An investigation into the geography of corporate e-commerce sales in the UK grocery market

Abstract

E-commerce is one of the fastest growing sectors of the UK retail economy. The vast and rapid expansion of internet usage has generated widespread on-line sales, making the UK one of the leading countries for e-commerce. There have been a number of important papers on the geodemographics of e-commerce usage based on the results of surveys. These have shown that geography is important in understanding e-commerce sales: especially when we disaggregate sales by age and social class for example. However, there have been fewer studies analysing the geography of actual on-line sales provided by retail companies. The aim of this paper is to investigate the geography of e-commerce activity in more detail, especially as seen in UK grocery retailing. It will be concerned exclusively with transactions between businesses and consumers (B2C) rather than either business to business (B2B) or consumer to consumer (C2C). The paper makes extensive use of newly acquired data from a major UK grocery retailer to investigate the spatial patterns in the locations of their on-line consumers (we shall subsequently refer to this as 'partner data'). This will enable us to build on the survey-based analysis in previous studies to explore the main drivers of on-line expenditure in more detail.

1. Introduction

E-commerce is one of the fastest growing sectors of the UK retail economy. The vast and rapid expansion of internet usage has generated widespread on-line sales, making the UK one of the leading countries for e-commerce. In 2016 around 15% of all UK retail trade was undertaken on-line (Econsultancy, 2016). Globally, on-line retail sales are predicted to hit $3,400 billion by the end of 2025 (www.statista.com). The reasons for this growth are multi-faceted; the desire for greater convenience and choice, lower prices, perhaps poor access to actual stores as well as increasing household access to broadband technology (Longley et al 2008, Longley and Singleton 2009, Riddlesden and Singleton 2014). However, little is currently known about the geography of actual e-commerce usage. There have been a number of important papers on the geodemographics of e-commerce usage based on the results of surveys. These will be explored and summarised in section 3. However, there have been fewer studies analysing the geography of actual on-line sales provided by retail companies. The aim of this paper is to investigate the geography of e-commerce activity in more detail, especially as seen in UK grocery retailing. It is important to understand the spatial structure of e-commerce as it applies to urban and rural regions. The paper will be concerned exclusively with transactions between businesses and consumers (B2C) rather than either business to business (B2B) or consumer to consumer (C2C). The paper makes extensive use of newly acquired data from a major UK grocery retailer who has provided data for use within the Consumer Data Research Centre (CDRC) to investigate the spatial patterns in the locations of their on-line consumers (we shall subsequently refer to this as 'partner data'). This will enable us to build on the survey-based analysis in section 3 to explore the main drivers of on-line expenditure in more detail.   Hence the paper provides unique insights into the relationships between retail provision and customer behaviour in a contemporary commercial environment.

The rest of the paper is structured as follows. In section 2 we discuss the growth of e-commerce in the UK grocery market in more detail. Then in section 3 we review the existing literature on the geography of e-commerce usage mainly from the standpoint of the demand side, including a number of useful analyses of demographic and geodemographic variables. In section 4 we present our analysis and discussion of the partner data for the Yorkshire and Humberside region of the UK. Concluding comments and suggestions for future research are offered in section 5.

2. Growth of e-commerce in UK grocery retailing

Given the fast growth of e-commerce in many retail markets it is perhaps unsurprising that estimates of its current importance do vary by source. In 2016, the UK online grocery market was estimated to be worth £9.8billion or around 6% of the total grocery market by Mintel (Mintel 2016), whilst Kantar Worldpanel (2017) report UK e-commerce grocery sales at 7.3% in 2016. The leading UK grocery

retailers have recognised the significance of on-line sales with Tesco as the principal UK market leader in both face to face and e-commerce channels: around 28% market share in the traditional UK grocery market and almost 40% in online sales (Kantar Worldpanel, 2016;Econsultancy, 2014). According to the data provided by the Institute of Grocery Distribution, approximately 20% of UK households buy their groceries on-line at least once a month and 11% use on-line channels as their main mode for grocery shopping (IGD.com, 2016). Moreover, 20% of the UK on-line users visit leading grocery retailers' websites every month. . Despite the current low overall market share (compared to other goods such as music, electrical goods, flowers etc), the on-line grocery market has doubled in value since 2009 (IGD.com, 2016).

The consumers' increasing demand for flexibility, convenience and reliability places a great pressure on the grocery retailers to create a seamless approach to the shopping experience through the availability of many different channels – in-store, on-line, click and collect- collectively known as omni-channel retailing. Consumers state the flexibility to shop any time and the convenience of groceries being delivered to their door (especially heavy items) as the main reasons for their choice of on-line channels. Moreover, on-line shopping is more likely to be planned than spontaneous compared to the in-store experience and e-shopping tends to be of a larger value with 12% of all grocery transactions of £60 or more made on-line during one visit, compared to 99% of all transactions worth less than £60 which are made in physical stores (Intelligent Positioning, 2013).

The future growth of on-line sales predicted by Mintel and other research organisations is likely to be driven by the diffusion of new technologies and the development of new trends – m-commerce and t-commerce for example, which will allow even greater convenience with a greater ability to shop on the move (Birkin et al 2017). Currently, 41% of all internet users complete their shopping on-line via a smartphone and 35% via a tablet device, and the trend is growing (Mintel, 2014). According to Google, the searches from mobile phone devices for on-line grocery doubled in 2014 and the internet-only based supermarket company Ocado reported that almost half of all transactions were completed via a mobile phone device (Essential Retail, 2014).

3. **The** g**eodemographics of e-commerce**

As e-commerce has grown so too has interest in the geography of the internet. Much of this interest has been shaped by studies exploring the geography of internet providers, their connectivity and the importance of spatial agglomeration in new 'electronic spaces' (Zook 2000, Warf 2001, Wrigley et al 2002). More recently attention has turned to the geography of consumer demand for online shopping. Many scholars have begun to analyse the variation of e-commerce usage among different demographic groups (Weltevreden 2007, Soopramanien and Robertson 2007, ONS 2011, Clarke et al 2015). As noted in the introduction, most studies have been based on consumer surveys rather than actual consumer purchase data provided by retailers. In this section we summarise the key findings in relation to geodemographics, those studies which have broken the market down by age, gender, social class etc. The first variable which has emerged as important is the age of the consumer. Clarke et al (2015) explore e-commerce consumers based on the extensive Acxiom Research Opinion Poll data and demonstrate that almost one third of all respondents aged between 25 and 44 are frequent e-shoppers, with the least on-line buyers belonging to the age category 65+, with less than 10% of them frequently shopping on the internet. The second important variable appears to be income or social class. Kantar Worldpanel (2016) have established that wealthier households are more frequent on-line spenders. Consumers with an annual income of £60k or more are spending 10% of their grocery budget online (Intelligent Positioning, 2013). Clarke et al (2015) also established that the wealthiest households are ten times more likely to buy on-line than households on a lower income.

Thus, so far, the implication is that internet usage will be higher in areas of high income and where there is a substantially younger population. Again Clarke et al (2015) highlight this through their map of the distribution of e-commerce users in Leeds (Fig 1). Area A on Fig 1 shows the higher usage in the northern suburbs of the City which are the most affluent. In contrast, area B on Fig 1 shows the less affluent south and eastern suburbs having little or no regular e-commerce activity in the grocery market. Area C on fig 1 shows the student area of Leeds – again high internet usage as we might expect (even if transaction value might be low). Area D begins to hint at other important issues. Although the area is relatively affluent, it is also increasingly rural. This backs up the 'efficiency' hypothesis of other studies - that consumers living in rural locations with limited access to shops are more likely to shop online (Farag et al , 2006, Lennon et al 2007, De Basio et al 2008).
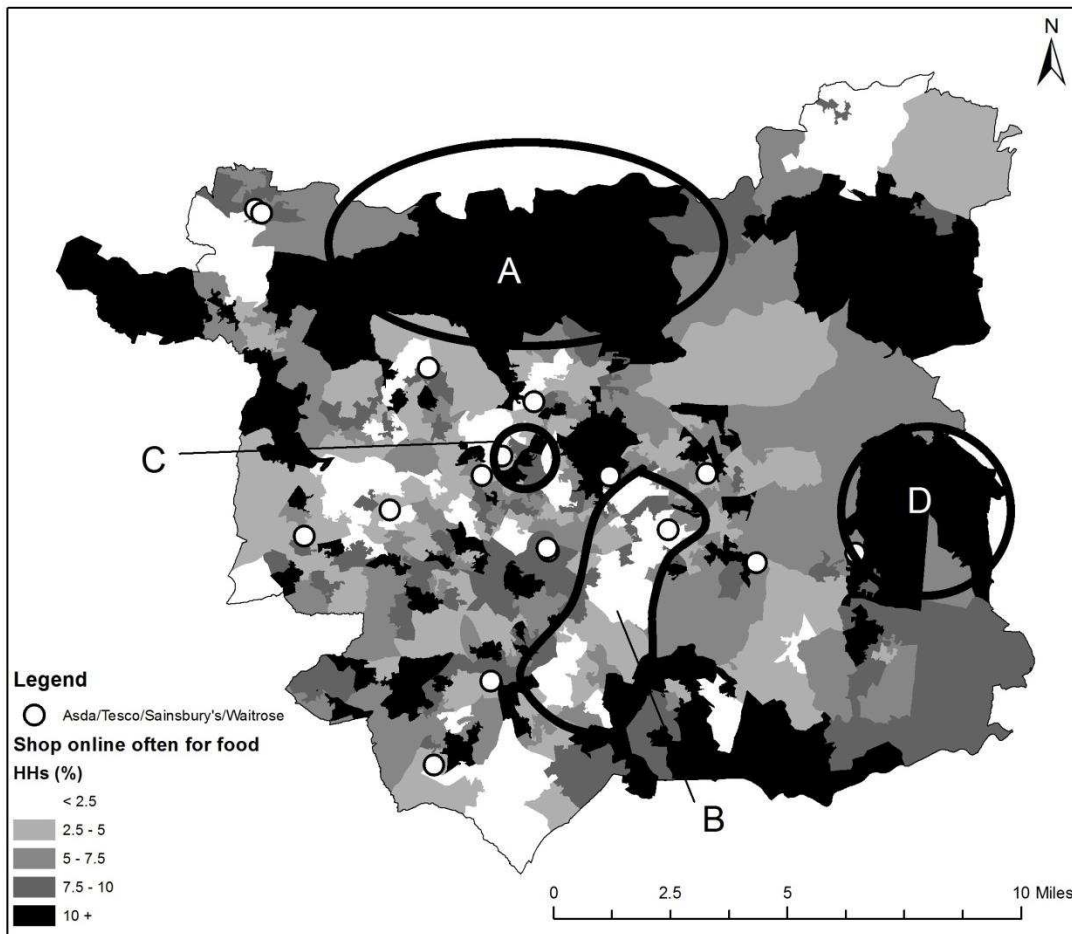
Figure 1. Online grocery penetration by lower Super Output Area in Leeds based on Acxiom ROP data: source Clarke et al 2015

If the characteristics of e-commerce shoppers are indeed multi-faceted, then it is useful to explore the potential of proprietary geodemographic systems to enhance the analysis presented thus far. Longley et.al (2008) identified 23 categories of on-line users in the UK within 8 principal groups (using cluster analysis) based on the level of engagement with technologies, ranging from complete non-adopters of e-commerce in Group A to e-professionals in Group H (see also Longley and Singleton 2009). Similarly, a study by the Office of National Statistics in 2010 (the British Population Survey –BPS) explored the combination of various socio-economic characteristics in relation to on-line expenditure using the UK Output Area Classification (OAC) system. This is an open-access geodemographic system built by academics for the UK Office of National Statistics (see Vickers and Rees 2007).

If we set 100 as the average e-commerce usage across all groups then, according to the BPS data, there is a clear indication that Blue Collar Communities (91), Constrained by Circumstances (84) and Multicultural communities (90) (the least affluent groups) are the least enthusiastic on-line shoppers. In contrast, the City Living (113), Prospering Suburbs (108), Countryside (107) and Typical Traits (109) are all enthusiastic on-line shoppers. For the Countryside group, the higher propensity to shop on-line

again supports the efficiency theory stating that less accessible areas will be greater e-commerce users (ONS 2011).

Using their own geodemographic profiling system (ACORN), CACI have produced estimates of e-commerce usage across different ACORN profile groups based on the Living Costs and Food Survey (LCFS) data, which covers about 50,000 respondents annually. CACI also have a set of control figures for on-line market shares which are estimated based on ONS Retail Sales Index (RSI), industrial reports, and company annual reports. The overall on-line local market shares for any chosen year are estimated according to ONS RSI data and projections derived mainly from the ONS RSI time series. Taking these national ACORN propensities to shop on-line for groceries it is possible to estimate the expenditure on on-line grocery shopping for each lower super output area (h) using the individual ACORN profiles for each LSOA The LSOA is a good scale to study the neighbourhood effects of on-line expenditure., Fig 2 shows our subsequent estimates of e-commerce usage for groceries across the Yorkshire and Humberside UK region by total on-line sales (Fig 2a) and by market share of total estimated grocery expenditure (Fig 2b) for each LSOA.
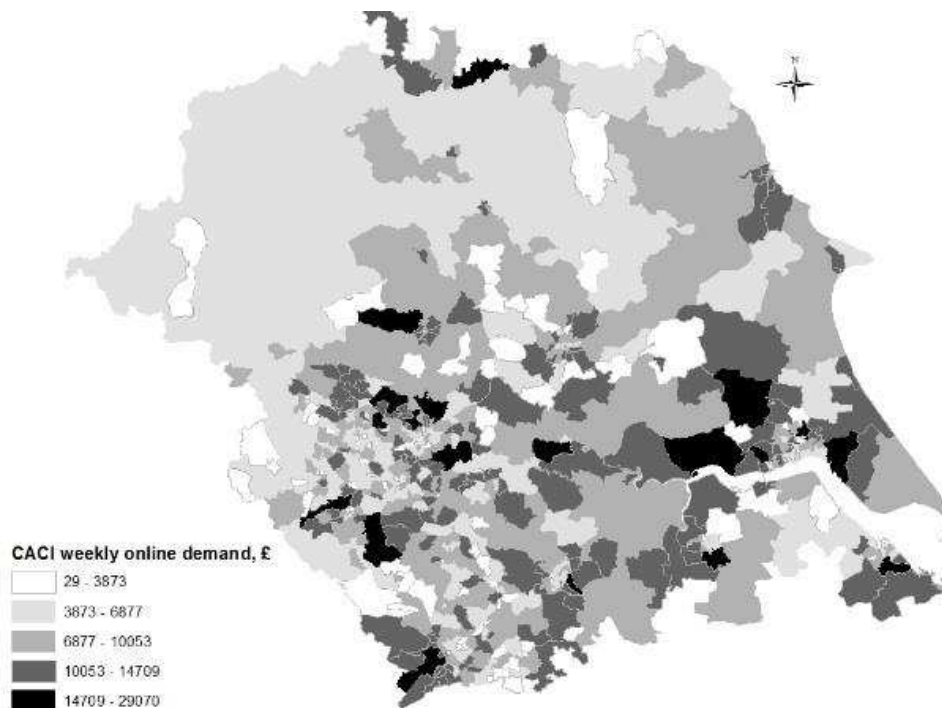
Fig 2a: Estimated weekly on-line expenditure for groceries in Yorkshire and Humberside: source authors based on CACI's national on-line expenditure profiles
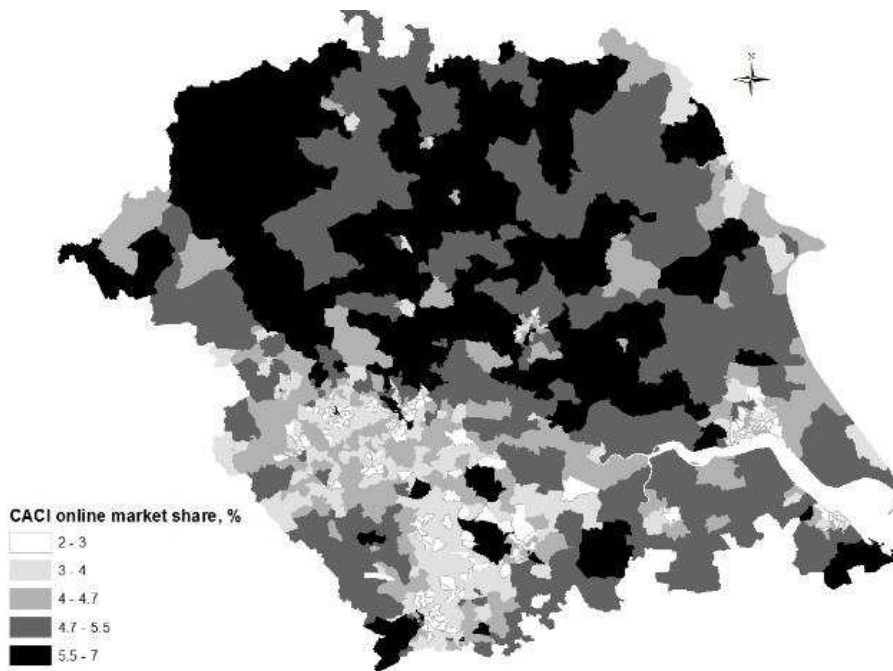
Fig 2b: On-line market share as a percentage of total grocery expenditure: source authors based on CACI national on-line expenditure profiles

According to these estimates, the largest demand for on-line groceries occurs within the more urbanised and suburban areas of the major cities with a weekly online expenditure of up to £29k per postal sector around metropolitan boroughs (fig 2a). The distribution of the on-line demand corresponds mainly with population density within the region, with the least populated areas in the northern part of the region having a low estimated weekly total on-line expenditure (as well as a low total for physical stores). When plotted as a percentage of total grocery spend, however, a different geography emerges (Fig 2b). Now, the less populated northern areas of the region seem to be enthusiastic e-shoppers, with market share estimates of over 6% (the national average) in many postal sectors. In contrast, many urban postal sectors are estimated to have a small market share of on-line expenditure in relation to the total market. [To verify the estimates using CACI data we have additionally estimated weekly on-line demand in an alternative way: based on the LCFS data for 2012 and weekly on-line grocery household expenditure disaggregated by social class. When estimated at the LSOA level there was an 82% correlation. Thus we can use the estimated data based on CACI data with confidence that these patterns seem logical and robust.]

4. Exploring the geography of partner e-commerce sales

In the previous section, we briefly reviewed some major studies exploring the geodemographics of e-commerce usage.. In this section we analyse data provided by a major UK grocery retailer on their e-commerce sales across Yorkshire and Humberside in the UK (as described in section 1). The data consists of the partner's on-line revenue derived from the loyalty card scheme: 814000 unique customers for a three month period in 2013. This accounts for 15% of the total population in the study area (5.3 million) and could be considered as a substantial sample (ONS, 2015). The data for on-line usage is representative of the partner's total online customers to the extent that 90% of the partner's customers use their loyalty card when buying on-line. The partner has a large physical store presence in the area with over 100 stores ranging from small convenience stores with a sales area between 800 to 3000sq ft., supermarkets with a sales area of up to 25000sq ft. to hypermarkets with over 60000sq ft. sales area (IGD, 2016). The data has been aggregated from individual postcodes to the postal sector geography level of resolution for confidentiality reasons (in the UK there are 1.7 million individual postcodes and 11199 postal sectors) The e-commerce data does not include click and collect customers. In 2013 this mode of delivery was small for our partner organisation. We make some recommendations for this area of e-commerce in the concluding sector.

Prior to the analysis of the spatial distribution of the partner's on-line revenue it is useful to explore the sales data for on-line purchases in comparison to the two major physical grocery retailing channels – convenience stores and supermarkets. To reflect only household expenditure (and eliminate likely business transactions) expenditure of over £200 per transaction has been excluded from the analysis. Over the three month period almost half of all on-line transactions were made just once; 5% of customers purchased groceries on-line monthly and only 2% of the customers were frequent on-line shoppers with at least one order made per month. Given such infrequent purchasing patterns, it is perhaps not surprising that the average expenditure per transaction is over £100 for on-line purchasing. (In addition, the partner offers free delivery on orders of over £100).

Analysing the convenience and supermarket sales shows that there is a substantial variation in comparison to on-line sales. Consumers spend substantially less at each visit to the supermarkets and local stores with £18.76 and £8.71 per transaction respectively, although these two channels are certainly used more frequently. In terms of product categories, customers' on-line expenditure reflects general grocery spending patterns with the largest proportion (almost 50%) spent on meat and fish, fruit and vegetables, and alcoholic drinks. These categories make up far more of the average 'basket' of purchases than for physical stores.

Some of this information is not what might be expected from the literature. In the past, theories of 'planned behaviour' and 'reasoned action' have been cited in support of the expectation that consumers

prefer, for example, to inspect the quality of fruit and vegetables in-store rather than on-line (Kang et al, 2016). However, the bulky nature of such products perhaps outweighs the questions around quality. Thus factors such as an easy shopping process and convenience appear to hold sway(Panda and Narayan Swar, 2013). The partner's reputation for high product quality may also reinforce this pattern of purchasing for fruit and vegetables. On the other hand, the high propensity to purchase alcohol on-line is much more in accordance with expectations, as here the product is again bulky but varies little between its appearance on the shelf and the screen.

Having discussed the frequency of transactions and types of products purchased, it is useful now to explore the geography of the partner's e-commerce sales. This helps to benchmark the partner data against ONS national profiles in order to provide a combination of reassurance and insight. First, we can profile sales by geodemographic type. We would expect areas with higher affluence and wealth to be important drivers of e-commerce activity (cf. section 3). Figure 3 shows the analysis of on-line expenditure within the ONS OAC demographic groups. More affluent demographic categories - Countryside, Prospering Suburbs and Typical Traits - have higher rates of online expenditure when indexed to a national average of 100 (the Y axis measures the index around 100). These groups account respectively for 18%, 32% and 25% of total online expenditure compared to 5% and 2% of total online expenditure within Constrained by Circumstances and Multicultural Communities.
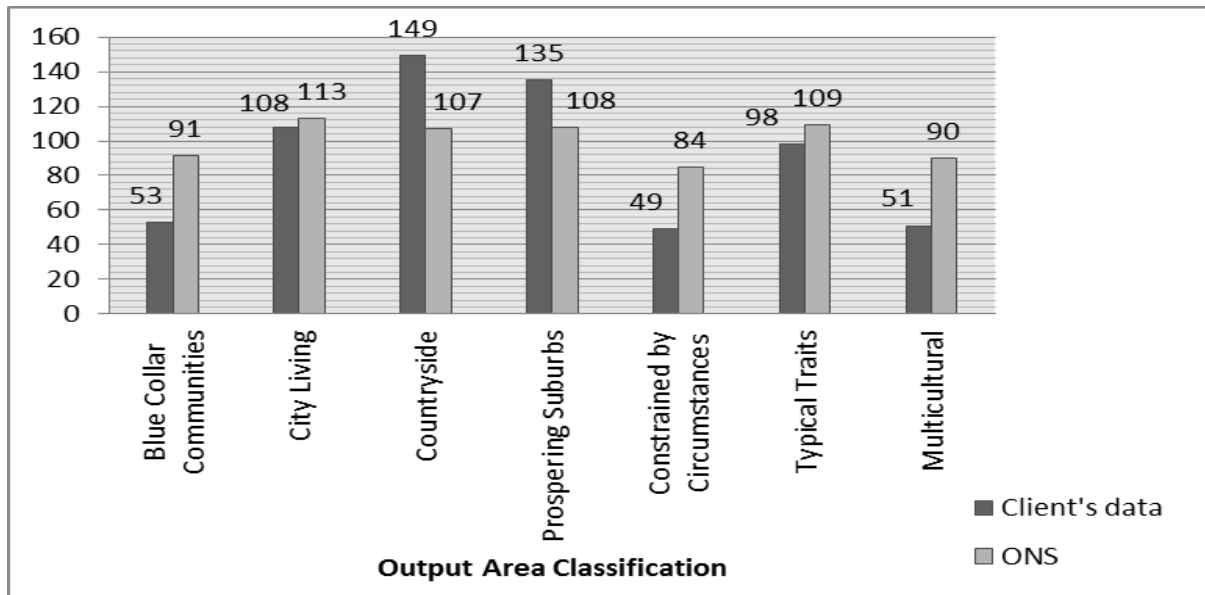

Figure 3. **On-line preferences among OAC Supergroups based on actual grocery sales data compared to ONS survey results**

As Fig 3 also shows, there is a good deal of agreement between the ONS survey data and the partner's online customers in terms of the main groups who are most active in e-commerce. Typical traits and

city living provide a very good match. However, there are some interesting differences between these two data sets within the Blue Collar Communities, Constrained by Circumstances and Multicultural categories. These latter groups are the lowest income groups in the UK population and these differences might simply be explained by the fact that that our partner supermarket chain is not very popular among customers belonging to these OAC groups. As with physical stores, brand attractiveness and loyalty is very important for e-commerce. The higher participation in internet purchasing of the Prospering Suburbs group might reflect the higher attractiveness of this particular supermarket among the customers of this OAC group for both physical stores and e-commerce. The higher rate for the Countryside group is also interesting and we shall explore the more detailed spatial patterns next.

Fig 4 shows the distribution of e-commerce sales across the region for our partner by total sales (Fig 4a) and by percentage share of partner's revenue (i.e e-commerce sales as a percentage of total grocery sales: ; Fig 4b). The total sales simply reflect the geography of the population – larger numbers in the city-regions.
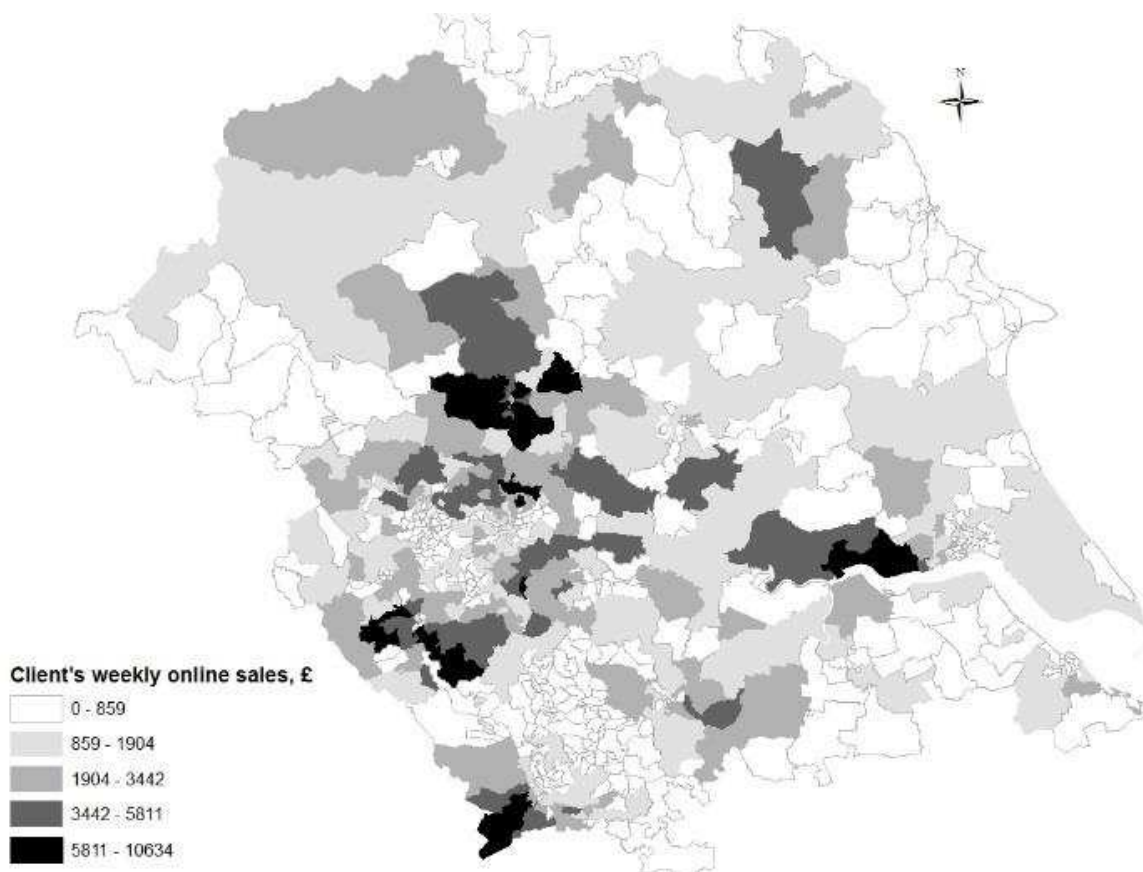
Fig 4a. Partner's weekly online sales (£ per week)
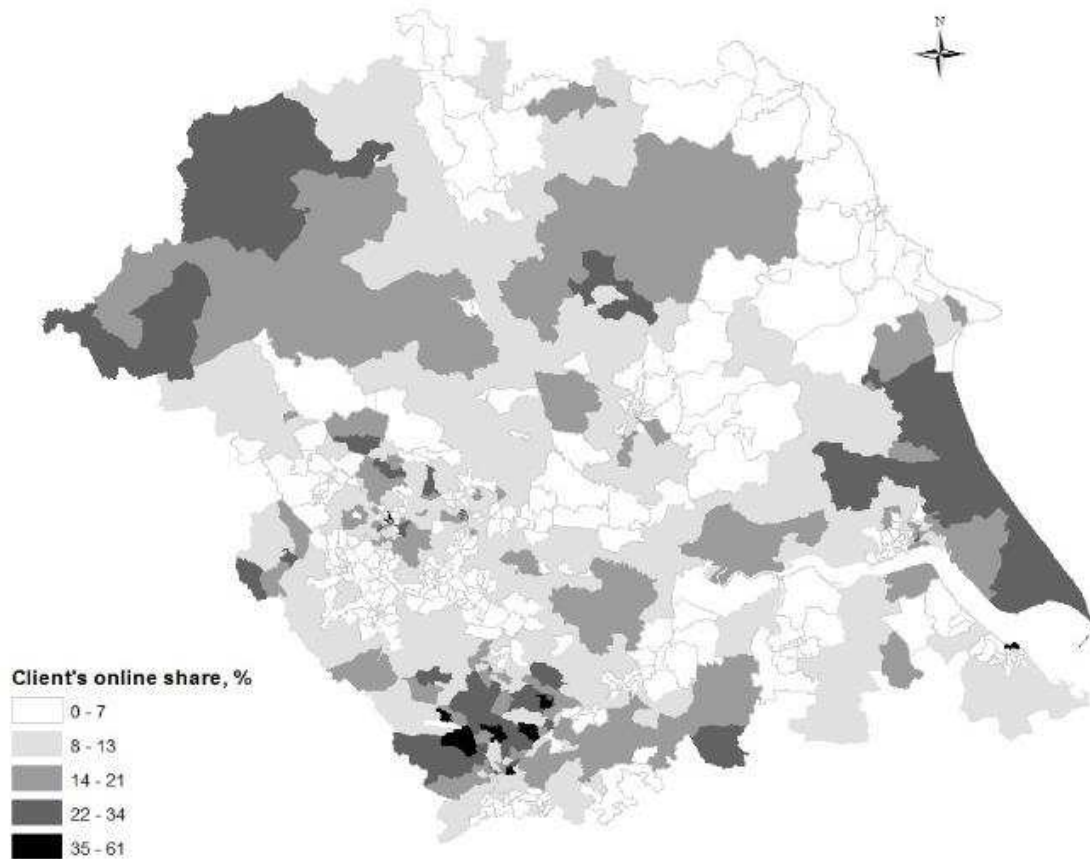
Fig 4b. Partner's online share as a percentage of total sales

So how can we start to make greater sense of the spatial patterns we see in these maps? The most important factors a priori here include store provision, geodemographics and population density, which we capture using 4 key variables.

1. C prov - grocery floorspace provision by competitors stores across the study area.
2. S prov - grocery floorspace provision of the partner
3. Share – e-business share in total grocery expenditure based on the loyalty scheme data provided by the supermarket chain.
4. Urban – rurality of the area (or population density) calculated as number of people per square kilometre at the individual postal sectors.

The provision measures for each postal sector (for both partner and its competitors) were generated as an allocation of square feet per thousand customers using a simple spatial interaction model to allocate floorspace between local areas (Clarke et al, 2002). This can be given as;

$$S_{ij} = A_i O_i W_j exp^{(-\beta C_{ij})}$$

Where:

S_{ij} is the flow of people or money from residential area i to retail unit j;

O_i is a measure of the available demand;

W_j is an attractiveness factor for retail unit j (i.e. size) ;

C_{ij} is a function representing the cost of interaction between demand zone i and store j, most commonly in the form of straight line distance between the two;

A_i is a balancing factor ensuring that all demand is allocated between the available grocery stores.

The average values for the four key indicators are presented in Table 1. The values lower or greater than average are considered to have higher or lower grocery stores provision in the area.

| Indicator	Average value
S prov	0.47 sq. feet
C prov	5.2 sq. feet
Share	10.3%
Urban-rural	0.002

Table 1 Average values for the quadrant analysis indicators around Yorkshire and Humberside

Building on the geodemographic analysis in section 3, and Fig 4 above, the first issue we wish to examine concerns the interaction between partner's provision of stores and urbanisation or population density and e-share. Table 2 demonstrates that given a lower physical channel provision in the more rural areas then the on-line usage uptake is the greatest at 11.2% (427 observations) compared to 8.1% e-share in the more urbanised areas that have a greater presence of partner stores. Interestingly, e-share is similar in the less urbanised areas with a greater partners' presence and vice versa.

Table 2 Partner's store provision and population density in relation to e-share

	S Prov <0.47	S prov >0.47
Urban<0.002	Average share 11.2% [N=427]	Average share 9.6% [N=44]
Urban>0.002	Average share 9.4% [N=255]	Average share 8.1% [N=65]

The second test we can apply to the partner's data is on the relationship between e-business share and partner's provision using a ranking technique. In the 80 postal sectors with the highest partner provision of the partner's stores the average rank of "Share" is 520, which is above the average of 396. There is thus a strong suggestion that there is a substitution between physical and virtual channels taking place here: with higher store provision, on-line grocery spend decreases. This substitution phenomenon (referring to when on-line purchases completely replace a trip to a physical store) has been argued elsewhere. For example, Dixon and Marston (2002) identified that 28% of their sample of 450 UK consumers in a town in southeast UK had replaced an in-store purchase (see also Weltevreden 2007). In Figure 5 we present visual evidence for the substitution between physical and virtual channels. The horizontal axis value is set to 10.3 (the average value for on-line sales) and the vertical axis is set to the average value of 0.47 for partner's store provision in the study area. Logarithmic values for store provision are used due to the small values compared to the online sales). The high concentration of data points in the top left quadrant of the figure emphasises the high correspondence of low online sales and higher physical stores presence in the area.
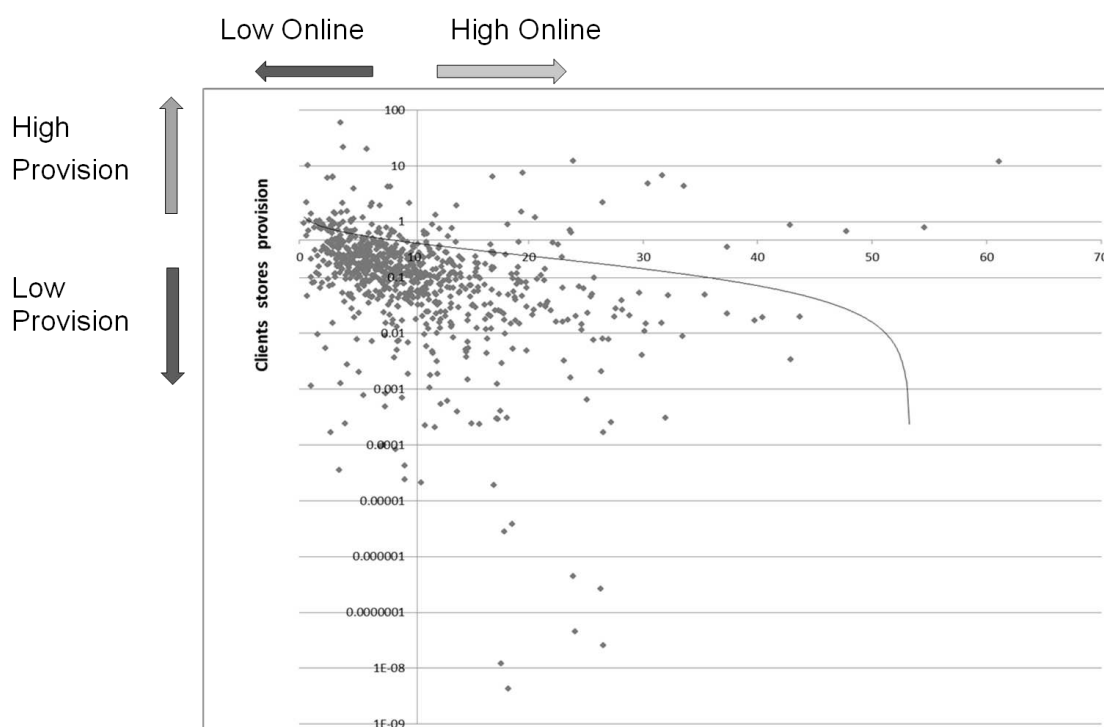
Figure 5. Online grocery sales versus partner's stores provision

Interestingly, however, in recent projects with two major UK high street retailers, CACI has established that their on-line sales actually increased as a result of greater store presence due to the effect of brand

awareness and the existence of a "click and collect" service (Langston 2011). Thus the relationship between store presence and internet sales may vary by product type and type of location (high street versus out-of-town etc).

The third test we perform is to examine the relationship between on-line sales, partner's store provision and all other store provisions. The hypothesis here would be that low levels of competitors' provision (C prov) will tend to encourage higher levels of partner's on-line use (S Prov) because there are few alternatives as far as physical stores are concerned. The evidence seems partly to support this hypothesis with a higher than average rank share in the areas with low partner provision and low competitor presence (the e-shares of between 10% and 14%). In contrats, the lowest e-shares of 4%-5% can eb found in the areas with higher partner store provision (Table 3).

Table 3 Partner's and competitors store provision in relation to e-share

	C prov < 5.2	C prov >5.2
S prov <0.47	Average Rank 378 (share 10%) [N = 667]	Average Rank 262 (share 14%) [N = 15]
S prov >0.47	Average Rank 632 (share 4%) [N = 61]	Average Rank 386 (share 10%) [N = 48]

The high e-share in the areas with lower partners' store presence but higher competitors' store provision may indicate that these consumers favour this particular supermarket despite having a good accessibility to competitor grocery stores. These might be especially loyal consumers to this brand.

Having looked at general patterns across the study area we can now concentrate on the details of the small-area geographies. The instances of the rather complex relationship of on-line share, physical store provision and accessibility can be seen in the small-area geographies of partner online sales in the maps below. Both figures show clear illustrations of spatial patterns, which we have indicated with a broad sweep, while recognising that a more formal contouring, hot-spot mapping or pattern recognition could be applied. Fig 6 shows the distribution of the partner's on-line market share with the additional layer of the total grocery floorspace per postal sector for the total of 1812 grocery stores across the region. Predictably the highest concentration of grocery stores is around large cities, e.g. areas G, H and F shows the greater distribution of grocery stores in the major regional cities - Leeds, Sheffield and York. Rural areas in the north of the region (areas A and B) have poor local grocery provision and high on-line shares (up to 34% in some postal sectors). The opposite situation is observed in areas D and E where e-commerce sales are very low perhaps due to the large physical store presence. Area C seems to be a major anomaly. Here, we have high e-commerce sales and a high level of store provision (with on-line shares of up to 34% and high grocery floorspace provision of up to 68000sq ft.). The

geodemographies of this area does not immediately point to a high on-line demand: thus, this is one area that needs greater research to try to explain these anomalies.
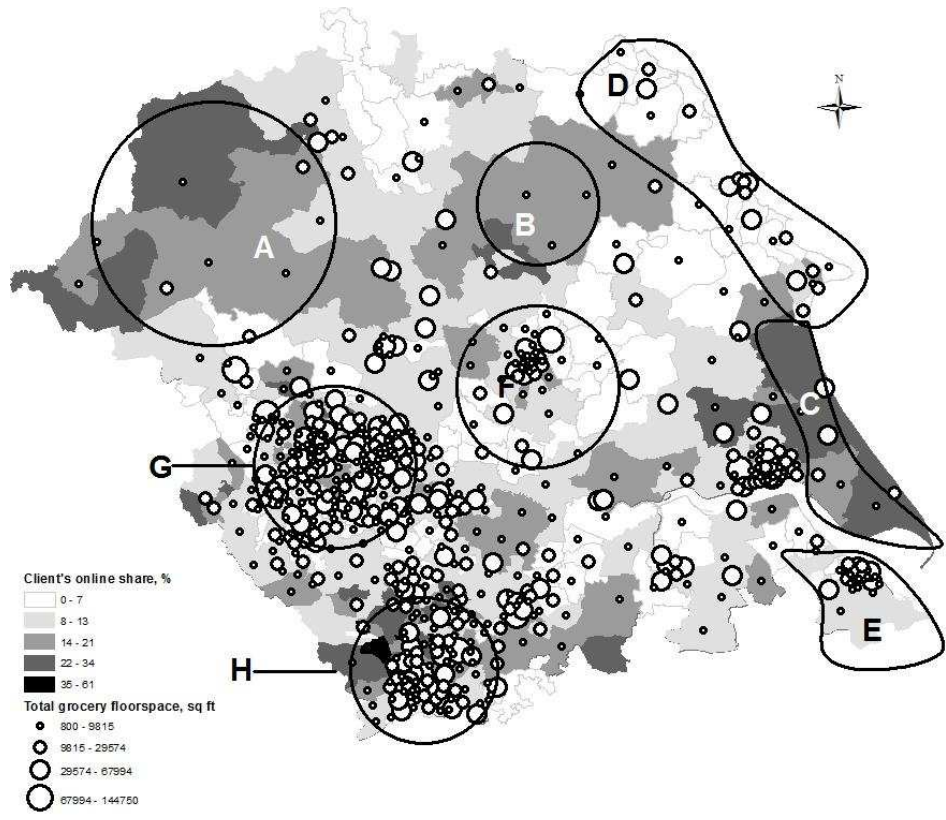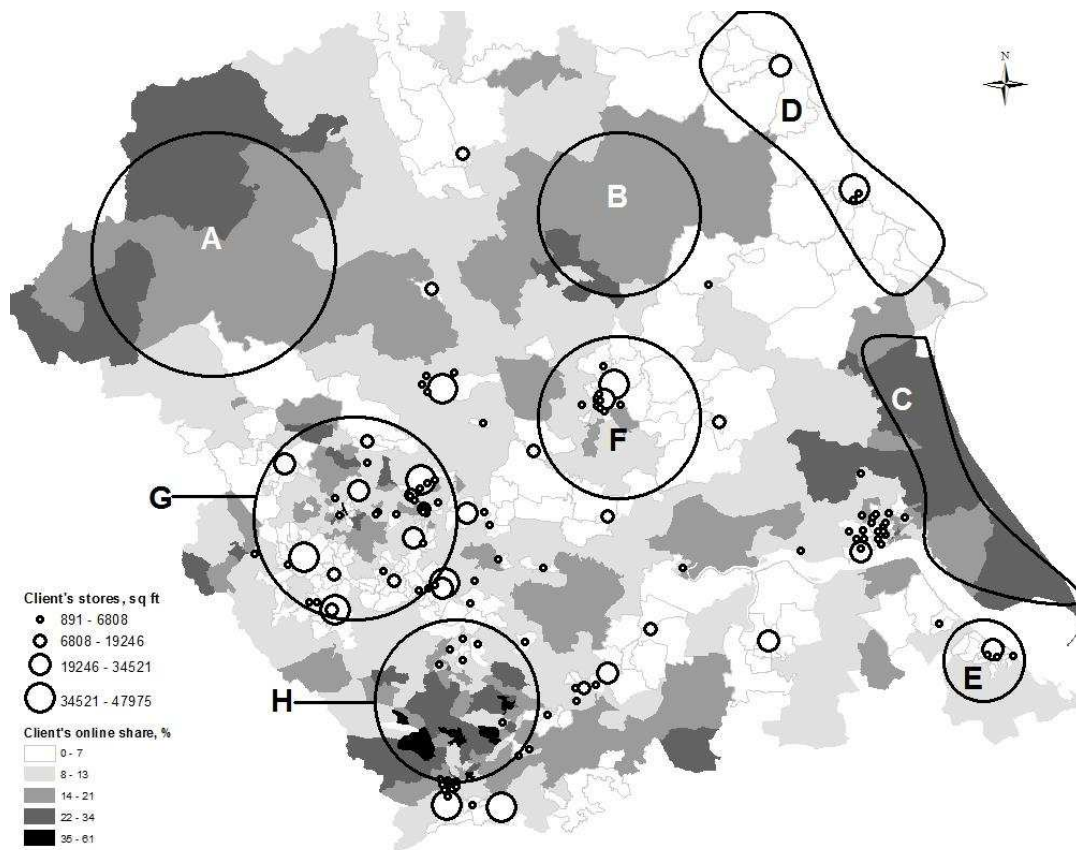

Figure 6. Total Floorspace in Yorkshire and Humberside and on-line partner market share

Figure 7. Partner's (client's) Grocery Stores in comparison to its on-line share

Fig 7 focuses on the partner's e-commerce sales and its stores only. The partner's stores are largely absent in rural areas A and B and these areas have the highest on-line expenditure of up to 34% per postal sector which demonstrate the substitution between physical and virtual channels and substantiates the efficiency hypothesis which was discussed earlier in the paper. Coastal areas D and E also have low on-line sales and access to an extensive network of partner's stores. The high market share for e-commerce for the partner in Area C, however, seems to be more difficult to explain. Here, the partner's on-line share is high despite the presence of a number of large partner stores in the neighbouring area of Hull. Sheffield (area H) is also interesting. Here there are some postal sectors with very high on-line expenditure (up to 61% in some areas). These tend to be the more affluent western suburbs but for our partner the majority of their stores in Sheffield tend to be smaller convenience partner's stores. Hence maybe the higher internet sales are a substitution for a lack of access to the major supermarkets of the partner.

The enlarged map of the Leeds and Bradford area (Areas F and G in Fig 7 – now see Fig 8) also shows interesting patterns and helps to reinforce the points made above. In the northern suburban areas of

Leeds, close to a major superstore of over 30,000 sq., there is low on-line market share. In contrast, the highest on-line shares are in certain southerly urban areas of Bradford and west/north-west Leeds where there is a limited presence of the partner's stores. The centres of both cities also show high levels of e-commerce usage. Consumers in these areas are more likely to belong to the City Living OAC category (young professionals) which was discussed earlier in the paper as having high overall e-commerce usage. Note too how much of East Leeds and inner north Bradford have low e-commerce usage even though there are plenty of (small) partner stores. Generally these areas do not have access to many superstores – many could be labelled food deserts (Wrigley 2002, Clarke et al 2002). However, geodemographics may be the overarching explanatory factor – many consumers falling into the categories of constrained by circumstance or multicultural. This reminds us that the demographic profile of on-line users is important in e-grocery purchasing decision making and accessibility is not the only major factor which has an impact on e-commerce activity.

Figure 8. Partner (client) stores and their online share in Leeds/Bradford

To conclude this section we argue that the analysis to date has identified four major issues in the relationship between on-line share, geodemographics and store provision:

1. High on-line share and high store provision due to demographic profiles of on-line customer (social class ABC1) and possible brand loyalty preferences
2. High on-line share and low store provision due to restricted accessibility to food stores

3. Low on-line share and high store provision. This scenario is interchangeable with the second factor and relates to grocery store accessibility as a major factor in the preference towards on-line spending.

4. Low on-line share and low store provision. This situation is expected in two instances. First, in the "food desert" areas with low grocery store accessibility and a less affluent population. Secondly, in the areas where customers have different brand preferences and use competitors websites to purchase online groceries.

5. Conclusions

In this paper we have first attempted to identify the demographic characteristics of on-line consumers by geodemographic type. The literature review revealed that such characteristics as age and social class are the major attributes of on-line customers. The typical on-line grocery shopper is aged 25-44 belongs to the AB social class categories (and is more likely to be well educated). For a more comprehensive analysis with multivariable demographic characteristics the OAC system was used which established that consumers within City Living, Prospering Suburbs, Countryside and Typical Traits are more likely to shop on-line

Furthermore, this paper has presented one of the first major spatial analyses of actual e-commerce sales for a major UK grocery retailer. This data shows some interesting spatial patterns. On the one hand, there is clear evidence that geodemographics and urban density are important, as found in many other survey based analysis of e-commerce activity. Geodemographic analysis of e-grocery shoppers found greater evidence in support that primary on-line grocery shoppers come from higher social class backgrounds – and are more likely to be rural than urban (in percentage terms). The quadrant analysis gives rise to other potentially important findings. Strong evidence was found in support of the efficiency theory with the prevalent number of occurrences of on-line spending in areas with lower physical stores provision and less urbanised areas with poorer access to retail stores. There is a clear indication of substitution of on-line and physical channels in areas with limited accessibility to grocery stores. That said, there is also evidence to support the diffusion of innovation theory with young, professional city centre residents being enthusiastic online shoppers despite the greater presence and the variety of the grocery stores.

As with many emerging studies in 'big data' analytics, caution must be exercised in the interpretation of the results. The data which were analysed here are particular to a partner organisation, hence analysis across a variety of supermarket brands and other data collection methods would add further value to this study. The addition of data from other sources (e.g. point of sales data) or from other retail grocers

would reduce the potential for bias and mis-representation. It would also be very valuable to study the click and collect shoppers in subsequent research. Given the cost of delivering to individual addresses it is not surprising that retailers which to expand click and collect to put more of the cost back on the consumer. Finding ideal sites for click and collect facilities, given the spatial variations in e-commerce usage discussed in this paper, would be a very interesting future location planning exercise.

Given these findings what are the implications for retailers? In marketing terms perhaps retailers should target more affluent, rural areas more generally when promoting e-commerce. They should also perhaps look at areas where access to their own physical stores is low as there is clear evidence of substitution taking place when access is poor. This relationship between a store network and the company's e-share of the market is fascinating. It poses interesting questions in relation to the impact on e-commerce sales of store opening and closures. It also raises the issue of can we add e-commerce to classic store location forecasting models. That would involve capturing the spatial patterns seen in the e-commerce sales data directly into models such as the spatial interaction model, posing interesting questions about brand attractiveness for e-commerce, the role of distance deterrence parameters and the relationship discussed here about the interplay between accessibility to physical stores and e-commerce demand. That might be extremely useful to retailers with multiple channels of delivery and provides the next major challenge for academics.

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