ENTREPRENEURSHIP & REGIONAL DEVELOPMENT, 16, JANUARY (2004), 41–54

Pizza over the Internet: e-commerce, the fragmentation of activity and the tyranny of the region

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The question this paper explores is the extent to which e-commerce may be liberating consumers and merchants from the constraints of space (and time) that have traditionally led to predictable regional patterns of retail location. Is distance dead, have the laws of regional organization dissolved away in the age of Internet shopping? Following a discussion of some figures, trends and definitions relating to e-commerce, the paper develops a tentative theoretical framework for the study of this question. First, the fragmentation of activity hypothesis suggests that the activity of shopping can be decomposed into a large number of different sub-activities, some of which can better be carried out physically and others electronically from a variety of different locations. Next, noting that the sub-activity of paying for a purchase is the single most critical one for the survival of a local retail presence, a general game-theoretic model is outlined to help to estimate the relative amounts of physical vs. Internet shopping that would help to safeguard a healthy local retail presence. The paper concludes that e-commerce is not about to end the 'tyranny of the region'. Regional structure principles remain important, although many familiar analytic approaches may have to be rethought or extended.

Keywords: e-commerce; retail; fragmentation of activity; local economy; spatial analysis.

1. Introduction

The title of this paper is a reminder of the fact that even in these days of advanced information and communication technologies (ICT), the constraints of space, place and region continue to govern the where and how of human activities. You can order pizza over the Internet, but it will still have to be delivered to you in the old-fashioned way, on foot or on wheels, from a nearby location. For every process for which 'distance is dead', there is another complementary one that obeys the traditional principles of hauling matter (including human bodies) across space, on which economic geography and regional science were founded. This paper explores some spatial implications of this inescapable duality between matter and information, as it manifests itself in the case of electronic commerce. As with many other processes of the information economy, enough of the familiar constraints of physical space (and time) remain in force to challenge any notions of regional dissolution, although the new emerging geographies may still be too complex to fathom.

Electronic commerce has thus far been studied primarily from the business perspective, with a focus on the advantages and occasional drawbacks of doing business over the Internet. Business to business (B2B) commerce, the largest, economically most important, and oldest segment, has naturally attracted most of the attention to date. Business to consumer (B2C) e-commerce is still very small especially outside

Entrepreneurship and Regional Development ISSN 0898–5626 print/ISSN 1464–5114 online © 2004 Taylor & Francis Ltd
http://www.tandf.co.uk/journals
DOI: 10.1080/0898562042000205027

the USA, although it is almost certain to continue to grow at a healthy pace, recessions and adjustments notwithstanding. Few academic studies of B2C have been published to date and again these tend to be from the business (retailer's) perspective. However as in the case of traditional retail location theory the new geographies of e-commerce need to involve the whole picture of supply and demand and cannot be fully understood by examining the business side only. In the interest of promoting a more balanced perspective this paper explores the B2C (or 'e-tailing') issue from the other, much less studied end of the retailing chain, namely, from the 'C' side. Rather than passively adjusting to whatever the information age is throwing at them, today's consumers are playing for their own purposes the same sort of utility-maximizing game that commercial players big and small are engaged in. As in the past the resulting new landscapes of commerce are more likely to reflect the evolving spatial compromise between the interests of firms and those of consumers than to be governed by the transaction-cost-minimizing strategies of business capital alone. This paper examines only a small part of this broad assumption, focusing on the constraints that may be placed on the structure of retailing through the ways consumers trade off the advantages of ICT access against the utility of physical access to brick-and-mortar facilities.

Major elements in the developing game between digital-age commercial firms and consumers are the hybrid physical/virtual networks of ICTs and transportation, as well as the changing consumer lifestyles enabled in part by these same networks. More specifically, the daily activity patterns of individuals appear to be changing in still subtle but increasingly radical and significant ways. This idea is captured in the *fragmentation of activity* hypothesis proposed by Couclelis (1998, 2000). Here the notion of activity fragmentation is used as a lens in trying to identify aspects of e-commerce that are likely to remain place-bound, and to reflect on some of the challenges regional science may face in developing appropriate models and theories for these phenomena.

Following this introduction, the next section provides an overview of e-commerce, including some definitions, summary figures, and widely reported facts concerning both the retailers and consumers of ICT-intensive economies. Next, the fragmentation of activity hypothesis is introduced and is applied to e-commerce in the following section. It appears that far from being 'dead', distance still binds retailing firms to place and region, even though the familiar location theories may no longer be very useful. This raises the broader question, briefly discussed in the conclusion, of whether new concepts, theories and tools may be needed for the regional science of the ICT age. The answer is a resounding 'maybe', and the paper closes with a few speculations regarding possible alternative conceptualizations of the problem.

2. E-commerce, e-tailing and teleshopping

In our consumer-oriented society, the activity of shopping is associated with a range of concepts of direct relevance to geography and regional science: spatial interaction, accessibility, mobility, land use and transportation, urban form and function, employment and the local economy, tourism, recreation, and the quality of life in a community. It is therefore intuitively plausible that any substantial changes in shopping patterns will have local and regional spatial repercussions. The hype that surrounds everything Internet-related (somewhat subdued following the recent

business downturn, but still very much alive) has fostered a chorus of prophecies concerning the impacts of e-commerce that the media and even serious publications have eagerly embraced. The 'party line' of e-commerce foresees massive changes in retailing structure, stressing globalization and global reach and predicting the demise of local 'brick and mortar' retailers (Drucker 1999). These scenarios extrapolate from the undeniable advantages of e-commerce for businesses (lower transaction costs, greater access to markets, flexibility, and so on) and for consumers (choice, convenience, downward pressure on prices, etc.) but are often based on techno-deterministic reasoning that neglects the complexities of institutional, social and spatial organization – not to mention human nature (Graham and Marvin 1996). On the other side are the sceptics who point at the still miniscule share of e-commerce and to the analogy with other technologies, innovations and practices that have been around for well over a century without making an appreciable dent into the way people shop. Many observers indeed see e-commerce as a natural evolution of catalogue shopping which back in the 1860s first brought the lure of big-city lifestyles into the farmsteads of rural America. Others note the close parallels of the Internet with the global telegraph networks of the mid-1800s and especially the eagerness with which commerce embraced the new technology back then. 'At its very birth, the telegraph system became the handmaiden of commerce', states the National Telegraph Review and Operator's Companion in the 1853 edition (quoted in Standage 1998). Whether evolution or revolution, these reactions of '*déjà vu*' do not detract from the fact that modern economists are taking all forms of e-commerce very seriously, based on both available data and growth forecasts for the near future.

2.1 Some figures on e-tailing

A first challenge in trying to quantify the effects of e-commerce is definitional. The US Census defines electronic commerce as 'any transaction completed over a computer-mediated network that involves the transfer of ownership or the right to use goods or services'. However the same Census document that puts forward that definition also discusses the many conceptual and practical difficulties of making it operational (Mesenbourg 2000: 3). What is a commercial 'transaction'? Does it have to involve money or can it also include barter or trade-in-kind transactions? What is a 'computer-mediated network'? Does fuel dispensed at electronic gas pumps (which are usually linked interactively to computer networks) qualify? How about telephone orders placed over a fully computerized interactive telephone network? And so on. It is thus not surprising that estimates of e-commerce retail sales volumes range widely depending on who is reporting them.

According to the US Bureau of Census's earliest data on e-commerce, in the fourth quarter of 1999 online sales by retail establishments reached US$ 5.3 billion, a puny 0.64% of all retail sales. Private estimates for the same period range from $4 to 14 billion, but the higher figures include sales of immaterial goods or services such as travel and event tickets that the US Census does not include in its counts (US Department of Commerce 2000). For the first quarter of 2001 the Census figure was $7.0 billion (0.91% of retail sales), up 33.5% from the first quarter of 2000. This looks healthy enough but given e-tailing's short history there is no agreement as what normal growth should be. Figures from 20% to 150% have been cited, while many analysts had earlier been expecting 80–100% growth, on the assumption

that e-tailing was poised to reach the takeoff point on the S-shaped innovation adoption curve (*The Economist* 2000c). Adding to the confusion is the recent poor performance of many sectors of the information-based economy, which encourages overly pessimistic forecasts by electronic commerce nay-sayers: 'It is fashionable these days to view the on-line business-to-consumer (B2C) market as a wreck', according to the lead article in *The Economist* (2001).

European B2C sales figures still lag far behind those from the USA, although direct comparisons are extremely difficult because of definitional discrepancies between the continents. Leinbach (2001) reports $300 million in e-tailing sales for the whole of Europe for 1998, compared to $4.9 billion for the USA for the same year. Priemus (2000) writes that in 1999 consumers in the Netherlands spent €147 million online, with 78% of the sales going to computer hardware and software, travel, and books and CDs. He further cites forecasts expecting e-commerce in Europe to grow by an average of about 100% a year for the next 5 years, to reach about 15% of retail sales in the long run. Beyond the USA, Europe and perhaps Japan, e-tailing in the rest of the world is still a negligible quantity.

2.2 The local retailers

Fuzzy figures and gloomy e-commerce forecasts notwithstanding, it is clear that there will be (in fact, there already are) brick-and-mortar retail establishment casualties on the way to the e-tailing society. Some sectors are more hard hit than others, notably those delivering information-based services (e.g. banking transactions: see van Geenhuisen and Nijkamp 2001) or material goods the use value of which lies primarily in the information they embody (e.g. music CDs). Travel agencies, neighbourhood bank branches and music stores are thus good examples of the kinds of retail outlets most directly challenged by the growth of e-tailing. (In principle bookstores should also be in that category although they still appear to be holding their own.) Goods that come in factory-sealed packages whether bought on-line or at an actual store, such as computers and a range of other consumer electronics, are also high on the list of categories migrating to e-commerce. That list keeps expanding although not in a linear fashion since new goods and services or novel variations and combinations of existing goods and services are entering the market all the time.

As Kenney and Curry (2001: 51) put it, 'The Internet confronts businesses with four unique characteristics: ubiquity, interactivity, speed, and intelligence'. Increasing numbers of retailers, whether local businesses or regional firms with local outlets, are trying to fight back by going on-line themselves. The transition is easier for the larger, regional firms which already handle national and international-scale marketing and distribution networks, although these too often find it difficult to handle the 'last mile' to the consumer's doorstep (unlike mail order operations, for which the web site is a natural extension of the paper catalogue). The transition to the Internet is much harder for local businesses, which lack both the capital and the know-how to attract and serve remote customers through effective web sites and infrastructure. Steinfield and Whitten (1999) discuss the mistakes local retailers often make when trying to establish a web presence. The most serious is to succumb to the lure of the global reach afforded by the Internet and neglect their local customer base. These authors argue that local retailers still have strong competitive advantages in the age of ICTs, at least for the current generation of customers reared on real rather than

virtual relationships. This is because physical presence continues to be very important with regard to a number of more or less intangible characteristics of the relationship between retailer and consumer. Trust, including both trust in a familiar seller and trust in the security of the transaction, is the first that comes to mind. It seems that electronic banks are having a lot of trouble attracting customers despite the ability to offer deals far superior to those of traditional banks (*The Economist* 2000b). Ironically, some of them are trying to counter this problem by establishing brick-and-mortar branches (Rawe 2001). Beyond trust there are several other advantages local retailers have that cannot yet be matched by alternative schemes, embeddedness, or the fact that local retailers and their families are part of the social networks of the community; their ability to know the local consumers' needs and behaviour first-hand; the possibility to offer creative and personalized pre- and post-sales services, and to combine sales with special services (e.g. lessons); and the local knowledge that benefits both local customers and out-of-town visitors. According to Steinfield and Whitten (1999), retailers who build on these strengths can weather the e-commerce competition and contribute to their communities' continued well-being by retaining the jobs and other socioeconomic advantages that a healthy local retail structure provides. Undoubtedly some kinds of retail businesses are better able than others to capitalize on such comparative advantages (*The Economist* 2000a). Below is a rough typology of 'webbable' consumer goods, grouped according to the ease with which they may migrate to e-commerce.

As candidates for e-tailing, *perishable* goods present somewhat of a paradox because of the high friction of distance associated with their market range. At one end is the pizza of the title of this paper that can only travel a very short distance between the oven and the consumer. Ordering pizza over the Internet (e.g. through TelePizza®) may appeal to the young and wired but is in fact no different than ordering directly from a neighbourhood franchise. Internet grocery shopping similarly requires outlets in the vicinity of a threshold number of customers although these can be warehouses rather than conventional stores. At the time of writing two of three major US Internet grocers closed within a week of one another, attesting to the difficulty of competing with traditional stores in the case of low-priced perishable goods. Where e-tailing does have an advantage is in the case of sufficiently high-valued perishable goods which customers can locate over the Internet and acquire from distant sources, subject to the constraints of refrigeration technology and fast transportation.

Convenience goods and *durables* are an extremely diverse category. Dozens of distinctions may be drawn from the perspective of their suitability for e-tailing. The distinction between 'search' and 'experience' (or 'low-touch' and 'high-touch') goods focuses on whether the customer would normally need just to locate an item with the right characteristics and price, or whether he or she would wish to handle, feel, try on, etc. the merchandise before buying. Clearly the former are better suited to e-tailing than the latter, although technological solutions are constantly being proposed to increase the realism of the teleshopping experience (e.g. sensory-feedback computer mice and joysticks, or correctly proportioned customer avatars for judging the fit of clothing offered on-line). 'Standardized' vs. 'differentiated' goods is another, closely related distinction. Goods not available locally or even nationally and specialized niche merchandise are good candidates for e-tailing, an option superior to traditional mail ordering because of the powerful search capabilities of the World Wide Web. Goods such as music (not to mention computer software) that can be easily 'dematerialized'

without loss of content obviously have the greatest affinity to e-tailing and are closely related to the next category, informational services.

To the extent that they may be considered part of commerce, personal *services* may be broken down into physical and informational, although even that distinction can be fluid. Of the physical services, merchandise transportation is clearly not 'webbable' (at least not yet!), while merchandise repair can now to some extent be carried out by the consumer with the help of detailed instructions obtained on the web. Many other service categories that may be characterized as 'informational' (including banking, brokering, travel services, etc.) have been among the pioneers of e-commerce.

2.3 How is the choice between physical and on-line purchase determined?

In summary, most kinds of goods in all the above categories may be offered through e-commerce as well as through traditional means, even though some goods are better suited to e-tailing than others. How does a consumer choose between physical and on-line purchase? Although few if any empirical studies have been published to date, the usual economic and behavioural criteria of lower price, lower transaction costs, convenience, safety and security, and psychological factors such as loyalty, trust, and the quality of the shopping experience clearly apply (Li *et al*. 1999). To these should be added the novelty of teleshopping and the ease of access to the necessary technology. In discussing the comparative advantages of each of the two options, observers of e-commerce have often concluded that local businesses will not be able to compete in the long run (Janelle 1999). This, however, is not a foregone conclusion, as Steinfield and Whitten (1999) have argued.

A problem with most of these discussions centring on the comparative advantages of physical shopping vs. teleshopping is that they tend to consider only *substitution* effects. However, it is well known that important innovations have broader effects, including complementarity, amplification, synergism, and restructuring of the original activity (Abler 1975, Mokhtarian and Meenakshisundaram 1999). These notions point to the potential of an innovation such as teleshopping to alter the nature of shopping to the extent that direct comparisons between old and new forms are no longer very meaningful. Indeed, seeing e-tailing as a simple information-age substitute of traditional retailing can lead to fallacies as that exemplified by the failure of the 'e-mall'. According to Kenney and Curry (2001), attempts to reproduce the suburban shopping mall in Cyberspace failed because the reasons for clustering a number of unrelated stores at one physical location (stemming from considerations of travel costs, parking, convenience, personal safety, and the enhancement of the social and recreational quality of the shopping experience) simply did not obtain in the space of the Internet, where shoppers have access to a potentially global marketplace devoid of physical constraints of the above kind.

3. The fragmentation of activity: a hypothesis

The failure of e-malls constitutes a cautionary tale reminding us that major innovations have 'soft' as well as 'hard' aspects (Occelli 2000). The hard aspects of an innovation are its immediate effects but these are often overshadowed by the soft effects, or the changes in the ways of doing things brought about by the innovation. The major innovation in this case is the widespread adoption of integrated ICTs,

of which e-commerce is but one aspect. In this section I discuss one particular soft effect of ICTs of special interest to geography and regional science. This is the potentially wide-ranging modification of the activity patterns of individuals and the corresponding modification of the meaning of a person's activity space. To handle a geography where (digital) interactions and transfers may take place at arbitrary distances, Couclelis (2000: 348) proposed the notion of *contact set*, defined to be '[f]or an individual, within a given time period, the set of geographic locations that are contacted either physically or digitally for the purpose of initiating a physical or digital transfer'. In the pre-telecommunications world both contacts and transfers were physical only and the individual contact sets were relatively small and fell within well-defined activity spaces limited in both time and extent by the available transportation technology. A century and a half of telegraphs, telephones and fax machines gradually and significantly dampened these constraints of space and time in industrialized regions. However, it is not until the recent advent and spread of integrated ICTs that an explosion of contact set size for individuals became possible, a trend greatly encouraged by the simultaneous drastic reduction in marginal contact costs (Graham and Marvin 1996). The growth in the absolute number of contacts is accompanied by a vast expansion of the geographic range within which the corresponding locations fall. Any number of the locations that are part of an individual's contact set may now be at arbitrary physical distances from his or her location, prompting certain writers to prematurely declare that distance is dead (Couclelis 1996, Cairncross 1997).

The fragmentation of activity hypothesis proposes an alternative and more useful view: *it is not distance that is dead*; *it is activity that is disintegrating*. For most of human history an activity used to be associated with one place at one time: work with the workplace, education with the school or campus, shopping with the commercial area, and so on. Moreover, through the perspective of time geography it became clear that distance constraints and coupling constraints among activities resulted in equally predictable allocations of activities along the time dimension: the eight-to-five working day, the evening at the movies, the Saturday at the shopping mall. It was largely these reliable regularities that made urban and regional planning and modelling possible. In the ICT age, by contrast, to the extent that an activity involves exchange of information either between people or between people and machines, that activity may be distributed over space and across time. For a still small but growing number of professionals the word 'workplace' no longer has much meaning. Equipped with laptop computers and cell phones, their workplace may be the office, the home, the hotel room, the great outdoors, the car, the airplane – or any combination of the above at different times. The same holds for teleshoppers, who may be doing their shopping from home (usually), from work (often), from the seat of an airplane (increasingly), or from anywhere else in the industrialized world through their wireless PDA device (soon). Thus the question of where and when a particular activity takes place now admits of many different kinds of answer. It may be all at one location, like it used to be; or at alternate locations (e.g. home and office); or it may be distributed along a route; or it may be distributed across a region; or it may be ubiquitous, as many activities may soon be thanks to wireless portable computing. Similarly, an activity can take place all in one time period, or at alternate times (sometimes before, sometimes after some other activity), or in some regular time sequence interwoven with other activities, or at several different times, or at any arbitrary time the individual chooses. This gives rise to the following taxonomy of space-time varieties of

Table 1. Space-time structures of activities in the ICT age (from Couclelis 2000: p. 347).

	Time				
Location	*One-time*	*Alternating*	*Sequential*	*Fragmented*	*Anytime*
One-place					
Alternate					
Linear sequence					
Distributed					
Ubiquitous					

activities in the information age, whereby the bulk of activities are still in the traditional upper-left corner, but are increasingly spreading in the direction of the lower right, which reflects the technocrats' utopia of 'anywhere, anytime' (table 1).

4. Teleshopping and the spatio-temporal fragmentation of activity

This section discusses two aspects of the fragmentation of activity as applied to teleshopping. First I consider a traditional localized shopper faced with the choice between regular retail and e-tailing. Here only the shopping activity is potentially spatio-temporally fragmented, and the issue is essentially one of substitution. The other, much more complex case involves a shopper who conducts the (fragmented) shopping activity on top of another fragmented activity – say, work. We can expect that the 'soft' effects of the innovation, namely, complementarity, amplification, synergism, and the eventual restructuring of shopping as an activity (and also as infrastructure), will be most pronounced in this second case.

Shopping is a complex activity consisting of a large number of different (sub) tasks. Table 2 presents an informal listing of such tasks that tend to be present in shopping for any but the most trivial goods. Some of these tasks must be carried out in sequential order, others may be carried out in parallel. Some (notably, paying for the purchase) can only involve one location per purchase while others may involve several locations (gathering information, searching, comparing prices, etc.). In the pre-ICT era and with the limited exception of catalogue (more generally, telephone) ordering, all these tasks used to be carried out within a limited geographical area, if not within a single retail establishment or mall, and within specific time frame(s). With the advent of e-commerce and for most categories of goods, most if not all of these tasks may in principle be carried out remotely by the consumer who is now able to contact any number of locations 'anywhere, anytime'. In this way a previously fairly localized activity becomes widely fragmented in space and time, and for each prospective purchase the associated contact set can explode in size. Convenience, the opportunity to maximize product information and choice and the possibility to locate the lowest price are the most touted advantages of teleshopping. On the other hand many shopping tasks (e.g. trying an item before buying, returning an item, or having an item serviced) are still more cost-effective, practical, efficient or pleasurable if carried out physically. Some tasks even have aspects that just cannot (yet) be replicated on the web, such as the instant gratification of taking possession of a physical purchase or the pleasure of meeting friends at the mall. For all these reasons shopping is a highly

Table 2. The different (sub) tasks of the activity of shopping.

1 – Become aware of need or want	7 – Decide on vendor
2 – Gather information about options	8 – Purchase (order/pay)
3 – Search/browse	9 – Track status (if an order)
4 – Seek advice/expert help	10 – Get item to base (usually home)
5 – Inspect alternatives	11 – (Eventually) return/exchange item
6 – Decide on item to be purchased	12 – Seek post-sales service

Table 3. Possible shopping patterns combining local and remote options.

Before	*Purchase*	*After*
Local	Local	Local
Local	Local	Remote
Remote	Local	Local
Remote	Local	Remote
Local	Remote	Remote
Local	Remote	Local
Remote	Remote	Local
Remote	Remote	Remote

popular social and recreational activity in the industrialized world and even the more dedicated Internet shoppers would be loathe to see the local retail stores disappear. It is indeed in the best interest of consumers to have available to them the complementary advantages of both teleshopping and traditional retail, but that option is not sustainable if more and more people use the local stores to just handle and try things out, only to purchase them at a lower price from remote e-tailers.

Note that of all the tasks constituting the activity of shopping only one, paying for the purchase, is critical to the survival of local retail. Some pre- and especially post-sales services are also becoming increasingly important income generators but few types of retail establishments could be sustained by such services alone. For the purpose of assessing local store viability it is thus possible to aggregate the tasks into three groups: pre-purchase, purchase, and post-purchase, and the consumer options with respect to these in two categories: local and remote, where 'local' means that at least part of the task involves interaction with a local retailer. Table 3 then summarizes the possible shopping patterns for any specific purchase.

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). Clearly for local retail the desirable patterns are the four that involve a local purchase, while for increasing numbers of consumers the opposite would be the case (lower prices and greater choice through remote purchasing). These conflicting interests that include the temptation for many people to be free riders define a social choice dilemma and in particular a strategic interaction problem where the utility of each consumer's choice also depends on the choices of others.

One possible formulation of the social choice problem presented by teleshopping may be based on Schelling's (1978) analysis of the *n*-person prisoner's dilemma (NPD). This formulation provides a qualitative feel for the structure of the problem and the eventual outcomes at the cost of a strong simplifying assumption – namely, that the choice between local and remote purchasing is binary. This of course is

the case for individual purchases but it is the aggregate level of purchases over time that determines the viability of retail in an area and therefore the level of consumer welfare in the long run. As in the case of the two-person prisoner's dilemma, the NPD assumes a structure of payoffs as follows:

$$T > R > P > S,$$

where T is the individual temptation to defect (here: to buy remotely), R the collective reward for co-operation (here: the utility of a healthy local retail structure), P is the punishment for defection (here: the societal cost of losing the community's retail) and S is the 'sucker's payoff' of remaining loyal to local commerce while others are enjoying the advantages of teleshopping. Unlike the 2-person PD, the NPD does not have a single equilibrium solution and the social optimum is usually reached when a specific fraction of decision-makers – but not the entire group – chooses to co-operate. The characteristic of this class of social choice situations is that the individual reward for co-operation increases with the number of co-operating decision makers, whereas the individual payoff of the originally more tempting choice decreases with the number of those making that choice. Assuming constant marginal utilities for simplicity, the corresponding model may be graphically represented as in figure 1. Again T represents the individual payoff of buying remotely, S the individual payoff of supporting local retail, and n is the number of others who choose S. The corresponding curves then give for each option the value of the payoff to *you*, the prospective decision maker, as a function of how many others choose the less preferred alternative. (Clearly, on the whole, the more people support local retail, the better your local retail infrastructure will be – although of course if too few people buy on-line that option may no longer be available.) The dotted curve represents the collective or average payoff, and its maximum, the collective optimum R, is in all cases higher than the stable equilibrium P achieved through unconcerted rational choice. The figure illustrates the case where the collective optimum is highest when a fraction of

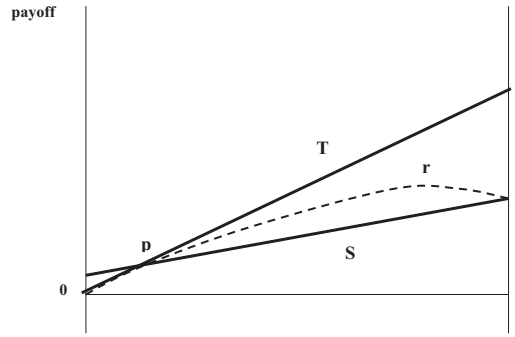

Figure 1. Illustrative individual and collective payoffs in the e-tailing (T) vs. retailing (S) choice. The corresponding curves give the value of each option to the prospective decision maker as a function of how many others choose the less preferred alternative (adapted from Schelling 1978, p. 242).

shoppers buy remotely, everybody then being better off than at the equilibrium, but not equally so. Couclelis (1985, 1989) has shown how this version of the NPD may be applied to a spatial context with the help of decision rules that take into account conditions in the vicinity of the decision-maker (e.g. the quantity and quality of retail establishments within a certain distance).

More generally the problem may be formulated as a 'resource-flow' model (Brueckner 2001, Brueckner and Saavedra 2001). In this framework a consumer cares about the amount of a particular resource that he or she is enjoying – in this case the level of retail in the local area. That level is affected by the purchasing choices (local or remote) of all other consumers in the area, so that the objective function of consumer i may be written as

$$\mathrm{U}(l_i, l_{-i}, X_i)$$

where l_i is the amount of money spent by consumer i locally over a relevant period of time, l_{-i} is the amount spent by all other consumers over the same period, and X_i is a vector of characteristics of consumer i, that includes i's distances from the different retail concentrations (this helps to define what is 'local' for each consumer). Brueckner (2001) shows how such a model may be estimated as a spatial lag model and solved for l, the vector of local shopping expenditures for all consumers in the system.

Familiar types of models such as the above can thus help to sort out the substitution effects of e-commerce and their consequences for both local retail and for consumers. Empirical research on consumer behaviour will also be highly useful in helping to understand how people decide between physical and digital options when carrying out each one of the component tasks of shopping (Li *et al*. 1999). However, all these approaches assume a reasonably well-defined concept of 'local retail' dependent on traditional notions of localized consumers. In the age of fragmented activities this is no longer necessarily a good assumption since shopping for a good can now be combined with the spatio-temporal fragments of other activities. Consider the following not implausible scenario: a frequent-flyer professor becomes aware of a new and improved PDA model while attending a meeting at location W. From her hotel room she searches for the item over the Internet and finds that it is sold at a store near location X, which is her next stop. She visits the store at X, tries out the device, but is shown a device of a different brand sold at that store that appears to be superior. The professor e-mails a graduate student for advice, searches the Internet some more from her plane seat laptop connection on the return flight, and orders that second device from the least-cost e-tailer. She receives the item while back home but regrets the purchase and returns the goods. Unwilling to wait any longer, she finally buys the originally coveted PDA from a store next to the conference hotel at location Y. Shortly thereafter she accidentally damages the device, searches the Internet for servicing centres, and ships the item for repair to location Z.

What does 'supporting local retail' mean in such a case, and how does one model spatio-temporally fragmented shopping on top of spatio-temporally fragmented work (or educational, recreational, etc.) activity? If the above scenario appears too far-fetched here are some additional ICT-related developments to consider. First is the slowly but inexorable rising trend towards part-time telecommuting. Once a significant number of commuter trips are eliminated, what will become of the substantial fraction of purchases that were normally made along the way from work to home? Will they be strung along routes to new destinations originating from home, will they be absorbed by e-commerce, or will they reappear distributed across urban space

in new and as yet unsuspected patterns? Another imponderable has to do with the many synergies between e-commerce and traditional commerce, leading to surprising solutions such as the Japanese convenience stores becoming teleshopping centres for their neighbourhood (and thereby strengthening their own material position: see Aoyama 2001). Finally, the advent of the much-touted 'place-based services' mediated through portable ICTs could signify the revival of some local commerce geared to visitors and the development of new synergies between e-tailing, traditional retailing, and the spatio-temporally fragmented lives of information-age consumers.

5. Conclusion: new concepts and models for regional science in the age of ICT?

In an increasingly wired society what ultimately will decide the fate of local retail is not the absolute size or the spatial extent of the consumers' contact sets but the actual fraction of sales realized locally. In general, the larger the shopper's contact set becomes, the smaller the fraction of it will be that which remains within the consumer's physical activity space, and – all other things being equal – the smaller the probability that the purchase will eventually be made locally. Local retail can survive by making sure that all other things are *not* equal – that is, by working to increase its comparative advantages relative to teleshopping.

This is the kind of common-sense conclusion that traditional thinking and economic geography concepts and models can fully support, based on traditional notions of how one form of economic behaviour is substituted for another. However, as this paper suggested some still limited but increasingly momentous changes are taking place in ICT-dominated societies that appear to undermine some of the foundations of this kind of analysis. For example, the abundant circumstantial evidence reflected in the fragmentation of activity hypothesis seems to imply that the age-old reliable association between activities and most suitable locations or adapted spaces no longer should be taken for granted. It follows that some fundamental tenets of theoretical geography, regional science and urban and regional planning become questionable. While we can safely assume that distance is not dead and that both retailers and consumers will continue to behave so as to maximize their respective utilities, the spatio-temporal constraints on these behaviours may be changing so radically as to confuse any analysis of spatial outcomes based on traditional assumptions.

A number of scholars from geography and related disciplines have speculated on the possible new forms of spatial thinking and analysis appropriate for the age of ICTs. The collection edited by Janelle and Hodge (2000) includes several examples of novel work, some of it already applied, which if pursued further could open up new vistas on the changing urban and regional structures of the information society. At a time when activity becomes increasingly person-based rather than place-based, Hägerstrand's (1970) oft-quoted question 'Where are the people in regional science?' becomes more pertinent than ever. Janelle's (1973) notion of the 'extensible individual' – the ICT-enabled individual who can reach far beyond the bounds of what is physically accessible – was first proposed three decades ago but has been revived recently (see Adams 2000 for an application). Others have gone further, proposing conceptual models of people and places that are at odds with the geometrical underpinnings of economic geography and regional science. For example, structuration theory suggests conceptualizations of place as network, as process, as communication, as interweaving

of communication and action, and so on (Adams 1988). Similarly, work inspired by Latour's 'actor-network theory' views the functional relations among people, things and institutions as the primary focus of research, rather than their attributes or locations (Murdoch 1998). Both these approaches imply the notion of relative space (space emerging out of relations), in contradistinction to absolute, Newtonian space (*a priori* existing space that contains things and relations). These intellectual projects merge together traditional notions of location, attributes, interaction, function and process to yield suggestive but as yet elusive alternatives to the map metaphor that still dominates spatial analysis and regional science. Some of these ideas could prove very valuable for modelling ICT-age phenomena if only they could be implemented. The notion of *proximal space*, developed as an intermediate construct between absolute and relative space may allow the most useful of these conceptualizations to be translated in a language compatible with mainstream regional science (Couclelis 1997, Takeyama and Couclelis 1997). Regardless of the merits of any particular proposals along these lines it is becoming increasingly clear that we are dealing with a space of socio-economic interactions that is in many respects qualitatively different from anything seen before. It is only reasonable to speculate that we may require some qualitatively different tools for its analysis.

In conclusion, this paper focused on the case of e-commerce but the underlying concern was indeed broader, grappling with the question of how to model the intersection of activity and space in the information age. Human activity is increasingly taking place in a hybrid space that is part physical, part virtual. It is thus subject to the principles of both these worlds while traditional concepts and theories only cover the former.

Unquestionably the familiar models and techniques still have their place but in a sense we only have optical telescopes to work with when there is evidence that a yet to be invented radio telescope would vastly expand our vision. For the time being we can only dream of glimpsing some novel ICT-age phenomena that we suspect surround us but that we may still be unable to detect.

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