

MOBILITY AND ACCESSIBILITY EFFECTS OF B2C E-COMMERCE: A LITERATURE REVIEW

EVERT-JAN VISSER* & MARTIN LANZENDORF**

**Urban and Regional Research Centre Utrecht, Heidelberglaan 2, Utrecht, The Netherlands. E-mail: e.visser@geog.uu.nl*

***Centre for Environmental Research Leipzig-Halle, P.O.Box 500136, D-04301 Leipzig, Germany. E-mail: Martin.Lanzendorf@ufz.de*

Received: June 2003; revised November 2003

ABSTRACT

This paper explores the mobility and accessibility effects of business-to-consumer (b2c) e-commerce by means of a literature review. The main questions are how b2c e-commerce affects (a) individual activity patterns and travel behaviour, (b) the freight transport and logistic decisions of firms, and (c) the location decisions of households and firms. The review shows that the direct (short-term) mobility effects of b2c e-commerce are relatively clear, and that an overall increase in both individual travel and freight transport can be expected. The indirect (long-term) changes for physical accessibility and mobility, however, are less clear and harder to deal with, due to the complex relationships, time lags, data problems and methodological (attribution) problems. Still, it appears that processes of decentralisation and sub-urbanisation of distribution systems for b2c e-commerce may gradually extend and shift, respectively, towards more remote and less densely populated areas in the Netherlands. This would reinforce the ongoing process of retail store closures in these areas, i.e., the spatial redistribution in retailing facilities, thus limiting physical accessibility. As a result, average trip lengths and car use for shopping trips may on the whole increase. With freight transport also increasing due to b2c e-commerce, its overall long-term effect may be an increase in motorised mobility, with urban consumers saving trips for shopping purposes and consumers elsewhere adding to their travel burden. Only certain products are feasible for e-commerce, however. Hence, the impact of b2c e-commerce on mobility and accessibility varies between product categories.

Key words: b2c e-commerce, travel behaviour, logistics, freight transport, accessibility

INTRODUCTION

The development of information and communication technologies (ICTs) is a trend that will continue shaping economic and social processes over the next decades, affecting mobility, accessibility and spatial structures. This paper deals with the use of ICTs in transactions between retailers and consumers (b2c e-commerce), analysing both the direct and indirect effects for mobility and accessibility. This is undertaken, because b2c e-commerce is (a) a relatively new technology that (b) affects individual activity

patterns and travel behaviour as well as logistic and freight transport decisions, while (c) so far hardly any research has been done on these effects in combination. Thus, two usually isolated strands of research are brought together – the individual travel literature and the logistics and freight transport literature, so as to develop a more integrated framework for assessing the mobility and accessibility impacts of b2c e-commerce.

The central question this paper seeks to answer is how e-commerce affects the activity choices and travel behaviour of individuals in

their household setting, the logistic and freight transport decisions of firms in a supply-chain setting, and the location, lifestyle and network decisions of these actors in a wider context of changing access to information, retail stores, residential and work locations. The paper is structured as follows. The following section specifies the conceptual framework and raises questions for the following sections. The third section focuses on the impact of b2c e-commerce on the activity and travel choices of individuals, along with lifestyle choices, residential preferences and work locations. The fourth section is concerned with the direct and indirect effects of b2c e-commerce for freight transport. The fifth section integrates the outcomes of the two previous sections, deriving hypotheses concerning the mobility and accessibility effects of b2c e-commerce for the special case of grocery products. The final section draws conclusions.

CONCEPTUAL FRAMEWORK

The authors define e-commerce as an internet-based technology enabling the exchange of product, order, payment and shipping information so as to conclude one or more stages in a commercial transaction process. For the purpose of this study, it is not necessary that parties actually transfer property rights, i.e., they need not commit themselves to a transaction in legally binding ways. Individual travel behaviour will be influenced also when people use the Internet merely to undertake search and comparison tasks.

In line with other studies (see e.g. Visser & Nemoto 2001), three main types of e-commerce are discerned: business-to-business (b2b), consumer-to-consumer (c2c), and business-to-consumer (b2c) e-commerce. This paper focuses on b2c e-commerce because it influences both individual travel behaviour and freight transport. Note, however, that b2c e-commerce stimulates b2b e-commerce: web/Internet-based marketplaces for goods or services, including transport and warehousing. This last may be necessary to actually deliver the products ordered through the Internet, and thus to effectively compete with other retailers using the Internet or other channels.

Important aspects of b2c e-commerce include promotion, ordering, delivery, and after-sales

support (Hameed 2003). Promotion can be customised, as contacts are used to build up a 'memory' concerning a person's interests and needs. Also, it can be interactive, with users learning about their requirements on the basis of immediate feedback. Next, the search and matching process may take place in reference or peer groups discussing and commenting on their experience with the product on sale. Ordering facilities include access to databases on products, payment and shipping alternatives. In the case of digital products such as software, news and music, the Internet also serves to procure or deliver products, which may save mobility time and costs – if and when these products are not reconstituted (Mokhtarian, oral communication, 16 June 2003). Finally, b2c e-commerce includes after-sales services, through the use of email, search-engines, and up-to-date bulletin boards.

The type of electronic device used for e-commerce can be a PC, TV or mobile equipment. From an accessibility and mobility point of view, what matters is that the device enables access to the Internet and that the information exchange takes place in an open network, as opposed to closed networks entailing a specific group of people (extranet or intranet). Hence, large numbers of potential buyers and sellers may connect with one another, irrespective of their location. However, the type of electronic device used for b2c e-commerce brings along different constraints for different kinds of people. This issue is dealt with in the next section.

To analyse the effects of b2c e-commerce, a value system perspective is useful (Bradley & Nolan 2000; Rayport & Sviokla 1995). Value systems comprise a number of firms involved in the subsequent stages of a process of making a product (from the collection of raw materials to the delivery of the final product) for a consumer. This paper focuses on the downstream end of value systems, and uses the more common terminology of 'supply chains'. Supply chains entail information, physical and financial flows connecting firms and consumers. Information moves in two directions: upstream and downstream. Goods move downstream in the direction of consumers, while financial flows (payments) go upstream in the direction of suppliers. B2c e-commerce stimulates the ongoing process of consumer preferences increasingly

steering activities throughout a chain (Normann and Ramirez 2000), a phenomenon also called 'supply-chain reversal' (Lambooy & Visser 2001). Next, b2c e-commerce stimulates so-called 'supply-chain integration', i.e., ongoing efforts by leader firms in the chain to co-ordinate all actors and streamline their activities so as to improve collective performance: lower supply-chain costs and better service (Lambooy & Visser 2001).

Using a supply chain perspective, b2c e-commerce may have different effects:

1. Access to information of different actors in the chain.
2. The shopping and associated travel behaviour of consumers.
3. Activity patterns and associated travel behaviour of consumers.
4. The residential and work location choices of consumers.
5. The volume (quantity) and nature (quality) of consumer demand.
6. Distribution systems for the delivery of goods ordered through the Internet, which includes responses in the logistic and transport sector to deal with home delivery and other service aspects of b2c e-commerce.
7. The spatial patterns of these distribution systems.

The first four effects will be dealt with in the third section, dealing with individual travel. The last effects are dealt with in the fourth section, on freight transport.

We distinguish between direct and indirect effects of b2c e-commerce. Direct effects for accessibility can be large, considering the virtual dimension of this concept, which Dijst (2004) defined as 'the extent to which a given spatial-infrastructure configuration allows people to develop activities at different locations at a particular moment in time, and firms to exchange information and goods as well as to meet and receive people at a certain moment in time'. Accessibility thus includes the information action space of consumers and businesses, which b2c and also b2b e-business is likely to enhance. In the mobility sphere, the direct effects of b2c e-commerce include using the Internet instead of physical travel for shopping or non-shopping activities. B2c e-commerce may thus substitute for physical travel; other ways in

which b2c e-commerce may affect mobility are as a complement (e.g. when virtual contact adds to continued physical transport), a modifier (e.g., when virtual co-ordination helps to better use vehicles than in the case of individual planning) or as an incentive (e.g. when virtual contact stimulates physical travel). Finally, direct mobility effects may relate to adjustments in logistic and freight transport decisions and systems for the delivery of goods ordered through the Internet.

Indirect effects for accessibility refer to changes in the activity system of people and/or the configuration of supply chains, location choices and land-use patterns. These effects also affect mobility patterns in the long term (Salomon 1986), including modality choices and car ownership and use. If, for example, the spatial distribution of retailing changes as a result of a widespread adoption and massive use of e-commerce by consumers, then travel for traditional store shopping has to adjust to the new locations of retail stores. Another possibility is that (spatial patterns of) transport infrastructure changes, although so far, policy-makers do not seem to perceive a need to adjust infrastructure investment policies in the light of e-commerce (AVV 2002). An important point may be that physical accessibility continues to matter, as ICT-enabled activities of individuals and firms so far seem to complement, rather than substitute, physical mobility (Mokhtarian 2003). Hence, we consider the effects of b2c e-commerce for the spatial-infrastructure configuration of retailing, residential and employment centres, the downstream end of supply chains (distribution systems). Next, we consider the potential of logistic responses and innovations to alter the spatial structure of distribution systems and increase the geographical outreach of Internet retailers, thus changing spatial opportunities of people in different regions.

Before dealing with the effects of b2c e-commerce, we will first address social and economic factors constraining the adoption and diffusion of b2c e-commerce (Figure 1). These factors relate to attitudes, motivations and other characteristics of consumers, and to the information requirements associated with online purchasing of different types of products.

Social perspective – In the United States, the b2c e-commerce market has been growing fast,

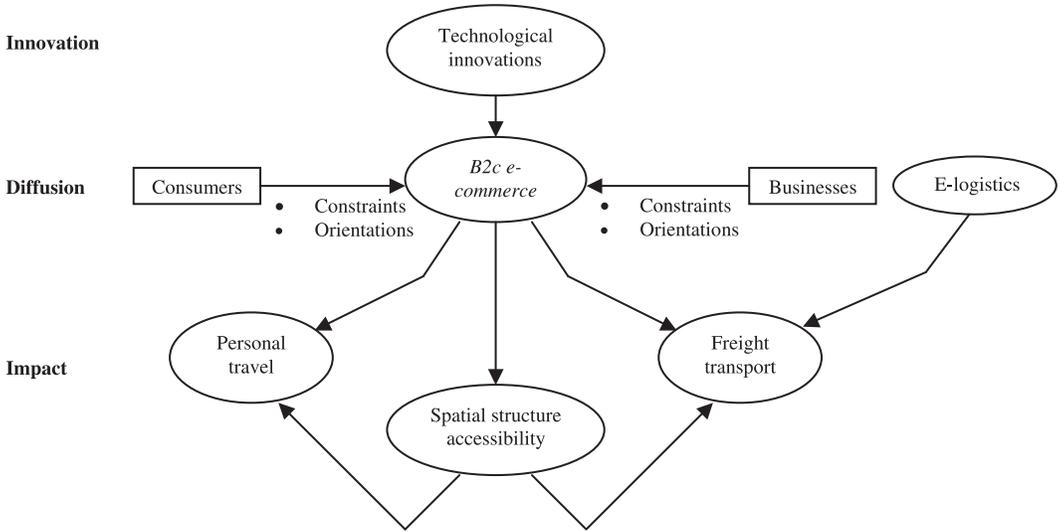


Figure 1. Conceptual model of the impact of b2c e-commerce on mobility and accessibility.

from \$20 to \$36 billion in 1999 (Golob & Regan 2001), to \$51 billion in 2001 and \$78 billion in 2002 (Forrester 2003). For 2003, Forrester (2003) expects b2c sales in the USA to grow by 'at least 25%'.

Despite this growth record, the number of households involved in online shopping remains modest. The OECD (2002) observes that in 2001, the share of households in North America and Northern Europe having access to the Internet varies between 40 and 60 per cent. The majority uses the Internet for communication purposes or to collect product information, whereas only 20 to 40 per cent of the Internet users have been involved in online shopping. This means that between 10 to 25 per cent of households in the most affluent countries of the world have engaged in b2c e-commerce at least once, while the share of b2c e-commerce in total b2c sales in the Netherlands in 2002 hardly exceeded two per cent, despite its fast growth (CBS data, in *Thuiswinkel.org* 2003). These rather low numbers relate to constraints regarding people's *ability* to engage in b2c e-commerce, and factors determining their *willingness* to do so.

The ability to engage in b2c e-commerce first depends on access to the Internet at home, the workplace or elsewhere (e.g. internet cafes). We assume that regular online shopping

requires people to have Internet access at a base point of daily activity spaces, for example at home. One reason for this is that online shopping can be a time-consuming process (due to information requirements, see below). Another reason is that delivery sometimes takes place shortly after an online purchase (e.g. 2 hours in the case of groceries), while home delivery is considered to be a core advantage of b2c e-commerce (Aanen *et al.* 2001). Hence, regular online shopping requires investing in a PC, modem, broadband, an Internet-capable TV (including a set-top box), or a mobile device. Gartner (2001) expects that b2c e-commerce continues to be primarily PC-based, but increasingly in combination with other platforms. Hence, people may spend on several devices at the same time. Using online facilities at the workplace is not always possible, as companies increasingly put limits to the private use of paid labour time. We conclude that people confront similar constraints whether using a PC, interactive TV and/or other devices to engage in b2c e-commerce.

Constraints are technical, educational, financial and spatial in nature. Problems with the security of payments over the Internet – whether perceived or real, are an example of technical constraints. Next, people probably need sufficient schooling and skills so as to master the use

of the equipment and services required to access the Internet. Next, financial constraints appear, related with the need to purchase and maintain (e.g. anti-virus software) equipment, the variable costs of Internet access (subscriptions and unit costs of telephone time), annual fees and income constraints related with the acquisition of a credit card, etc. Finally, spatial constraints relate to the availability and quality of virtual infrastructure and education, which differ across space, as well as to income inequality, which is especially relevant at the international level.

In connection with these constraints, age is likely to be an important aspect on which Internet users and non-users differ. Young people grow up learning English (so far the most important language used on the Internet) and computer skills at school, during their free time, alone and/or with friends. Other people may have to put quite some effort in the acquisition of these skills. Survey data for the United States (Casas *et al.* 2001; ACNielsen 2001) indeed indicate that Internet users are younger than non-users. Gender seems to matter less; the share of men and women was almost identical in both groups. Income is important though; online households more often have an above-average income (\$60,000 or more). Other characteristics that seemingly influence the likelihood of having Internet access at home are the household size, a female head of the household who is not older than 45, a college degree, full-time employment or living in a relatively affluent and well-established family.

Not all people with access to the Internet also engage in b2c e-commerce. With Internet access spreading across households, the share of Internet shoppers among Internet users remains relatively low. AC Nielsen (2001) found that 52 per cent of people with Internet access actually engage in b2c e-commerce, mostly (in order of importance) books, CDs, DVDs, videos, clothing, flowers, computer hardware, entertainment-related services, durable household goods, groceries and drugs. So, even when people have the money, education and skills to access the Internet, this does not mean that they also involve in b2c e-commerce.

Of course, income matters, and Internet shoppers are found to have relatively high household incomes (Casas *et al.* 2001). Gender

and age are also relevant, with middle-aged men more likely to engage in Internet shopping. However, Scarborough Research (2001) suggests that Internet shoppers above all lead an 'active, on the go' lifestyle, undertaking a trip abroad relatively often, attending more often professional sport events, subscribing more often to a health club, and so on. These people may put a higher value on the time-benefits of b2c e-commerce, but it also enhances their status.

Four other arguments can be found in the literature to explain the limited involvement of Internet users in Internet shopping. First, shopping trips are often part of trip chains; hence, shopping requires little extra effort and travel and is often part of routine behaviour. Second, the trade-off between shopping travel time reduction and extra costs of home delivery may only be in favour of b2c e-commerce in the case of time-pressed families with a double income (Gould & Golob 1997; Farag *et al.* 2003). Third, shopping often serves a discretionary or recreational purpose, for which Internet shopping can be no substitute (Salomon 1986). Finally, attitudes towards new technologies, towards the experience of something new or towards brick-and-mortar shopping may limit an individual's willingness to engage in b2c e-commerce, as has been shown in a comparative way for telecommuting (Mokhtarian & Salomon 1997).

To sum up, highly educated, preferably young but especially middle and high-income people are, in the authors' view, potential Internet shoppers. People currently engaging in b2c e-commerce may roughly be divided into two subgroups: time-pressed and double-income households, often with one or more children, for whom Internet shopping yields highly valued time savings, and people with an 'active, on the go' lifestyle, with sufficient financial means and educational skills and for whom Internet shopping is efficient and status-enhancing. In practice, these two profiles overlap. Table 1 gives examples of group profiles that we find interesting in the light of their propensity to engage in b2c e-commerce. Apart from the 'time-pressed' and 'active, on the go' profiles, we add young adults under 30 years with a high affinity with the Internet medium, who may become Internet shoppers once their income increases, and elderly people with sufficient financial means but limited physical capabilities,

Table 1. *Some household types and their affinity with b2c e-commerce.*

Household type	Affinity with b2c e-commerce
1. Young adults (< 30 years)	Skilled, frequently using the Internet, eager to know new things but with limited financial resources; not yet regular Internet shoppers, but likely to be so in the future, especially when living in rural areas.
2. The elderly (> 60 years)	Insufficient skills, sometimes with financial means and lacking certain physical abilities, but not at all time-pressed; hence limited involvement in b2c e-commerce, which may gradually change over the next two decades, especially when living in rural areas.
3. Time-pressed families	Highly skilled, double-income, time-pressured households with children and some affinity with new technologies; potential or present Internet shoppers, especially when living in rural areas.
4. 'Active, on-the-go-lifestyles'	Highly skilled, high-income, time-pressured professionals with a high affinity for new technologies; potential or present Internet shoppers, especially when living in rural areas.

whose skills so far may fall short of the requirements, but this may change once aging baby-boomers enter this group. We also expect that a residential location in a rural area enhances the propensity to engage in b2c e-commerce.

Economic perspective – A second set of constraints to the further development of b2c e-commerce is related with the type of products on offer on the Internet, in relation with the level of transaction costs and the potential of e-commerce to reduce these costs. Products differ on two related aspects: the availability of information about the quality and value of products, and therefore uncertainty about these aspects. In this section, we deal with these issues and present a product classification according to the likelihood that products are traded through the Internet.

We defined e-commerce as an Internet-based technology enabling the exchange of information so as to conclude one or more stages in a transaction process. The process dimension of transactions is crucial for understanding the importance of transaction costs and the prospects of e-commerce. As a transaction process takes time, and information about quality is incomplete, people will spend resources (time, money) to find information and make sure that the transaction, if any, will be in their interest. This gives rise to two types of costs: transport costs (related with physical travel) and so-called transaction costs, which can be defined as the

costs of economic exchange under uncertainty (Nooteboom 2002). Uncertainty not only refers to product quality, but also to the intentions and future behaviour of trading partners. This behaviour could derail during three stages of the transaction process: contact, contract and control (Nooteboom 1994).

E-commerce has the potential to reduce some transaction costs, insofar as information becomes available that was not available before (Pant & Hsu 1996; Garicano & Kaplan 2000; Nooteboom 2002). This effect may be largest in the contact stage of the transaction process (see Table 2). In the contract stage, firms also shift administration costs towards consumers. In the control phase, however, problems may arise of a nature that makes e-commerce less useful to exert 'voice' (to paraphrase Hirschman).

Suijker (2001) generalises the transaction-cost reduction argument, assuming that b2c e-commerce enables buyers and sellers to perform transaction activities more effectively (with better results) and more efficiently (at lower costs). Sale prices may decrease along with transport charges, the unit costs of Internet access, the opportunity costs of search time, as well as transaction costs. B2c e-commerce reduces transaction costs along with the opportunity costs of search time, but the other effects are still subject to debate (see for example, Schmitz & Latzer 2002). So far, the sale prices of some goods sold through the Internet remain relatively high, which may reflect a lack of

Table 2. *Transaction cost reductions due to e-commerce.*

	Consumers (buyers)	Businesses (suppliers)	Advantages of e-commerce
Contact	Search for product alternatives, become aware of needs and possibilities to fulfil them, match alternatives, and evaluate outcomes.	Look for selling alternatives, consider manifest or potential needs of clients, and determine their capacity to fulfil these needs.	Enhanced access to information implies better search, matching and evaluation possibilities. Efforts to enhance customer loyalty may reduce this advantage, however.
Contract	Negotiate the terms of a transaction, draft a preliminary contract, anticipate possible future problems, and propose changes in the contract.		Shift of administrative costs from sellers to buyers. Online planning systems reduce costs at his stage.
Control	Monitor the realisation of the transaction process, compare with contract details. Deviations lead to haggling, adjustment of contracts, sanctions or third-party mediation.		More information available through online control systems, e.g. tracking-and-tracing. In case of opportunistic behaviour, e-commerce is not a sufficient tool to handle problems.
During the entire process	Both parties invest time, effort and money in preventing misunderstandings, mistakes and misspecifications, incomplete fine-tuning or applications.		More and better (interactive) information facilitates ongoing communication.

Source: adapted from Nooteboom (1994), pp. 32–33.

ability or willingness of a critical mass of consumers to engage in e-commerce and associated dis-economies of scale and scope for firms, or a natural response of entrepreneurs when facing enhanced competition, i.e., to enhance the loyalty of e-shoppers through trust-building, branding, differentiation and customisation of products, and service; anything that helps to *reduce* competition.

Transaction and opportunity cost reductions are likely to be different for various types of products. Products differ regarding the need for information required to verify quality and make a purchasing decision (Chen & Dhillon 2003). Hence, certain products may not even be feasible for e-commerce. In this regard, the distinction between 'search, experience and credence goods' is useful. The quality of search products can be determined prior to purchase and consumption; examples are CDs, books, pre-classified groceries, or tactile products such as apparel, footwear or jewels. The quality of

experience products can only be assessed during or after consumption; examples are movies, holidays, etc. Credence products are products whose quality can hardly or never be determined, not even after consumption. So, buyers simply have to believe that consumption was useful. Examples are certain advisory services.

The more products have characteristics of credence products, the more trust is required for a transaction to take place, and the less likely it is that e-commerce contributes to building trust and enable the transaction. Firms invest in brand names to offset this problem, but it is likely that b2c e-commerce will gain less in the case of credence, and possibly also experience products, as compared to search products. Over time, consumers gain experience and suppliers may invest in their reputation and brand, so that a good that today qualifies as an experience good may develop into a search good in the perception of the buyer. Over time, the potential of e-commerce may thus increase.

With a view to the assessment of the mobility effects of b2c e-commerce, an important question is how activities at the contact, contract and control stage of the transaction process differ across search, experience and credence goods. In which cases and at which stage is proximity and face-to-face contact required, i.e. physical travel? When can the exchange of information take place through the wires? In the case of experience products, we hypothesise that consumers first collect information on well-defined aspects of shopping alternatives with the help of the Internet, and then go to a nearby store so as to verify those product features that are less clear (or to assure oneself that good advice will be available after signing the contract). In the case of search goods, the entire transaction process may take place with the help of the Internet, so that freight transport substitutes for trips of individual consumers. Other aspects to be taken into account are the frequency of purchases and availability of products (which in fact are the basis for another product classification that can be found in the literature, between convenience, shopping and speciality goods).

Concluding this section, it is observed that the growth potential for b2c e-commerce is largest in the case of search and experience goods, as transaction costs are not prohibitive and e-commerce has the potential of reducing this type of cost. Next, the travel impact of b2c e-commerce is likely to be largest in the case of search goods, although when taking into account freight transport, the net outcome remains unclear. In the case of credence products, physical travel and face-to-face contact and communication are likely to be required. A final comment is that the emphasis in this section has been on reducing transaction and opportunity costs, but the social (status) effects and pleasure that people derive from shopping on the Internet also need to be taken into account. These factors are beyond the scope of this paper, but enhance the uncertainty about the size of mobility effects of b2c e-commerce.

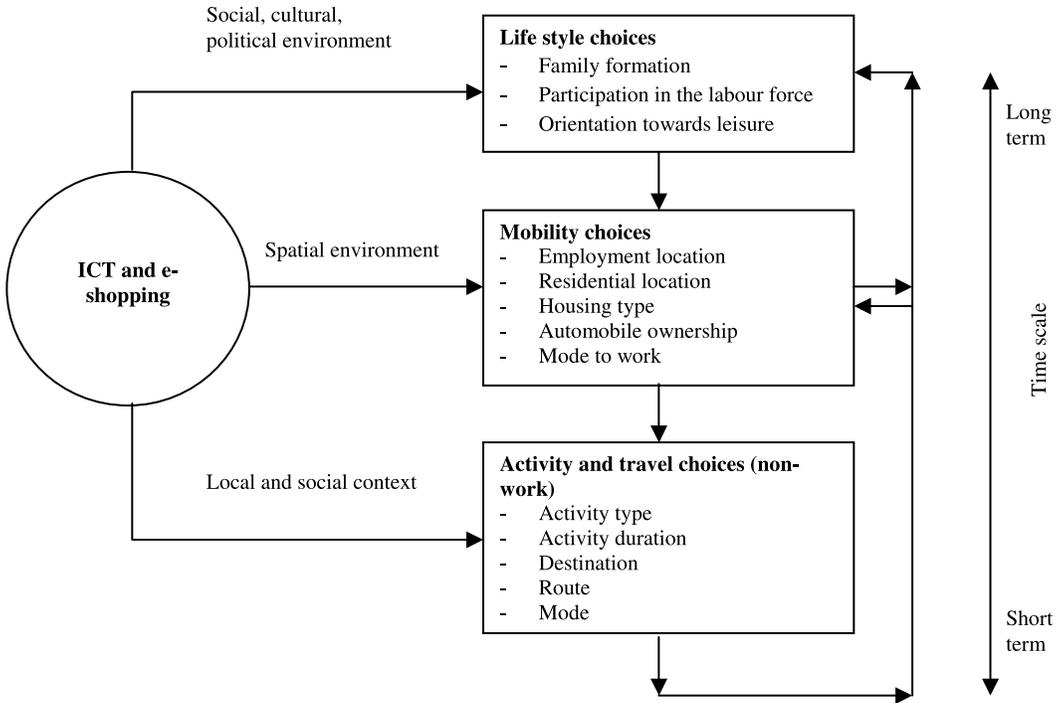
IMPACT OF B2C E-COMMERCE ON ACTIVITY AND TRAVEL BEHAVIOUR

This section deals with the effects of b2c e-commerce (e-shopping) for activity patterns, shopping and travel behaviour, along with life-

style, residential and work location choices of consumers. These effects are key issues in scientific and political debates, e.g. the possibility that new ICTs and e-shopping substitute for physical travel. At first, research showed a net decrease of physical travel for the case of telecommuters (Niles 1994; Pendyala *et al.* 1991). Recent findings, however, suggest that this is only a short-term effect. Over a longer time period, travel distances are not observed to decrease. One explanation for this could be that savings in commuting travel times and costs to some extent convert into other or longer trips for non-work activities (Mokhtarian 2000; Golob & Regan 2001). Next, residential and employment location choices may change, which in turn affect travel demand (Niles 1994; Pendyala *et al.* 1991; Golob & Regan 2001).

To assess the direct effects of e-shopping on travel, this paper uses a model suggested by Salomon (1983) that distinguishes between three types of travel related choices: long-term lifestyle choices (such as the formation of a family, labour market participation or orientation towards leisure), mid-term mobility choices (regarding employment and residential location, housing type, car ownership or the mode of travel to work), and short-term activity and travel choices that are non-work related (see Figure 2). These three choice types are discussed below.

First, the impact of new ICT (including e-shopping) on lifestyle decisions is hard to estimate. Casas *et al.* (2001) found that e-shoppers in the United States often have an 'on-the-go' lifestyle. A detailed analysis of the impact of new ICTs on lifestyles is not available in the literature, but we suggest that individualisation and the spread of new technologies go hand in hand. It is hard to discern a cause and effect relationship between the two processes, which can best be thought to represent a parallel change. New ICTs allow for distinct activity and life choices of individuals and, at the same time, lifestyle pioneers foster the dissemination of new technologies and activities (e.g. regarding leisure time), demanding and thus pulling new technologies. For example, the use of ICT for leisure activities is linked with a change in leisure orientations. As we consider the lifestyles of people to be relatively stable over a



Source: adapted from Salomon (1983).

Figure 2. Impact of new ICT technologies on travel related choices.

longer period of time, however, the associated changes in travel behaviour are beyond the scope of this paper.

Second, e-shopping may facilitate new mobility choices, albeit most likely in combination with other uses of ICT. Just as in lifestyle choices, mobility choices depend on a number of factors. Hence, we do not expect that e-shopping alone will have a directly measurable impact on mobility choices, although it may affect these to some extent once new decisions have to be made, and especially if e-shopping is combined with other uses of ICT. Regarding residential location choices, for example, a combination of regular e-shopping with (part-time) teleworking may offer opportunities to choose a location in more remote areas. A larger potential space of locations is available once the time scheduling becomes more flexible and living near a work or shopping location is less important. Research on telecommuters, however, suggests that they shop closer to their home than other people, often even within walking distance

(Pendyala *et al.* 1991). Hence, it remains unclear if telecommuters would substitute electronic for store shopping.

Car ownership is another important mobility decision that can be affected by e-shopping. There is solid empirical evidence that owning a car is a good predictor of car use, as well as the future use of alternative travel modes. Research on car-free households (where no member owns a car) suggests that taking goods from the store back home is perceived to be a major problem in everyday life (Reutter & Reutter 1996). For these households, e-shopping may solve a major problem and, hence, support the idea that car use is a major thrust of environmental qualities. If, however, e-shopping would affect the spatial distribution of brick-and-mortar shopping stores, and the average distance to the nearest store increases for households, then it becomes more difficult to shop near the home – a necessary condition for shopping for car-free households. In general, a good supply of shopping stores close to residential areas is a necessary

condition for reducing car travel for shopping purposes. Hence, enhanced e-shopping may indirectly reduce opportunities for shopping with slow travel modes, such as walking and cycling, and for living without a car. Ultimately, e-shopping may thus threaten the opportunities for living without a car.

Third, empirical evidence suggests that e-shopping influences activity and non-work travel decisions. Using a structural equation model and activity dairies, Gould and Golob (1997) conclude that e-shopping induced savings in travel times for working women partly converts into travel for other purposes, although most of the saved time is used for other activities (mainly maintenance) at home. However, in their 1999 household travel study in Sacramento (California), Casas *et al.* (2001) found no evidence that Internet shoppers travel less for shopping purposes than non-Internet shoppers, while the total number of trips between the two groups was not significantly different. To explain this, we refer to three characteristics of shopping activities and travel: first, shopping is not just a maintenance task, but often a social or recreational activity as well, which can thus not be substituted by the use of ICT; second, if shopping trips are chained with other activities like commuting, personal business or fun shopping, e-shopping does not necessarily reduce travel times or distances as the travel still takes place for the other purposes; third, it is not clear as to what extent e-shopping in fact substitutes for in-store-shopping. AC Nielsen (2001) reports that only 10 per cent of online shoppers in the United States purchase groceries online, which suggests a high degree of complementarity of online and store-shopping by e-shoppers. The travel impact of e-shopping, however, depends on the degree of substitution of online for store shopping. Above, it was suggested that the frequency of store trips largely depends on the type of product purchased. This is significantly higher for groceries than most other products; hence, it may be that the low share of online grocery shopping is one reason why the travel impact of e-shopping appears to be modest.

Finally, there is not much evidence on the effect of telecommuting or e-shopping on the modality choice. Evidence from the United States suggests that telecommuting makes car-pooling more difficult, as flexible work arrange-

ments lead to working only a few (parts of) days per week in the office and the other (parts of) days at home. Hence, it is more difficult to make an arrangement with other people to undertake joint car trips. In the case of Europe, the situation differs as the mode choice involves more than driving alone or with passengers.

IMPACT OF B2C E-COMMERCE ON DEMAND CHAINS AND FREIGHT TRANSPORT

This section deals with the effects of b2c e-commerce for various aspects of freight transport, particularly size, composition, duration, frequency, modality and spatial patterns, taking into account a variety of mechanisms:

- size and quality of consumer demand
- distribution systems
- responses in the logistic and transport sector
- the location behaviour of firms in this sector.

Demand effects – Above we saw that e-commerce may reduce certain costs of purchasing, such as transaction costs and the opportunity costs of search time, and in some cases also sale prices. These economies are likely to increase the market share of e-commerce, at least for some product types. In turn, this boosts the purchasing power of those consumers involved in e-commerce. Hence, they are able to buy larger quantities of products with the same income and time they have at their disposal. B2c e-commerce may therefore enhance the size of demand and the freight-tonne volume of transport (Smith *et al.* 2001).

Next, e-commerce may induce shifts in consumption patterns. TLN (2000) mentions three possibilities: an increase in impulse, long-distance and anonymous purchases, enhanced demand for products that can only be found with search engines, and enhanced demand for products that can only be bought on the Internet. Insofar as these shifts lead to longer physical distances that products travel before they get to the consumer, this further increases freight transport (in terms of tonne-kilometres, see Figure 3).

Some authors (see e.g. Mokhtarian 2003) raise the possibility of increased per-capita spending on consumption, due to special qualities of the Internet (convenience, the interactive nature of

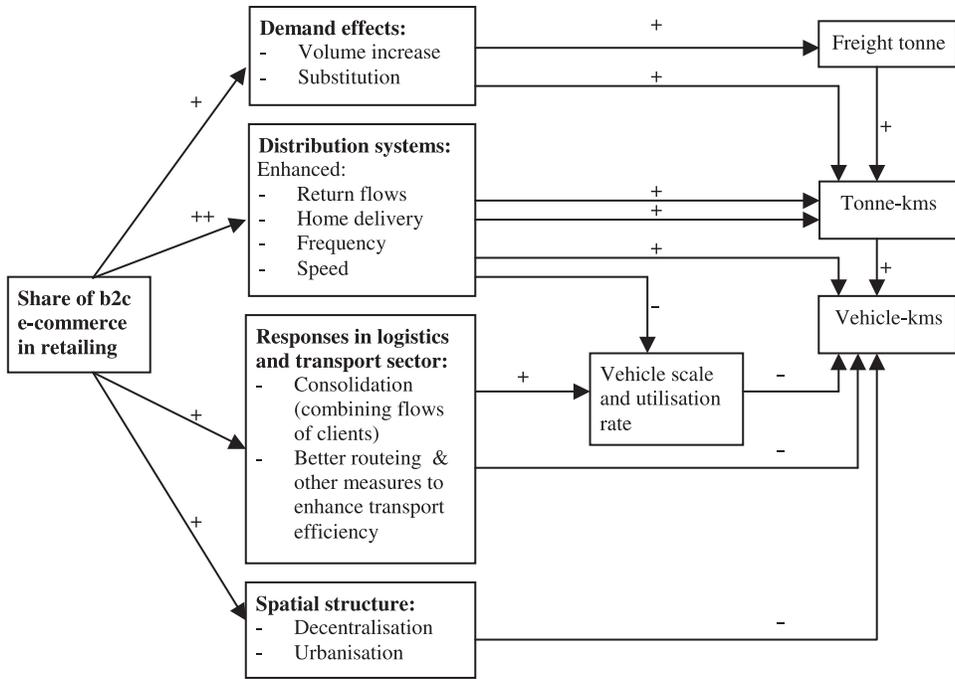


Figure 3. Effects of b2c e-commerce on freight transport.

communication, possibilities for highly customised marketing and products, and so on). This would further increase the volume of freight transport.

Distribution systems – Entrepreneurs often respond to enhanced competition by trying to increase the loyalty of their customers through branding, differentiating and customising products, and enhancing customer service. This last aspect is helpful to figure out the impact of b2c e-commerce on distribution systems. Customer service refers to the contact, contract and control stages of transactions. At the contact stage, 24-hour connectivity and information are important. At the contract stage, buyers need not worry about delivery time, timing, reliability and location, nor about the seller’s flexibility regarding delivery and product specifications. Also, options for on-site installation, advice and training should be offered. At the control stage, no deviations between contract and realisation should occur. Alternatively, consumers need guarantees, ways to complain, spare parts or additional information, for example on maintenance.

The customer service explosion (see de Wit & van Gent 1996) shows that logistics has become part and parcel of the marketing strategy of firms. The service offer at a website plays an important role in the e-shopping decision of consumers. Consumers promptly react to variations, changes and deviations regarding service. So, customer service is likely to shape new delivery systems and influence freight transport flows. This happens through an increase in both home delivery and return flows (see Table 3), as well as the enhanced frequency and speed of delivery.

Home delivery is a central feature of distribution systems for e-shopping (Visser & Nemoto 2001; Iding & Verduijn 2001). Although buyers may be prepared to accept delivery in a locker, drop box, special depot or a well-known shop in the neighbourhood, or at a gas station or at work (Aanen *et al.* 2001), home delivery is responsible for the largest effect of b2c e-commerce on transport and travel. Trucks and small vans substitute for consumers travelling to shopping centres. This increase in freight

Table 3. *Traditional distribution and e-commerce compared.*

Traditional retailing		E-commerce
Delivery at retail stores	Consumer's shopping trips	Direct home-delivery
<ul style="list-style-type: none"> • Large quantities • Homogeneous loads • Large trucks (vans) • One stop • Transport companies & own transport • Vehicle movements to and within shopping areas • No delivery failures 	<ul style="list-style-type: none"> • Small quantities • Heterogeneous loads • Passenger cars • One stop • Own transport • Vehicle movements between shopping and residential areas • Few delivery failures 	<ul style="list-style-type: none"> • One piece delivery • Heterogeneous loads • Small vans (trucks) • Many stops • Couriers and parcel services • Vehicle movements to and within residential areas • Many delivery failures

Source: Visser and Nemoto (2001), p. 13.

tonne-kilometres translates into an increase in vehicle-kilometres insofar as the scale of transport operations decreases (the size of vehicles is so far smaller than those used to supply traditional retailers, due to the still limited size of the market, infrastructure constraints, and speed requirements of e-shoppers) and delivery frequency increases (also as a result of failed delivery attempts). Next, home delivery leads to a deeper penetration of freight transport into residential areas.

In traditional retailing, delivery failures are relatively rare compared with b2c e-commerce, in which shoppers depend more on sellers to deliver the right product in the right way. The logistic service associated with b2c e-commerce needs to fine-tune timing and location of the delivery with the individual activity schedules of different types of consumers. So far, this appears to be too ambitious. B2c e-commerce generates relatively large return flows in terms of tonne-kilometres, first because one delivery often requires various delivery attempts, and second because of goods being returned to the seller after reception and inspection by the e-shopper – often a necessary condition to purchase goods online.

The final two customer service aspects that may influence distribution systems and freight transport are the enhanced expectations of consumers, also in rural and remote areas, regarding the frequency and speed of delivery (Smith *et al.* 2001). One should not overstate this, however, as Internet sellers often offer few delivery time options, e.g. within four, eight or twenty-

four hours. Next, outsourcing transport services and decentralisation of delivery systems may further mitigate the freight transport effects of enhanced speed and frequency.

On the whole, we conclude that the customer service-aspects of b2c e-commerce are particularly important in enhancing the volume of transport, in terms of the number of tonne-kilometres and vehicle kilometres (see Figure 3).

Responses in the logistic and transport sector – B2c e-commerce implies a struggle to combine the fulfilment of enhanced service requirements of e-shoppers with a cost-effective delivery. Internet sellers may find this too complicated a task and decide to outsource distribution activities to specialised logistic service providers. The latter may be better able to optimise freight transport associated with b2c e-commerce, for example by combining cargoes of different clients, working in high-demand areas only, combining delivery and return services, switching from cars, vans and trucks to bikes and motorbikes or water transport, e.g. for inner-city transport, using ICTs for better logistic planning and control, reconfiguring the supply chain (decentralisation, to be discussed below), or developing new logistic concepts, e.g. cross-docking (also to be discussed below).

Regarding the use of ICT, a distinction should be made between e-logistics (the purchase of logistic or transport services through online marketplaces, by shippers or a first-tier logistic service provider) and the wide range of ICT-enabled operational planning and control

systems that can help to improve transport efficiency, such as advanced planning and scheduling (APS), used to optimise supply chains and measure performance, enterprise resource planning (ERP), used to optimise warehousing processes, routing software, mobile communication, board computers (a 'black box' containing logistic data for evaluation purposes), tracking-and-tracing and global positioning systems (GPS).

These countervailing measures of individual firms may not be enough to counteract the freight transport effects of b2c e-commerce. Stand-alone initiatives are generally unlikely to have sufficient impact. Co-operation between various actors in supply chains may be required to contain freight transport enhancements due to b2c e-commerce.

Spatial and related changes in supply chains –

A more structural manner in which Internet sellers or their logistic service providers may combine enhanced service with a cost-effective delivery is to locate the distribution centres near the homes of consumers. Hence, e-commerce may lead to a process of decentralisation of the most downstream end of distribution systems, especially in high-demand, urban and metropolitan areas where the scale of operations is sufficiently large to justify the construction of dedicated distribution centres. Decentralisation obviously improves service and lowers transport costs, by reducing the distance between the distribution centre and clients, creating economies of scale in upstream transport costs (from producers of goods to the suburban distribution centre) along with economies of scale and scope in downstream transport costs. The latter scale effects are contingent on the size of the market and hence on possibilities to consolidate deliveries to a large number of e-shoppers. On the other hand, decentralisation induces an increase in depot costs (related with the construction of the site, capital and handling costs of stocks, etc.). The trade-off between increased depot costs on the one hand and enhanced service and lower transport costs on the other hand thus determines the degree of decentralisation. In line with this, Vermunt & Binnekade (1999) observe a trend towards cross-docking activity in distribution centres. This means that the latter lose their storage function and in

turn facilitate fast transshipment of goods and consolidation of flows originating from producers or upstream distribution centres. Cross-docking thus helps to contain storage costs and to increase speed.

Evaluation – So far, the analysis of the freight transport effects of b2c e-commerce indicates that the latter increases in tonne volume terms (due to a one-off positive effect on demand and economic growth), alters spatial patterns of freight transport (due to shifts in consumption patterns), enhances service requirements of consumers (with considerable freight transport effects), and stimulates advancements in logistic and transport technology, along with outsourcing and the decentralisation (sub-urbanisation) of distribution systems (see Figure 3, which summarises the various effects dealt with in this section).

The mitigating effects of outsourcing to logistics firms and technological development in the logistic and transport sector are most relevant in urban areas, where the concentration of demand warrants sufficient economies of scale so as to enable the consolidation of flows, the decentralisation of distribution systems and other measures that contain the increase in freight transport vehicle-kilometres. Hence, the potential for countervailing measures is largest in urban areas, where the growth of b2c e-commerce and associated freight transport is also largest. It should be kept in mind, however, that b2c e-commerce induced freight traffic so far appears to complement – rather than to substitute, freight transport generated in traditional distribution channels. Hence, it appears that in urban settings, the overall effect of b2c e-commerce on freight transport is an increase in volume, tonne-kilometre and vehicle-kilometre terms, despite ICT-enabled logistic innovations and decentralisation of downstream distribution in urban areas.

ACCESSIBILITY EFFECTS OF B2C E-COMMERCE: HYPOTHESES FOR GROCERY E-SHOPPING

In this section, a few hypotheses are formulated regarding the mobility and accessibility impact of e-shopping, assuming an increasing use of the Internet for buying groceries. A special feature of e-grocery shopping is that for maintaining a regular household, at least one, but often

more shopping trips per week are required. The effects of e-grocery shopping for activity and travel patterns are dealt with first, and then indirect effects for freight transport due to changes in distribution systems, and for individual travel and freight transport combined due to a changing spatial distribution and accessibility of brick-and-mortar stores are examined. It is noted that the spatial distribution of grocery stores in most European countries is characterised by the relative importance of small shops in urban areas compared with large-scale hypermarkets and shopping malls at the edge of cities (see e.g. Evers (2001) for the Netherlands). We assess the accessibility effects of e-grocery shopping from this European perspective.

For activity scheduling, it is hypothesised that e-grocery shoppers use the net time savings for longer periods of social, recreational or leisure activities, at home or outdoors. The mobility impact is largely unknown, however. First, the share of (grocery) shopping time per week is low compared to that of other activities. Next, shopping is frequently trip-chained with other activities. So, the stand-alone effect of e-shopping on time budgets and travel reductions is probably small. Together with other ICT activities, however, it may facilitate considerable changes in individuals' time budgets, activities and travel patterns. This interaction effect is likely to differ across social groups, however, as social and economic constraints hinder large groups in society to participate in e-shopping, or to prefer traditional shopping for social or recreational reasons. This may be true for the elderly, despite their relatively poor physical health and associated mobility problems, as this group has limited skills in using Internet-based ICTs, and often combine shopping with social activities. Clearly, social differentiation has a spatial dimension; different social groups are not evenly distributed across space, due to some extent to different location preferences.

An important indirect effect of b2c e-commerce for freight transport is due to changes in distribution systems. For online grocery shopping, these follow the general logistic rule that service be maximised (regarding speed, frequency and reliability of delivery) at the lowest logistic (i.e., depot and downstream transport) costs possible. In line with this prediction,

a Dutch online grocer was observed to decentralise the downstream end of its distribution system and stimulate cross-docking of fast-moving products (van Hofwegen 2002). The urban bias in its geographical market coverage results from the two-hour delivery guarantee for customers living no more than 25 kilometres from one of the three distribution centres run by the grocer, and the decision not to outsource logistic and transport functions (for service-related reasons). Hence, this grocer concentrates on a market area with a minimum of 500,000 households, so as to reap economies of scale in depot and urban transport costs. These are relatively high, as delivery trips are longer – the goods are carried 'into a client's kitchen', and more frequently than in the traditional (retailing) situation. Small vans and trucks drive deep into residential areas, yielding a relatively large number of dispersed deliveries – efforts to bundle deliveries and achieve efficient route planning notwithstanding.

Any attempts towards geographical market extension are subject to similar rules and trade-offs, between service and cost levels, market potential and the optimal location for relatively small depots serving a large number of customers. Relatively dispersed consumers in peripheral areas can only be served using the existing distribution structure, until the construction of a new depot becomes feasible, which is a matter of scale (of the market, the number of clients, order size and value). Until then, consumers in these areas need to be prepared to pay for additional transport costs, and to accept a less speedy service.

Meanwhile, in the same regions, the number of traditional supermarkets and shops is decreasing as a result of insufficient demand and related dis-economies of scale and scope. This process is thus underway, but may be stimulated if and when online grocers manage to expand the geographical areas they cover, thus making their services available and accessible for consumers in more peripheral regions. Hence, trends in e-shopping demand and traditional supply channels work in the same direction, of e-shopping services spreading and traditional services thinning out, in the peripheral and rural but perhaps also in urban areas.

To sum up, it is hypothesised that e-grocery services have some potential to migrate towards

rural areas and thus to mitigate, albeit to some extent, the trend towards a diminishing accessibility of traditional shops for rural consumers (see e.g. Evers 2001). With this, the mobility enhancing impact of b2c e-commerce may also spread. Congestion, noise, pollution and lack of parking space constitute more of a problem in urban areas, however. There, distribution of goods ordered through the Internet will over time provide urban (transport) planners with a huge challenge. However, if e-commerce stimulates the closing of traditional grocery stores in remote areas, this may cause a spatial redistribution of other traditional stores as well, in the direction of places where demand concentrates. Hence, the physical accessibility of traditional shops would reduce for consumers in remote areas, affecting their travel patterns for other shopping purposes, the need to have a car, etc. Assessing these effects of electronic (grocery) shopping across regions is a complex task, but will have to be performed, as they may become relatively important in the future.

CONCLUSION

In this paper, the mobility and accessibility effects of b2c e-commerce were analysed by means of a literature review. The distinction between direct (short-term) and indirect (long-term) effects for both virtual and physical accessibility as well as for the travel behaviour of consumers and the freight transport behaviour of firms was established. The direct mobility impact of b2c e-commerce is relatively clear. There is no reason to expect that consumers will travel less; their travel demand for non-shopping purposes may even increase. Considering both freight transport and individual travel, we expect an overall increase in mobility, which is especially due to home-delivery and customer-service enhanced freight transport substituting for the shopping travel of consumers. This process has so far been largely confined to urban areas, and mainly suburban residential areas.

The indirect (long-term) changes for physical accessibility and mobility are harder to deal with, for practical reasons (time lags, lack of data), methodological problems, the number of choices involved, the complexity of the relationships, and the relatively high level of

uncertainty. This paper nevertheless shows that the current process of decentralisation and suburbanisation of distribution systems for b2c e-commerce may gradually extend towards more remote and less densely populated areas, as has been seen in the example of online grocery in the Netherlands. This, however, may contribute to the ongoing process of the closure of traditional retail stores in these areas, thus limiting physical accessibility of such stores for non-urban consumers and enhancing the utility of e-commerce for this group of people. As a result, average trip lengths and car use for shopping trips may increase. As freight transport also increases due to b2c e-commerce, the overall effect will be an increase in motorised mobility throughout the country, with only urban consumers being able to save time and trips for shopping purposes, but consumers elsewhere adding time and distance to their travel burden.

The size of the mobility and accessibility effects of b2c e-commerce varies between product categories, however. In the case of search and experience (including tactile) goods, it has the potential of reducing transaction costs and there is growth potential for b2c e-commerce. Its travel impact may thus become significant over time – although when taking into account freight transport, the net outcome is less clear. In the case of credence products, transaction costs are prohibitively high, b2c e-commerce is not likely to take off, face-to-face contact and physical travel remain necessary, and the overall mobility impact could be negligible. Next, social status and the pleasure that people derive from shopping also needs to be taken into account. These factors also enhance the uncertainty about the mobility and accessibility impact of b2c e-commerce over time.

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