CLICKS VERSUS BRICKS ON CAMPUS: ASSESSING THE ENVIRONMENTAL IMPACT OF ONLINE FOOD SHOPPING.

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Abstract

There is some debate concerning the relative environmental impacts of online shopping (clicks) and conventional shopping (bricks) (Sui and Rejeski, 2002; Abukhader and Jonson, 2003; Hesse, 2002). With e-tail spending in general having increased by over 400% in the last 4 years and 17.5% of all retail spending now taking place online (IMRG, 2008), it is important to understand the environmental consequences of this shift in purchasing behaviour. The debate is particularly fierce in the groceries sector, with several of the large British supermarkets proclaiming the environmental benefits of their online operations. The truth behind these claims is very difficult to assess because of the complexity of the "last mile" issues involved in comparing groceries sold online and conventionally.

In order to gain an insight into the travel issues associated with online and conventional grocery shopping, a survey was carried out on the students of Heriot-Watt University's Edinburgh campus in April 2008. This paper contains an analysis and discussion of the results of the survey and discusses the implications for green logistics. It shows that students shop for food online less than the general population and that their shopping online for food is statistically correlated with car ownership, where they live and nationality. Overall it appears that shopping online has made very little difference to the monthly car mileage of the respondents.

Key words: home delivery, consumer travel behaviour, grocery distribution, online shopping.

Introduction

Shopping is a huge generator of travel. In Great Britain, the average person makes 219 shopping trips a year, accounting for 21% of total trips made. This is greater than the 160 trips per year made for commuting (DfT, 2006). Of the 219 trips, 42% are made as car drivers and 21% as car passenger. In terms of mileage, each person travels an average of 926 miles per year on shopping trips, 82% of which is done in a car. Over the last ten years, the average number of shopping trips per person has dropped by 7%, but the average length of trip has increased by 9% as people abandon frequent trips to local shops in favour of less frequent trips to edge-of-town or out-of-town centres.

The environmental impact of these trips is considerable. Defra (2007) has calculated that cars produce 54% of the carbon emissions of transport, which itself accounts for 28% of the domestic emissions of CO_2 by source[1]. Defra calculates that each medium sized petrol car emits 136 grams of CO_2 per passenger kilometre (costing between £20 and £100 per tonne, depending on whose value is used). The ONS (2004) calculated that emissions from private vehicles arising from household personal use of transport (of which, shopping is a major component) amounted to 17.7MtCO_2eq[2]. Since vehicle miles travelled (VMT) is the main aggregate variable determining transport's carbon footprint, methods to reduce car use are constantly being sought. One potential candidate for this is online shopping.

Literature Review

Over the years, there has been a great deal of debate about the net impact of the use of information and communications technology (ICT) on travel and transport, particularly its impact on energy use and the environment. Much of the research is confined *either* to the effects on passenger travel *or* on the effects on freight transport (for a review of the research in this area, see Yi and Thomas, 2007). The overall theme of much of the passenger travel literature on the relationship between the environment and ICT is to determine to what extent the relationship is substitutional or

[1] Source figures allocate emissions according to where the fuel is consumed and so do not attribute emissions arising from fuel refining or electricity generation to the transport sector but to the energy sector.
[2] 1 tonne carbon = 3.67 tCO_2eq(uivalent)

complementary. Substitution refers to the extent to which ICT replaces physical travel (for instance teleconferencing replacing the need for physical meetings) whereas complementarity refers to the extent to which use of ICT is *in addition to* physical travel (for instance people may browse in shops as well as ordering from the internet).

Apart from the direct substitutional and complementarity effects arising from the use of ICT, there is a growing literature on what is termed the "rebound effect". Erdmann *et al* (2004, p5) define the rebound effect as being "effects which occur when the efficiency gains stimulate new demand that counterbalances or even outweighs positive environmental gains." Sui and Rejeski (2002) suggest that there is great potential for positive environmental impacts in terms of the 3 Ds; namely dematerialisation, decarbonisation and demobilisation. They suggest however, that because of the rebound effect, many of the benefits do not actually materialise. They conclude (p158) that "the law of entropy points to the inevitability of environmental degradation no matter how sophisticated our technologies are." Reijnders and Hoogeveen (2001) argue that the increased growth enabled by ICT will inevitably lead to greater environmental problems because it leads to greater consumption of goods and that energy consumed in the production and use of the computer reduces the environmental benefits considerably. Rejeski (1999), in Germany, found that people using online bookstores spent twice the average amount that they spent in conventional bookstores, so the net environmental impact was negative.

So to what extent is online shopping a substitute for physical travel? The RAC foundation (2006) found that 80% of online purchases still resulted in a physical journey. As Mokhtarian (2004, p6) puts it: in e-shopping "products are detached from the physical cues afforded by a bricks-and-mortar store". Consumers therefore are likely to browse before purchasing online. In terms of shopper's behaviour, people are social beings. Mokhtarian (2004, p9) suggests that "It is likely that a number of shopping trips are "invented" in order to justify (often subconsciously) an urge simply to get out and go somewhere." In the same way as telecommuting has not made an appreciable difference to peak traffic levels, it could be that online shopping will not necessarily reduce the number of car trips. Instead of driving to the shops, maybe people will drive to the gym or to reading clubs etc. Without detailed empirical research over a period of time, the overall impact will remain unknown.

On the freight side of the relationship between e-tailing and the environment, the position is also very complex. Much of the focus of the research on the freight aspect is on the problems of "the last mile", i.e. the final segment of the journey from company to consumer. This involves issues such as vehicle types, drop densities, geographical coverage, returns, "not at homes", delivery windows and load consolidation. In addition to this, there are issues of the building of additional e-fulfillment centres, the greater use of air freight transport, the wider geographical sourcing of both inputs and final products and the greater choice of products on sale. Cairns (2005), models the impact of home deliveries of groceries specifically on traffic and suggests that online grocery deliveries could reduce vehicle km by at least 70%. Although she briefly considers some of the indirect affects in her discussion of the validity of her and others' models, she still concludes that there will be a substantial reduction in traffic. She suggests that the grocery market is somewhat unique however, in that it is "typically a trip least valued in its own right" and is highly car dependent because of the need to carry things. The implication is that there is less likelihood of complementarity in this sector than others.

Mokhtarian (2004) sets out a conceptual analysis of the impact of online shopping on travel, based on a more aggregate economic consideration of some of the indirect effects. On the personal travel side, she states that many shopping trips are made as part of a trip chain and the amount of travel reduced by ordering online is actually quite low. On the freight side, amongst other things, she addresses the possibility that because goods are cheaper online, more will be demanded and this in turn will increase the number of deliveries made. Additionally, online ordering increases the potential for goods to travel further as they can be ordered from anywhere in the world. She also looks at the changing demographics to assess likely influences on aggregate demand and therefore freight movements. Overall she comes to the conclusion that "the combined outcome of all factors does not appear to support any hope that e-shopping will reduce travel on net; to the contrary there may be negative impacts due to increased travel, even if those impacts are likely to be localised and/or small in magnitude for the most part."

Similar arguments are raised by Hesse (2002, p229) who argues that e-tailing is just another step in the development of logistics structures which will not impinge on cultural mores. He suggests that

shopping is a cultural experience and that "new technologies are deeply embedded in culture and in social practices, in daily routines and habits that are far from being rapidly changed by new order-and-delivery services." On the freight side, he argues that e-tailing will result in a greater propensity to use air transport (environmentally more damaging) because of both the time sensitive nature of e-tailing and the ability to order and source goods from further afield. He also argues that huge e-fulfilment and consolidation centres will need to be built (and that they will not replace the traditional warehouse, but will be in addition to them), often on green-field sites, to cope with the distribution of products bought online.

Although there exists quite a large body of research on the impact of ICT in general on total vehicle km travelled, the fact remains that little research has been undertaken into the consumer travel behaviour associated with online versus conventional shopping specifically. Indeed, Foley et al (2003) goes as far as to describe this as a 'major imponderable'. In order to produce a full assessment of the environmental impact, passenger travel behaviour must be combined with an analysis of the freight movements involved in home delivery. Additionally, any analysis must include an understanding of the substitution effects.

Before we go on to the empirical work, it is important to establish why it is so necessary to have an understanding of the relative environmental consequences of clicks vs bricks. Estimates of B2C e-tailing vary according to source (and is dependent on what is included in the definition). According to IMRG (2008), e-retail spend in the UK now amounts to £46.6bn (17.5% of total retail shopping), with 27m e-shoppers. The growth in e-tailing is quite astonishing: Since 1995, annual growth rates in consumer e-tailing have averaged over 100% and in 2007 was 54%. E-tailing is obviously dependent on household internet access. In 2007, 61% of households in the UK had internet access and 84% of those had broadband (ONS, 2007). Grocery shopping is one of the biggest e-tail shopping categories. Between January and April 2006, 20% of adults aged 16+ had purchased food or groceries online in the previous 12 months (ONS, 2007). According to Mintel (2007), grocery store-based e-tailing accounted for 21% of the total e-tail market and online sales at Tesco, the largest UK grocer, topped £1bn in 2007.

The Research Question

Many retailers are making claims about the environmental benefits of online grocery distribution. For instance, Jonathan Faiman, co-founder of Ocado, who do the on-line deliveries for Waitrose supermarket, claimed for instance that "each Ocado van replaces up to 20 cars on the road which overall can result in huge savings of unnecessary car journeys" (Guardian, 2007). The environmental section of the Tesco website boasts that each delivery van saves 6000 car journeys per year. These claims have never been proven and their validity is questionable.

One of the long-term aims of the Green Logistics Project (of which this paper is part) is to assess the carbon footprint of online versus conventional shopping through an analysis of consumers' shopping habits, together with an analysis of the associated freight movements nationally. However, as the literature review above reveals, the issue is very complex, so it was decided to pilot the study with a survey of the food shopping habits of students at the Heriot-Watt campus. The advantage of so doing is that students are a self-contained group with relatively simple lives and this would allow a fairly detailed picture to be built up to serve as a base for the more complex study to follow.

Methodology

Heriot-Watt University campus is located on the outskirts of the Edinburgh (the capital of Scotland) approximately 3 miles from the nearest supermarket. It has 1300 residents living on campus and 4700 students living off campus. The survey took place on two consecutive days in April and consisted of a self-completion questionnaire administered by two of the authors of this paper (with some help from the Students Association). The subject of the survey was food shopping rather than grocery shopping. The reason for this was that the definition of groceries is in practice quite imprecise and means different things to different people. This, coupled with the fact that many of the students come from Overseas with English as a second language, led to the decision that "food" shopping (specifically excluding takeaways) was a more appropriate wording. Students were approached at cafes and

seating areas around campus. A total of 358 questionnaires were completed (the refusal rate was very low), divided equally between male and female students.

Results of the survey

An analysis of the data showed some surprising results. In total, 83% of the sample had not shopped online for food. A further 10% of the sample bought less than a quarter of their food online. This means that the student sample shopped for food online less than the general population (ONS, 2007). As the survey was of young people (84% of them were 25 years old or younger), it might have been expected that they would have been more likely to shop online as they are likely to be familiar with using computers for many purposes.

Mokhtarian (2004) suggested that the reasons for shopping online were: larger choice of goods, lower prices, greater information, less need to be sociable and greater convenience and speed. Reasons why respondents in the survey shopped online are given in table 1 below.

Table 1. Reasons why respondents food-shop online

Reason	*Average score (max=4)*
It saves me having to carry things	3.38
It gives me more time to do other things	3.31
I only buy what I need rather than buying luxuries	2.72
I can choose the shop I want to buy from	2.65
There is a better choice of goods online	2.45
Products are cheaper online	2.36
I don't like shopping	2.15
It is better for the environment	2.13
I have a physical difficulty getting to the shops	1.82
It saves me having to park	1.67

N.B Average scores are calculated from a Likert type question.

It is clear that the responses of the students are not altogether in line with Mokhtarian's analysis and that choice and price actually come second to the physical convenience of not having to carry things and having more time to do other things. The third highest average score on the agreement scale is one which has been heard anecdotally, but has not been suggested in the wider literature. The idea of confining spending to what is needed rather than what is attractive is also confirmed by the finding that 47% of respondents said that they spend less online than they used to when they physically visited the supermarket (with 32% saying that they spent the same amount). It could be the case that this reason is confined to the student population (as they are generally on a low income). This needs to be tested in a more general survey. If they are buying fewer items because they shop online, this is better for the environment and could be viewed as contradicting some of the rebound effect arguments as espoused by Sui and Rejeski (2002) and others. However, this depends on what else the money saved is being spent on!

Whether or not respondents shopped online is significantly correlated with age (those aged 26+ are significantly more likely to shop online than those under the age of 26). This could be associated with income or the presence of other commitments requiring more of a juggling of time – the cause is impossible to discern from the survey.

Overall, 39 nationalities were represented in the survey. For analysis purposes, these were divided into 4 groups (British (58%), other European (20%), Asian (16%) and other (6%)). Asians are significantly more likely to shop online than other nationality groups (P=0.031). There was no difference in the percentage of British respondents who shopped online compared to other Europeans. This is surprising as it is generally felt that the British do a lot more online shopping than other Europeans. Finally respondents who live on-campus are significantly more likely to shop online than respondents who live off-campus (31% compared to 12%). This is not really surprising as students living on-campus have no immediate access to shops, whereas students living off-campus are likely to have much greater access.

Overall, 38% of the respondents either owned or had access to a car (much lower than in the general population). Ownership of a car is highly correlated with whether or not respondents live on campus (with only 2% of respondents who live on campus having access to a car compared to 50% of those living off campus). Interestingly, owning or having access to a car is highly significantly linked to whether respondents shop online, as is shown in table 2.

Table 2. The relationship between having access to a car and shopping online.

	Shop online	*Don't shop online*	*Total*
Own/access to car	9 (7)	118 (93)	127
No access to car	48 (24)	156 (76)	204
Total	57	274	331

P=0.000. Figures in brackets are row percents

Thus 7% of those who own a car shop online compared to 24% of those who do not own a car. It is clear from this that online shopping is useful to those who do not own or have access to a car. This is supported by the earlier finding that not having to carry shopping was seen as the main advantage of shopping online. This relationship between car access and whether or not respondents shopped online suggests that as respondents' incomes increases in the future (and their tendency to own a car increases) the likelihood of them shopping online will decrease. However, this is contradicted by the earlier finding that older respondents are more likely to shop online than younger respondents. It seems likely that the major explanatory factor in the likelihood of shopping online is the location of the students (i.e. whether or not they live on campus). This requires further analysis of the data. The causal direction of the relationship between car ownership and residential location is unclear. It could be that students who own a car opt to stay off campus, or alternatively it could be that students that live off campus feel the need to own a car to travel to the University. The vast majority of students who live off-campus live either in the centre of Edinburgh or in its suburbs, with access to local shops.

Thinking about how the relationship between residential location, car ownership and shopping for food online relates to the population as a whole, this might suggest that people who live in rural areas (or suburbs without shops), particularly those without access to a car, are likely to be the big internet shoppers. This has implications for the delivery side of the equation. Without further analysis of the existing data and further study of the wider population, this must remain a speculation.

There is a suggestion above that having access to a car reduces the tendency to shop online for food. The results of the survey suggest that the reverse is also true, i.e. that being able to shop online might actually reduce the need to have a car, as shown in table 3.

Table 3. Attitudes to online food-shopping issues by online shoppers

	Strongly agree	*Agree*	*Neutral*	*Slightly disagree*	*Strongly disagree*	*Not applicable*
I think it is better for the environment than going to the shops	3 (5)	15 (27)	24 (43)	6 (11)	3 (5)	5 (9)
It has encouraged me to buy other things online	9 (16)	19 (33)	14 (25)	8 (14)	6 (11)	1
It has reduced the need for me to have a car	5 (9)	12 (21)	10 (18)	5 (9)	9 (16)	16

N.B Figures in brackets are row percents.

Thus, 30% of respondents agreed with the notion that online shopping reduced their need for a car. In environmental terms, this is a very important finding. If the ability to shop online reduces car ownership (and therefore, use), in the general population, this would be of significant interest environmentally. Unfortunately for the environment, there is also evidence that the ability to shop online also influences people's residential decisions and encourages them to move further from their workplaces thereby increasing their total mileage (Shen, 2000)!

Table 3 also indicates that shopping for food online also encouraged respondents to use the internet to purchase other goods. This may or may not be a good thing for the environment. Attitudes of respondents suggest that they believe it not to be worse for the environment than shopping conventionally!

Seventy-four percent of respondents who shopped online for their food joined together with others for a delivery. This percent was greater for those living on campus, but those living off campus were still inclined to do this. The mode number of people they shared with was 2 (34%), but 27% shared with 3 others and the same percentage shared with 4 others. This is a habit which is probably largely confined to the student body to reduce the impact of delivery charges, but it is possible that it occurs in some other sections within society. Environmentally, this is a positive action as it reduces both car and delivery vehicle mileage compared to one-to-one deliveries. It is something that could be encouraged nationally and something which unattended delivery systems (such as street based drop-boxes) could facilitate.

When asked about what mode of transport the respondents who shopped online used before they shopped online, 33% used private transport (by car either on their own or with friends) and 67% either walked (15%) or took the bus (52%). Furthermore, 37% of those who shopped online said that they still visit the shops as frequently or more frequently as when they shopped conventionally. From these two findings, it seems that the net reduction in private transport mileage is going to be fairly small. Indeed, only 1 respondent stated that online shopping had reduced their monthly car mileage!

Conclusions

The relationship between online shopping and the environment is a complex one. In the survey of students reported in this paper, only a small percentage of respondents actually shopped online for their food. There was a positive correlation between shopping online for food and nationality, residential location and car ownership. Because of the strength of the negative relationship between car ownership and shopping online, the overall difference to vehicle mileage made by the ability to shop online was minimal. The tendency of students to group together when making online orders is probably the most beneficial aspect for the environment as this reduces vehicles miles travelled by both passenger and goods vehicles.

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