns*

We next investigated how working at home versus working at a site (or sites) away from home affects participation in shopping activities We focused only on days in which work activities of at least 4 hours' duration were recorded and divided

these days into three groups (i) days on which a worker performed work-related activities only at sites away from home, (ii) days on which work activities were conducted both at home and away from home and (iii) days on which work was performed only at home Our sample sizes were 5263 days with work solely away from home, 367 days with work both at home and away and 287 days with work solely at home The breakdown of activities into work (away-from-home and at-home), shopping and away-from-home discretionary activities for the three groups is shown in figure 3 The time for each away-from-home activity includes the time travelling to the activity site These times are different from the times listed in tables 4 and 5 for workers, because we are limiting the present analyses to days on which workers recorded at least 4 hours of work, the statistics in tables 4 and 5 are for all workers on all days of the week

Persons working exclusively at home on a given day spent significantly more time shopping on the work day than did persons working away from home ($p<0.01$) In-home workers also spent more time engaged in away-from-home discretionary activities—46 min versus 37 and 31 min for the other two groups—but these differences were not statistically significant ($p = 0.086$), due to high variations in discretionary activity participation Away-from-home workers performed approximately half of their shopping activities on the way to or from their work sites 53% of shopping activities were linked to the work trip for those who worked exclusively away from home, and 49% were linked to the work trip for those who worked both at home and away This indicates that away-from-home workers are likely to frequent shops located along the corridor between their home and work site(s) and in the vicinity of their work site(s) Trends towards increased incidence of at-home work will likely shift the focus of shopping activity spaces towards residential

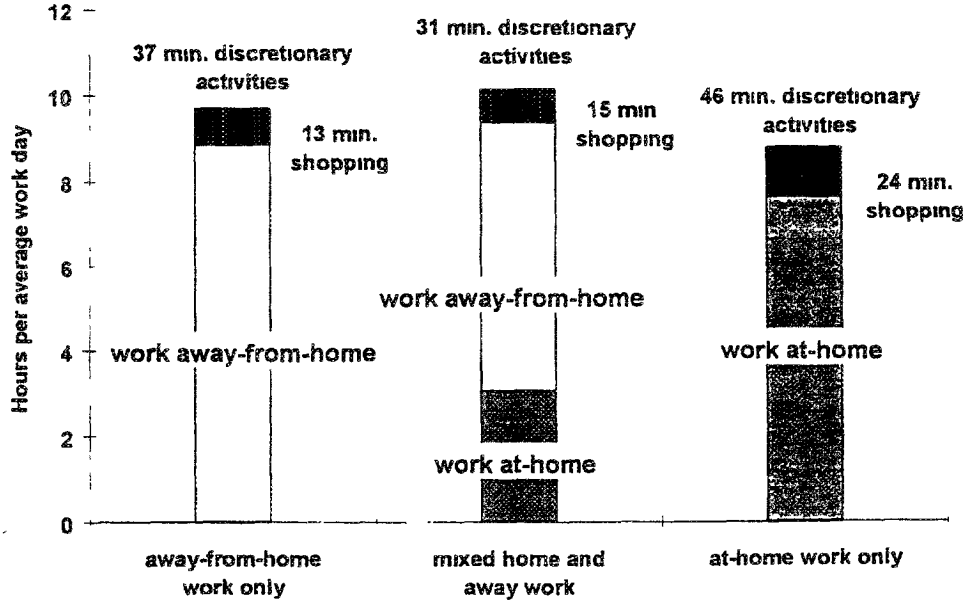


Figure 3 Average activity duration on work days for three types of workers (away-from-home activity times include travel to the activity site)

locations Pendyala *et al* (1991) also observed similar contracted action spaces centred on the residential location of home-based workers

5 4 *Effects of reduced shopping travel time on activity patterns*

We now address the question as to how activity patterns might change if individuals adopted in-home shopping For each substitution of in-home for out-of-home shopping, the individual would gain time equal to the travel time associated with the saved shopping trip, assuming for now that the actual duration of the shopping activity remains the same Such time savings can be converted into either in-home or out-of-home activities To the extent that travel time savings are converted into enhanced out-of-home activities, this will in turn generate new travel, and increased travel can also arise out of the substitution of further, more preferred, activity sites as a response to more available time The observation that travel time savings are often partly offset by newly generated travel led to the institution of travel time budgets in travel demand models (Zahavi 1979 Golob *et al* 1981, Gunn 1981, Downes and Emmerson 1985) More recently, it has been established that the greatest proportion of travel time savings will typically manifest itself in increased in-home activities, but a significant portion of travel time savings will also find its way to increased out-of-home activities and to newly generated travel (Golob 1996 Golob and McNally 1997, Purvis *et al* 1996)

Here we are concerned explicitly with travel for shopping, a focus that differs from previous studies Our question is how shoppers would use savings in shopping travel time resulting from substitution of in-home for out-of-home shopping Discretionary activities, in-home and out-of-home, are the prime candidates for at least some of the saved shopping travel time, because these activities represent what people would generally prefer to do if they had more time available It is also possible that busy people might have a latent demand for out-of-home maintenance activities, such as personal and household business and providing rides for other family members

We specified a structural equations model along the lines of Golob (1996), Lu and Pas (1997) and Golob and McNally (1997) In the model, we employ a three-way categorization of all out-of-home activities excluding shopping based on a hierarchy of needs that has been used in many time-use and travel studies (Chapin 1974, Robinson 1977, Reichman 1977, Gunn 1981) (i) out-of-home work (subsistence activities), (ii) maintenance, which includes activities that households typically need to perform on a regular basis (such as eating meals, engaging in personal or professional services, medical care, taking care of household or personal obligations, picking up or dropping off passengers, school and religious activities at non-home locations), and (iii) out-of-home discretionary activities, which encompass social, recreational and entertainment activities (such as visits to friends or relatives, engaging in cultural and civic activities, amusements, hobbies, exercising, athletics, rest and relaxation, attending spectator athletic events, or making incidental or tag-along trips) We kept shopping and its travel separate, and total activity durations were computed over each individual's two diary days

The structural equations model has five endogenous variables (i) the duration of all out-of-home work activities, plus the travel time for these activities, (ii) the duration of all out-of-home maintenance activities, plus the travel time for these activities, (iii) the duration of all out-of-home work activities, plus the travel time for these activities, (iv) the duration of all out-of-home shopping activities, and (v) travel

time to all shopping activities In addition, we found ten exogenous personal and household characteristic variables to be important in explaining differences among adults in their demand for these activities

The structure of the relationships among the endogenous variables is depicted in the flow diagram of figure 4 Based on the results of Golob (1996) and Golob and McNally (1997), we postulate that the structural model reflects a hierarchy of activities more work activities mean less non-shopping maintenance, shopping and discretionary activities, and the more shopping or other types of maintenance activities mean less discretionary activities These direct effects among the activity participation variables are indicated by the five arrows joining the boxes in the upper two rows in figure 4 The other part of our basic postulate is that shopping activity time requires travel time, as indicated by the (positive) arrow from shopping activities to shopping travel in figure 4 The base model is thus represented by the 6 links among the endogenous variables labelled 'positive' and 'negative' in figure 4, together with 17 links to the endogenous variables from 11 exogenous variables

The three hypotheses to be tested are labelled 'H1', 'H2' and 'H3' in the flow diagram Hypothesis H1 asserts that a reduction in shopping travel time will lead to an increase in non-shopping maintenance activities *ceteris paribus* Hypothesis H2 asserts that a reduction in shopping travel time will lead to an increase in discretionary activities, and H3 captures a feedback relationship that a reduction in shopping travel time will lead to an increase in shopping maintenance activities The base model with the hypothesized links can be shown to be identified with 11 exogenous variables Our approach was to test whether each hypothesized link

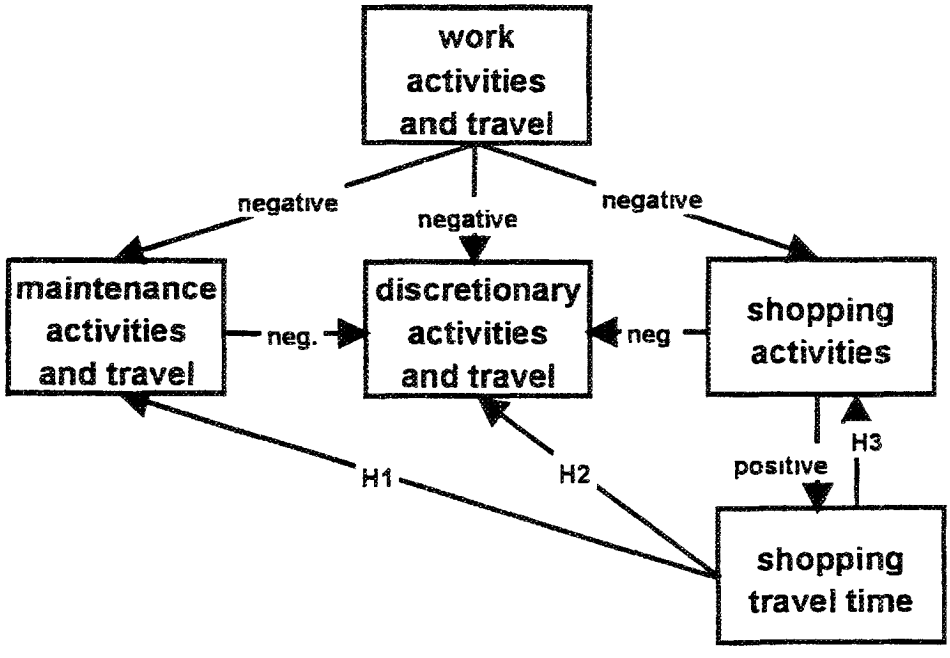


Figure 4 Flow diagram of direct effects among the five endogenous variables in the structural equations model (arrows labelled with positive and 'negative' indicate postulated signs of effects, arrows labelled 'H' indicate hypotheses to be tested)

individually leads to a statistically significant improvement in the model's explanatory power, then to test for significant improvements with pairs of the links and with all three links

The model was estimated using the method of asymptotically distribution-free weighted least squares (ADF-WLS), described in Bollen (1989), and accomplished using the standard PRELIS2 and LISREL 8 software (Joreskog and Sorbom 1993a, 1993b) Golob and McNally (1997) demonstrate that the ADF-WLS estimation method is the most appropriate one for this type of activity analysis The base model fits well for the total sample however, each of the three hypotheses concerning the effects of shopping travel time on activity participation can be rejected individually and in all combinations

We next fit the model and its hypothetical derivatives on the sample of 1810 busy women with non-zero out-of-home work activities The base model chi-square is 46 02 with 41 degrees of freedom, which indicates that the base model fits well and cannot be rejected at the $p = 0\ 05$ level When link H1 is added to the model, the chi square drops to 32 33 with 40 degrees of freedom As these two models are nested, the difference in chi-square statistics is chi square distributed with degrees of freedom equal to the difference in degrees of freedom of the two models The test chi-square statistic is thus 13 69, which is highly significant at one degree of freedom Neither of the other hypotheses leads to such a significant model improvement The best combination of two hypotheses is H1 and H3, which leads to a model with a chi-square value of 31 74 with 39 degrees of freedom While this is also a significant improvement over the base model, the test statistic measuring the improvement of H1 plus H3 over just H1 is a difference in chi-square values of 0 59 with one degree of freedom, which is not significant

The estimated direct effects among the endogenous variables for the final model with link H1 added to the base model are listed together with their z-statistics in table 6 Each of these effects corresponds to an arrow in the flow diagram of figure 4 with the column variable in table 6 Listed in table 7 are the direct exogenous effects on which the endogenous effects are conditioned

We interpret these results to mean that female workers have a latent demand for out-of-home maintenance activities If more time is available, they would participate

Table 6 Structural equations model direct effects among the endogenous variables (z-statistics in parentheses)

	Influencing variable				
Affected variable	Work activity	Shopping activity	Maintenance activity	Discretionary activity	Shopping travel time
Work activity					
Shopping activity	−0 353				
	(−14 7)				
Maintenance activity	−0 270				−0 110
	(−10 4)				(−3 70)
Discretionary activity	−0 359	−0 079	−0 049		
	(−13 1)	(−3 22)	(−2 10)		
Shopping travel time		0 824			
		(35 4)			

Table 7 Structural equations model direct effects of the exogenous variables (*t*-statistics in parentheses)

Exogenous variable	Affected variable				
	Work activity	Shopping activity	Maintenance activity	Discretionary activity	Shopping travel time
No of children in household < 6 years	0 094 (2 82)			−0 087 (−3 90)	
No of children in household < 12 years	−0 197 (−5 91)	−0 057 (−2 48)			
No of children in household 12–16 years			0 069 (2 99)		
Age (in years)	0 509 (4 01)	0 488 (4 01)	−0 403 (−3 23)	−0 122 (−5 46)	
Age (in years) squared/100	−0 545 (−4 28)	−0 467 (−3 82)	0 304 (2 44)		
Whether person is a driver (dummy)				0 080 (3 62)	
Household income < 20 000 (dummy)					0 026 (1 91)
Household income 40 000–60 000 (dummy)					
Household income > 60 000		0 053 (2 32)			
No of household vehicles		−0 055 (−2 44)			
Ratio of household vehicles to drivers			0 039 (1 70)		

more in such activities Work is largely responsible for repressing this demand, but our results indicate that shopping travel time is also a significant component of the time that could be converted to maintenance activities The elimination of some shopping trips due to the substitution of in-home for out-of-home shopping should lead to an increase in demand for activities besides shopping

6. Conclusions

The growth of new broadband communications channels like the Internet has renewed interest in the potential of 'teleactivities', including electronic home shopping We have suggested that the development of electronic home shopping will bring into play many interactions between communications and transportation We cited examples ranging from contraction in the channels through which goods are distributed, to the ways in which buyers and sellers 'meet' Most of our examples centred on future transactions by consumers but there is already a flourishing business-to-business trade that uses electronic shopping networks (*The Economist* 1997) Business-to-business markets have developed first, perhaps because business travel is fully cost-justified and non-recreational

In the present investigation, we have focused on the consumer market We have suggested that predicting individual shopping activities is complicated by the

difficulty of predicting future changes in shopping markets at large We began with broad conceptual issues and then narrowed our focus to studying household activity patterns Since communication and transport interactions are likely to take place at many levels, we miss the mark if we look too narrowly, say, just at time spent shopping Time spent shopping in stores is likely to change in reaction to the range and variety of products sold on-line, and the ease and cost with which they are available on-line, and delivered to the home Likewise, the range of stores that are visited in person is likely to be modified as consumers gain more free time or expand their awareness of alternatives The caution we have exercised throughout this investigation is that transportation and communication interactions can lead to unanticipated but far-reaching levels of change

As a methodology, activity analysis is suited to study future home shopping interactions, because it begins with the assumption that activities motivate trip taking If the reasons for engaging in the underlying activity change or are met in other ways, then trip taking may change This is particularly useful as electronic versions of activities begin to substitute for, or change, in-person travel However, activity analysis might tend to understate occasional shopping travel that is undertaken for recreational reasons (for a related discussion see Salomon and Koppelman 1988)

From the empirical results, we find initial evidence that electronic home shopping may serve a niche role In our sample, drawn from a large U S metropolitan area, time to shop represented nearly one-third of the shopping activity (activity = time to store + time to shop), and about 25% of each activity duration In total, men spent, on average, nearly 2 5 hours per week shopping, and women close to 4 hours The actual time spent in travel is probably higher since people may under-report time spent to park, or to load and unload parcels Moreover, this count does not include additional shopping time which was spent in aspatial' activity Shopping time may include in-home activities, like using information from catalogues, browsing ads and phoning around for prices

Focusing, then, on just out-of-home shopping, women travelled to shop further than men, irrespective of their employment status To the extent that female workers face time pressures in carrying out household roles, the option of in-home shopping might be attractive Unfortunately, since these women may not be home during the daytime to receive deliveries, other arrangements have to be made to make home shopping useful We discussed some of these in section 4 4, like the idea of a retrofitted exterior icebox, remote parcel pick-up or telecommunications-assisted appointment times

Those who wish to promote future home shopping will take courage from the results for working women, but there is also some contradictory evidence Non-working females spend considerable time both shopping and travelling to shop Non-working men also spend more shopping time, and initiate more shopping trips than workers The implication is that people with more free time channel some of it towards in-store shopping Support for this can be found in the results for age groups 56 to 70 They also increased their time spent in shopping activities One hypothesis is that as people gain free time, shopping may be viewed as less of a chore and serve a recreational role Societal trends towards shorter work weeks, and an increase in early retirement, could constrain the growth of electronic home shopping

If time is identified as one facilitator/constraint on the choice of telecommunications and transport, then mobility might be examined as a second The empirical

results show that after age 70, shopping declines as a percentage of out-of-home activity Shopping-related travel might be difficult for older people as they give up their cars or rely more on mass transit

As we try to identify potential interaction between transport and communications, one of the clearest results is for the subsample of teleworkers Their results suggest that sociability may be a third facilitator/constraint on the choice of telecommunication and transport We observed that as more time was spent performing work activities at home, there was an increasing amount of time spent in shopping activity Away-from-home workers spent, on weekdays, 13 min in shopping and 37 min in discretionary activities Full-time teleworkers engaged in 24 min of shopping activity and 46 min of other discretionary activity

On the one hand, staying at home may be less 'efficient' because more individual trips have to be initiated, in lieu of combining shopping trips with commute travel However, the large increase in shopping time for teleworkers suggests that shopping might also serve a more recreational role and allow people to get out of the house Shopping and other out-of-home activities may take on new importance if people work from their homes Teleshopping cannot be studied in isolation from other teleactivities particularly since there is a common underlying communications network

Some of the strongest evidence about electronic home shopping and future choices between transport and communications can be seen in the results for maintenance travel activity Our forecast is that working women who have travel time savings from shopping trips will convert a portion of this time saving into demand for more out-of-home activities related to personal and household business and other family obligations This is initial evidence that future savings of time spent in travel may increase the activity space of individuals (Wigan cited by Salomon and Koppelman 1988) and that relationships between communication and transport may produce newly generated travel The reduction of travel-related shopping will increase levels of trip making for other purposes

We turn now to future research endeavour on transport/communication interactions In further study, it would be useful to corroborate these results and analyse data from other travel/activity studies It would also be valuable to monitor changes in both shopping and travel-related activity, as home shopping accelerates There are a growing number of subscribers to home shopping services in both the U K and U S A who could be administered travel/activity diaries Probably the most needy research, though, is towards an expansion of the data collection instrument, so that (i) 'aspatial' shopping activity is recorded—e g browsing activity that currently takes place from home, and (ii) 'spatial' shopping trips are counted, even if they did not culminate with a purchase or transaction Methods that probed these alternatives would be helpful and provide new insight into potential communication and transport interactions They are also more likely to capture early change that is taking place today, as shoppers look to Internet sites for information gathering but make subsequent purchases at stores One of the lessons from this study is that the ability to browse product information electronically might reduce the number of 'window-shopping' visits, but it may also serve as a 'catalytic stimulus' towards more travel Over the long run, it could also alter the timing and frequency of travel to stores as more product categories are sold on-line, and the reason for initiating in-store visits changes Clearly this is complex information to collect, and it will depend upon the precision and detail of our survey instruments, as well as on the ability of respondents to articulate their shopping activities

The development of electronic home shopping highlights future interactions between communications and transportation It also reminds us that if some people choose to shop without travel, others will still choose to travel and shop, or travel without shopping

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