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The geography of Internet adoption by independent retailers in the Netherlands

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Abstract. So far, the literature on Internet adoption by retailers has paid little attention to spatial variables. Using data on approximately 12 000 independent retailers, we investigate the geographical diffusion of Internet strategies in the Netherlands. In particular, we examine to what extent Internet adoption differs among shopping centers, cities, and regions, while accounting for organizational variables. Results suggest that independent retailers at city and village centers are more likely to adopt information-only and online sales strategies than independents located at shopping centers at the bottom of the retail hierarchy. Furthermore, independent retailers in large(r) cities have a higher probability of adopting the Internet than their counterparts in small(er) cities. On the regional level, the likelihood of Internet adoption is higher for independent retailers in core regions than for independents in the periphery. Thus, geography seems to matter for Internet adoption by independent retailers.

1 Introduction

Business-to-consumer (b2c) e-commerce can be regarded as a disruptive innovation that, in the late 1990s, was reviewed as having the potential to make existing business models obsolete (Burt and Sparks, 2003; Wrigley et al, 2002). The history of retailing is replete with such innovations, such as the introduction of department stores and mail order. The rise of the Internet as a new channel for commerce provides threats to brick-and-mortar retailers. For example, in the Netherlands, the substitution of in-store shopping with online shopping by consumers has already caused some retailers to go bankrupt or to close some of their outlets (Weltevreden, 2007a). However, b2c e-commerce also provides opportunities for retailers—for instance, by developing a website retailers can enhance the relation with their customers by providing additional services, such as subscription to an e-mail newsletter. Furthermore, by engaging in online sales they can extend their market to areas in which they have no physical presence (Steinfield et al, 2001).

To date, there is a growing interest among geographers in the spatial distribution of online shoppers and the explanatory value of spatial variables for the adoption of online shopping by consumers (see, for example, Farag et al, 2006; 2007; Krizek et al, 2005; Ren and Kwan, 2006; Sinai and Waldfogel, 2004; Weltevreden, 2007a; Weltevreden and van Rietbergen, 2007). For the Netherlands, results indicate that consumers in urbanized areas are more likely to search and to buy online than

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consumers in rural areas. Nevertheless, Dutch online shoppers in rural areas buy more frequently online than their counterparts in the more urbanized areas (Farag et al, 2006; Weltevreden, 2007a). Given the fact that the adoption of online shopping by consumers differs across urban settings it is reasonable to presume that the adoption of Internet strategies by retailers will differ in space as well. Understanding the diffusion patterns of b2c e-commerce adoption by consumers and retailers may provide insights into the spatial implications of this new form of commerce for shopping centers and urban form.

Despite a growing interest in the factors that determine the adoption of the Internet by retailers (Doherty and Ellis-Chadwick, 2006), few studies have investigated the explanatory value of spatial variables. Noticeable exceptions primarily focus on explaining differences in Internet strategy adoption among retailers at city centers (see, for example, Boschma and Weltevreden, forthcoming; Currah, 2002; Weltevreden and Atzema, 2006; Weltevreden et al, 2005). As such, systematic empirical research analyzing Internet adoption by retailers at different shopping locations and urban settings is virtually nonexistent.

In this paper we aim to fill this gap in knowledge by examining the geographical diffusion of website adoption among 11 627 independent retailers [(1)] in the Netherlands. While controlling for product and organizational variables, we investigate to what extent the adoption of a certain Internet strategy by independent retailers differs among shopping centers, cities, and regions. Three *types* of Internet strategies are distinguished: no website (pre-Internet strategy), an active website without online sales (information-only strategy), and an active website with online sales (online sales strategies). For independent retailers with an active website, we also investigated the *adoption time* of a domain name.

The outline of this paper will be as follows. In section 2 a brief description of the Dutch retail context will be given so that the results presented in later sections can be contextualized whenever appropriate. Section 3 provides the theoretical underpinnings of our study. We turn to the data collection and methodology in section 4. Regression models testing our hypotheses are presented in section 5. We close with conclusions and directions for further research.

2 The Dutch retail and transport context

Compared with other high-income countries, such as France and Germany, the Netherlands has an 'old-fashioned' retail structure, characterized by a large number of small-scale shops per capita concentrated in urban areas, and only few large-scale hypermarkets and shopping malls at the edges of major cities (Evers, 2002). In the Netherlands, fully enclosed shopping malls have emerged mainly in city centers, similarly to within the UK, but to a lesser extent and at a smaller scale (Guy, 1994). Table 1 presents some figures on planned shopping centers to highlight the differences in retail structure between the Netherlands and other major European countries. As shown in this table, the Netherlands has the second highest gross leasable area per capita, but the smallest average shopping center size.

The exceptional retail structure in the Netherlands can be attributed to a restrictive retail planning policy for more than five decades, which prevented uncontrolled retail growth at the fringe of urban areas and protected traditional shopping centers and the

[(1)] In this paper only independent retailers with one outlet are included, as they are most influenced by their location as compared with multiple retailers. For the latter type of retailers the decision to develop a website is often taken at the headquarters and therefore is less influenced by local conditions.

Table 1. Gross leasable area (GLA) of planned shopping centers (PSC) in European countries (2006). Sources: NRW (2006), Eurostat (2006).

Country	Total GLA (m^2)	PSCs	Average size of PSC (m^2)	Total population ($\times$1000 inhabitants)	Total GLA of PSC per per 1000 inhabitants
United Kingdom	13 913 161	648	21 471	60 393	230
France	13 154 680	609	21 600	62 886	209
Germany	11 543 364	472	24 456	82 438	140
Spain	8 575 138	421	20 368	43 758	196
Italy	8 298 621	525	15 807	58 752	141
The Netherlands	**5 495 527**	**435**	**12 633**	**16 334**	**336**
Poland	4 275 216	197	21 702	38 157	112
Norway	3 658 998	216	16 940	4 640	789
Sweden	3 015 452	201	15 002	9 048	333
Austria	2 270 500	129	17 601	8 266	275

functional retail hierarchy (Evers, 2002). City and village centers are, therefore, still at the top of the retail hierarchy in the Netherlands. The recent deregulation and decentralization of retail planning policy in the Netherlands is unlikely to result in a more relaxed policy, as the new provincial guidelines are largely consistent with the previous national guidelines concerning peripheral retailing (Spierings, 2006).

It should also be remembered that the Netherlands is a small and highly urbanized country in which, even in rural areas, consumers have a relatively good shop accessibility in comparison with larger countries such as Germany, Canada, or the US. As a result, the Netherlands differs from other West European countries and the US in terms of the share of total distance that is covered by slow transportation modes. In 1990 the share of walking and cycling in the total distance traveled was 12% for the Netherlands, compared with 4% for Western Europe as a whole (Schwanen et al, 2004). Of all shopping trips in the Netherlands more than half are made on foot or by bicycle. Together, these modes account for 20% of all kilometers traveled for shopping purposes (Dieleman et al, 2002). The outcomes of this paper thus should be interpreted with the Dutch retail and transport context in mind, though the conceptual framework and research methodology can be applied to any country or region.

3 Theoretical framework

Like any other innovation, the adoption of Internet strategies by independent retailers can be considered as a diffusion process that takes place in space and time. When studying this adoption process from a geographical perspective, several spatial logics are expected to operate simultaneously: (1) a shopping center hierarchy differentiating between shopping locations within cities, (2) an urban hierarchy differentiating between different cities, and (3) a regional hierarchy to distinguish between more densely urbanized and rural regions.

3.1 Shopping center hierarchy

An important part of retail location theory is based on the central-place theory of Christaller (1933). In this theory, goods are classified in terms of thresholds—that is, the population necessary to make the supply of a good profitable. The highest threshold goods are, therefore, only available in the largest urban centers, while low-threshold goods are traded locally. Since the catchment area for lower order goods is considerably smaller than for higher order goods, a hierarchy of shopping centers emerges with

a few central places supplying the whole range of goods surrounded by larger numbers of towns and villages offering smaller product ranges.

Berry (1967) applied the central-place concept of Christaller to intraurban shopping locations resulting in an urban shopping center hierarchy. Berry defined five categories, ranging from the convenience center with the lowest catchment area to the metropolitan central business district with a regional or national function. Higher order centers encompass large numbers of retail outlets and specialized shops, while the lowest order centers are only important for the provision of daily goods to the surrounding population of those centers. A previous study found that Berry's retail hierarchy also applied to the Netherlands, though with city centers at the top of the retail hierarchy (Borchert, 1998).

Internet penetration is expected to be lowest in shopping centers at the bottom of the retail hierarchy, since they mainly retail daily goods that are less suitable for b2c commerce. However, after accounting for the type of product, we still expect independent retailers in these localities to show lower levels of adoption than independents in higher order centers for two reasons. First, higher order centers, such as city and village centers, have larger catchment areas, and thus serve large numbers of consumers of which the majority do not reside in the vicinity of the center. As the Internet provides a medium to communicate over any distance and at relatively low costs, retailers with many distant and dispersed customers will have a higher payoff from adopting the Internet. Second, the position of a shopping center in the hierarchy strongly correlates with the size of the location. Higher order centers generally contain more retail outlets than lower order centers. Assuming that retailers within the same shopping area are part of a communication network, or are able to learn by imitation (see Boschma and Weltevreden, forthcoming), an innovation will spread faster in higher order centers than in lower order centers.

Hypothesis 1a. *Independent retailers in shopping centers at the top of the retail hierarchy adopted the Internet earlier than their counterparts located in shopping centers at the bottom of the retail hierarchy.*

Hypothesis 1b. *Independent retailers in shopping centers at the top of the retail hierarchy are more likely to adopt information-only and online sales strategies than their counterparts located in shopping centers at the bottom of the retail hierarchy.*

Note here that specialized (eg factory outlet centers) and large-scale retail locations (eg furniture districts) fall outside the hierarchical shopping center classification. Like city and village centers, the specialized and large-scale retail locations have large catchment areas. For example, consumers are willing to travel large distances to visit a furniture district. For these localities the Internet may also be an excellent tool to reach (potential) customers residing far from the shopping center in an easy and inexpensive way. Therefore, we assume that independent retailers at these localities have the same likelihood to adopt the Internet as their counterparts at city and village centers.

Furthermore, there is a considerable number of retailers that are not located in a shopping center in the Netherlands, also referred to as solitary retailers. These retailers do not experience the advantages of retail clustering in a shopping center (eg high footfall). Instead, they need other means to attract customers. For solitary retailers the payoff to adopt the Internet is expected to be high, as the Internet provides the possibility of market extension and of informing potential customers (Steinfield et al, 2001). As such, we expect that:

Hypothesis 2a. *Solitary independent retailers and independents at large scale/special retail locations adopted the Internet as early as their counterparts at city and village centers.*

Hypothesis 2b. *Solitary independent retailers and independents at large scale/periphery retail locations are as likely to adopt information-only and online sales strategies as their counterparts at city and village centers.*

3.2 Urban hierarchy

According to the *urban density hypothesis* retailers in large(r) cities have a higher likelihood to follow an Internet strategy, as the adoption costs decrease when population size and density increase (Foreman et al, 2005a; 2005b). There are various reasons why these adoption costs are lower in large(r) cities. First, large(r) cities usually have a more advanced telecommunication infrastructure (eg broadband and fiberglass networks) which stimulates Internet adoption (Foreman et al, 2005a; 2005b; Kolko, 2000). Second, large(r) cities contain a larger pool of specialists—such as web designers and other computer specialists—that retailers can hire to develop a website (Foreman et al, 2005a; 2005b; Kolko, 2000; Moss, 1998). Third, innovations diffuse faster in large(r) cities, because of a higher probability of knowledge spillovers and imitation of successful strategies (Boschma and Weltevreden, forthcoming; Brown, 1981; Foreman et al, 2005a; 2005b; Kolko, 2000; Pred, 1977). Finally, the adoption of Internet strategies is influenced by local consumer demand (Anderson et al, 2003; Boschma and Weltevreden, forthcoming). Consumers in large(r) cities have a higher probability to engage in online shopping as they are better educated, have higher incomes, and are more time-constrained; thus having a lifestyle that stimulates them to shop online (Anderson et al, 2003; Kolko, 2000). To summarize:

Hypothesis 3a. *The larger the city in which an independent retailer is located, the earlier it adopted the Internet.*

Hypothesis 3b. *The larger the city in which an independent retailer is located, the higher the probability of adoption of information-only and online sales strategies.*

3.3 Regional hierarchy

Internet adoption is not only expected to vary among cities of different size, but also among densely populated areas [regions with many (large) cities] and peripheral areas (regions with few cities). Agglomeration economies responsible for the hierarchical diffusion of Internet adoption from large to small settlements apply to the regional level as well. According to the filtering-down theory, innovations are consecutively established at lower levels in the regional hierarchy (Thompson, 1968). The filtering-down theory is based upon the notion of an urban product life cycle, with new innovations starting in metropolitan areas and moving to rural areas when the innovation matures. The speed of regional diffusion is determined by the speeds by which the fixed setup costs of innovation decline and the regional demand for the innovation increases. Thus, following Thompson, at the regional level a geographical diffusion pattern from core regions to peripheral regions is likely to occur. Nonetheless, the core regions retain their first-mover advantage relative to the other regions.

Hypothesis 4a. *The higher the urban density of the region in which a shop is located, the earlier it adopts the Internet.*

Hypothesis 4b. *The higher the urban density of the region in which a shop is located, the higher the probability of adoption of information-only and online sales strategies.*

Yet, for certain types of goods hypotheses 4a and 4b are not expected to hold. What is specific for Internet adoption—in the form on online sales—is that additional logistic costs are involved in the distribution of purchased goods to the consumer, and that these costs vary for different types of goods. In this context,

the distinction between core urbanized regions and peripheral rural regions is also of importance. Consumers in peripheral locations have the highest benefits from access to the wide variety of goods provided via the Internet, because they need to travel larger distances for the purchase of goods (Anderson et al, 2003; Farag et al, 2006; Sinai and Waldfogel, 2004; Weltevreden, 2007a). They can use the Internet to overcome isolation from high-quality retail locations. This argument, however, mainly applies for goods that can be easily delivered by mail (eg books and CDs) or parcel services (eg cosmetics and clothes), since the delivery costs of mail and packages are independent of the distance in most countries (including the Netherlands). A previous study showed that the probability of buying CDs, videos, and DVDs via the Internet is higher for Dutch consumers with a relatively bad accessibility to shops (Farag et al, 2006). Retailers selling 'mail and parcel goods' in peripheral regions may, thus, be more inclined to engage in online sales than their counterparts in core areas to better service their more dispersed customers.

By contrast, for 'freight goods' that cannot be distributed by mail and parcel services (eg groceries and furniture), retailers in core areas may be more likely to engage in online selling. To be profitable in terms of logistics, online grocery retailers, for example, must have a high density of customers (Murphy, 2003; Visser and Lanzendorf, 2004). To summarize, the likelihood of engaging in online sales will differ between core and peripheral regions, depending on the type of good that is transported:

Hypothesis 5a. *Independent retailers in the periphery that sell 'mail and parcel goods' are more likely to adopt an online sales strategy than their counterparts in the core area.*

Hypothesis 5b. *Independent retailers located in the core region that sell 'freight goods' are more likely to adopt an online sales strategy than their counterparts in the periphery.*

3.4 Control variables: product and size

The adoption of Internet strategies by retailers largely depends on the characteristics of their product and their organization (size). As such, one needs to account for these firm characteristics when studying the geographical diffusion of Internet strategies. Otherwise, composition effects of retail locations may distort the empirical results.

Internet adoption varies among retailers of different products because consumers' shopping efforts vary with respect to the type of product (Klein, 1998; Peterson et al, 1997). Search-goods sectors—such as books, videos and DVDs, and CDs—are among the most popular products bought online by Dutch consumers (Weltevreden, 2007b). Not surprisingly, search-good retailers have a high likelihood to adopt an information-only and even more so an online sales strategy, as compared with retailers selling experience or convenience goods (Boschma and Weltevreden, forthcoming; Ellis-Chadwick et al, 2002; Weltevreden and Atzema, 2006; Weltevreden et al, 2005). Since experience goods require more physical evaluation by consumers and often come in collections that change regularly (eg clothing), retailers selling these kind of products are less likely to sell online. The same holds for convenience-goods (ie daily items, such as groceries and personal care items) retailers, as these items are frequently purchased and are part of consumers' daily routines. It takes more effort to acquire information about those products online than a daily trip to a neighborhood or convenience center. As such, experience-goods and convenience-goods retailers are more likely to follow an information-only strategy (Boschma and Weltevreden, forthcoming; Weltevreden and Atzema, 2006; Weltevreden et al, 2005).

Internet adoption of retailers is also influenced by the size of the retail organization. Larger firms have several advantages over smaller firms with regard to the adoption of technological innovations, such as the Internet. Compared with small

firms, larger firms have a greater ability to raise capital, to bear the costs of the innovation, and to bear the risk of failure (Brown, 1981). Empirical studies show that large(r) retailers indeed have a higher probability to follow an Internet strategy, as compared with small(er) retailers (eg Ellis-Chadwick et al, 2002; Morganosky, 1997; Weltevreden and Atzema, 2006; Weltevreden et al, 2005; Worzala et al, 2002).

4 Methodology

4.1 Data collection

We used a subset of the 2004 retail location database of Locatus with data of all retail outlets in the Netherlands. The subset contains data about every independent retailer with one outlet in thirteen retail categories (11 627 independents), representing 10.8% of all retail outlets of independent retailers in the Netherlands. The following variables are included in the dataset: name; address; formula; sector; floor space; and shopping center type (see table 2 for descriptive statistics).

Some remarks about Locatus's method of data collection should be made. Collecting retail data of every shopping location in the Netherlands is a time-consuming business, as employees of Locatus physically visit every shop. As such, Locatus attempts to update the data of each retail outlet at least once in every four years. However, many shopping locations are visited more frequently (once a year or more) as Locatus's customers demand accurate data. With respect to our dataset, 22.3% of the shops were last visited by Locatus in 2004, 70.1% in 2003, 6.1% in 2002, and 1.6% in 2001.[(2)]

Through a time-consuming procedure (December 2004 to March 2005), we searched for the websites of the independent retailers in our dataset via Google.[(3)] Despite the fact that Google is the most accepted and used search engine—searching through more than 8 billion web pages worldwide—it is not able to find all websites one is looking for. A study conducted in Germany revealed that Google was only able to find 61% of all '.de domains' (Heise Online, 2004). To improve the accuracy of the data, we also searched directly for websites by typing likely domain names in the address bar of the browser. We argued that retailers largely choose domain names that are closely related with their company name. In some cases this strategy resulted in 'hits' that we could not find via Google. To further improve the accuracy, the data were reexamined by three trained coders. After we obtained the web addresses, we made use of the Whois database on the Internet to find the registration date of each domain name.

4.2 Dependent variables

We use two dependent variables to investigate the geographical diffusion of retail Internet adoption. First, we use the date of domain name registration as proxy for the *adoption time* of independent retailers. This analysis is an innovation diffusion analysis as the dependent variable measures the number of days that independents have had a domain name (table 2). Note that independent retailers without an active website have been left out of this analysis. Many of them do not have a domain name, while in the cases of those that have one, we could not trace it without an active web address. This analysis, however, does not give insight in the type of Internet strategy independents follow.

[(2)] We were able to investigate the accuracy of this dataset by comparing it with our own dataset that consists of data on every retail outlet in eight Dutch city centers which were collected in 2003 – 04 (see Weltevreden and Atzema, 2006). The Locatus data turned out to be highly accurate, at least for those eight city centers.

[(3)] The fact that it takes much time to gather data on Internet strategies of retailers is the main reason for using a subset of the retail location database of Locatus. From this database we selected thirteen retail categories that vary in terms of prospects for e-commerce (see table 4).

Table 2. Descriptive statistics.

Internet adoption	Domain name registration in days (mean)	Internet strategy (%) [a]			
		pre-Internet strategy	information-only strategy	online sales strategy	total
(*dependent*)					
Domain registration in days	1 600				
No website	–	100	0	0	70
Information-only strategy	1 565	0	100	0	24
Online sales strategy	1 762	0	0	100	5
Shopping center hierarchy					
Small neighborhood/ convenience centers	1 603	72	23	5	6
City district/large neighborhood centers	1 572	74	21	5	13
City/village centers	1 574	72	23	5	63
Solitary urban locations	1 627	68	26	7	10
Peripheral/large-scale retail locations	1 721	54	41	5	8
Urban hierarchy					
Small-sized cities	1 567	72	24	4	48
Medium-sized cities	1 589	69	25	6	34
Large-sized cities	1 705	70	24	7	18
Regional hierarchy					
Periphery	1 559	73	23	5	37
Intermediary	1 596	69	26	5	31
Core (Randstad)	1 644	69	24	6	32
Retail category					
Supermarkets	1 459	87	12	2	2
Delicatessen stores	1 346	60	32	9	3
Drug stores	1 528	89	8	3	5
Perfume and cosmetics stores	1 474	73	22	5	1
Ladies-wear stores	1 334	87	13	1	29
Family-wear stores	1 595	79	20	2	17
Men's fashion stores	1 585	69	20	2	9
Sport shops	1 531	60	35	5	4
Furniture stores	1 571	57	42	1	12
Toy stores	1 451	56	33	11	4
Computer stores	1 899	25	51	23	7
Book stores	1 759	48	23	29	5
CD shops	1 670	60	27	13	3
Size					
Log (floor space) (m^2)	0.095 [b]	1 956 [c]	2 106 [c]	1 907 [c]	1 992 [c]
Valid *N*	3 334	8 175	2 840	612	11 627

[a] Percentages may not add up to 100% due to rounding.

[b] Pearson correlation coefficient, significant at $p < 0.01$.

[c] Mean of log (floor space).

Therefore, we also distinguish three *types* of Internet strategies that independents adopted at a particular moment in time (early 2005): (1) a *pre-Internet strategy* (no website), (2) an *information-only strategy* (a website, but without online sales), and (3) an *online sales strategy* (see table 2). As some retailers have more than one website, we decided to include the most sophisticated one in our analyses. Independent retailers that have a website 'under construction' were considered to have an information only strategy, while independents that have an empty domain name were not considered to have an informative website. Furthermore, we speak of an online strategy when consumers can order products via the website. The payment need not necessarily be conducted online. By looking at these two dependent variables we are not only able to investigate which independent retailers at which locations were the first on the Internet, but also to what extent they use the new commercial possibilities as provided by the Internet.

4.3 Independent variables

As independent variables we use three spatial variables: (1) a shopping center hierarchy, (2) an urban hierarchy, and (3) a regional hierarchy. In addition, we use two control variables: product and size.

First, the typology of shopping centers was also already present in our dataset (see table 3).[4] Besides the shopping centers presented in this table, solitary urban retailers, solitary retailers at business parks, and solitary peripheral retailers are also distinguished. To have sufficient numbers of cases in each category, some shopping locations

Table 3. A typology of shopping centers [source: adapted from Locatus (2004)].

Type	Definition
City/village center	The largest and central shopping location in a city or village (five stores or more).
City district	A shopping center with more than fifty stores operating next to a large city center (ie a hundred stores or more).
Large neighborhood center	A shopping center with between twenty-five and fifty stores operating next to a city or village center.
Small neighborhood center	A shopping center with between ten and twenty-five stores, or a center with five to ten stores and two or more supermarkets operating next to a city or village center (and city districts/large neighborhood centers).
Convenience center	A shopping center with five to ten stores and one or no supermarket operating next to a city or village center (and city districts/neighborhood centers).
Large-scale retail location	A shopping center with five or more stores, with a mean floor space of 500 m^2 or more per shop. The sectors 'pets, flowers and plants', 'consumer electronics', 'bikes and car accessories', 'do-it-yourself', and 'furniture and home furnishing' must make up at least 50% of the total floor space in these centers.
Special shopping center	A shopping center that does not belong to one of the other categories (eg factory outlet centers, shopping centers at airports).
Solitary shop	A shop that is not located in one of the preceding shopping centers.

[4] Note that city and village centers can be very small (five to fifty stores in villages) or very large (more than 400 stores, for example, in Amsterdam) and that other levels in the shopping center hierarchy are only present at a certain urban size.

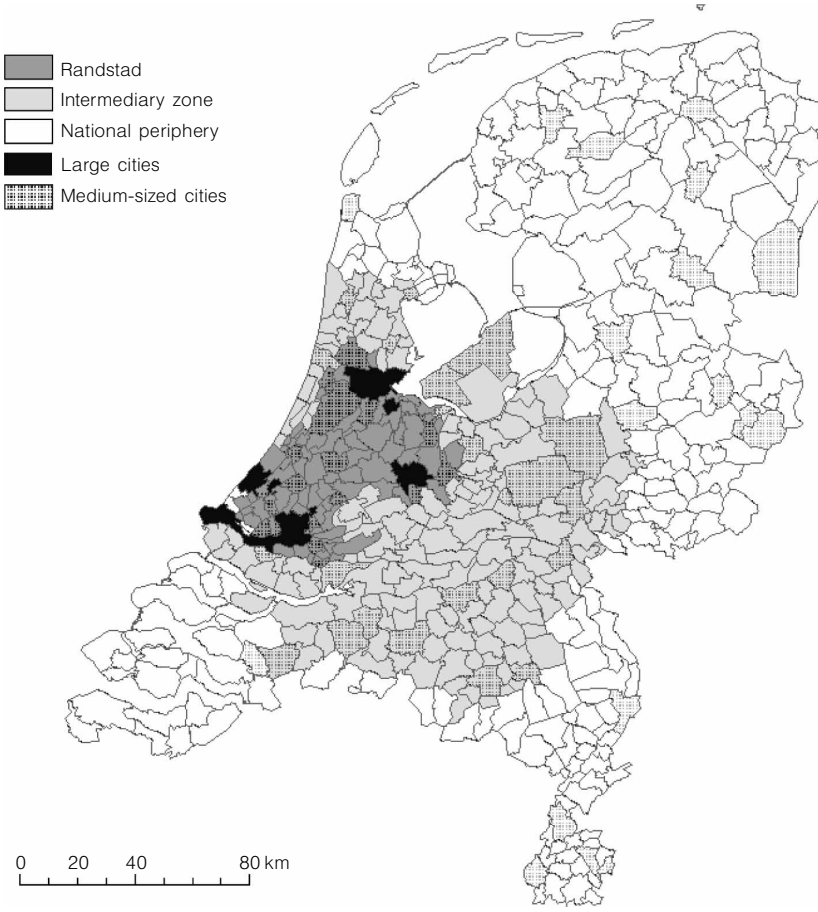

Figure 1. Urbanization map of the Netherlands, including the core region (Randstad), the surrounding intermediary zone, and the periphery.

were put together. We combined city district centers with large neighborhood centers, and combined small neighborhood centers with convenience centers. Furthermore, solitary retailers at business parks, solitary peripheral retailers, and special shopping centers were combined with peripheral or large-scale retail locations, resulting in the shopping center typology as presented in table 3.

Second, within the urban hierarchy three levels are distinguished, depending on the number of inhabitants (in 1996) of the municipality in which the independent retailer is located: large cities (>200 000), medium-sized cities (45 000 – 200 000), and small-sized cities (<45 000) (see figure 1). Using this definition, there are only four large cities in the Netherlands: Amsterdam, Rotterdam, The Hague, and Utrecht.

Third, at the regional level one can make a distinction between the most urbanized parts of the Netherlands, also known as the Randstad, and more rural parts (the periphery). Since the 1950s the Randstad has expanded southwards and eastwards to surrounding regions. On the base of employment gravity values, we made a distinction between the core region (the Randstad), the surrounding intermediary zone, and the periphery (van Oort, 2004), which we will use in our analysis (see figure 1).

Fourth, we apply a sector classification and a product typology. The first distinguishes among thirteen retail categories (see table 4) and includes convenience goods,

Table 4. Sectors differentiated by product characteristics and logistic intensity.

Product type	Mail	Parcel	Freight
Convenience goods	–	Drug stores, Perfume and cosmetics	Supermarkets, delicatessen
Experience goods	–	Ladies wear, family wear, mens' wear, sport shops	Furniture
Search goods	Books, CDs	Computers, toy stores	–

search goods, and experience goods.[5] To test our two specific hypotheses (5a and 5b) concerning regional differences in online sales adoption, we also use a product typology, which deals with the logistic intensity (ie delivery costs) of products: (1) mail goods (low cost, independent of distance), (2) parcel goods (medium cost, independent of distance), and (3) freight goods (high cost, dependent on distance). We assigned our thirteen retail categories to one of those three product types (see table 4).

Fifth, we use a measurement for the size of independent retailers. Recall that all independents in our sample have only one outlet. As such, we use the floor space of independent retailers (measured in m^2) as a size indicator. This variable was already present in the original dataset, and is a good proxy for the size of the organization. In the analyses we use the logarithm of floor space as it led to a better model fit.

5 Results

5.1 Domain name diffusion in the Netherlands (1994 – 2005)

In figure 2 four maps are displayed that show the geographical distribution of domain name registration in the Netherlands for the period 1994 – 2005. The black dots on the maps represent new adopters in a specific year, while the grey dots represent independent retailers that adopted a domain name in previous years.

In 1994 hardly any independent retailer had registered a domain name. Four years later (in 1998)—just before the Internet hype—domain registration became more popular, but was largely concentrated in the core region (Randstad) and in the large and medium-sized cities (compare figure 1 with figure 2). Between 1999 and 2002 the majority of the independents with a website in our sample registered a domain name. In this period domain name registration expanded to small cities and peripheral regions, while independents in the core region and large and medium-sized cities continued to register. Note that the majority of the (large) multiple retailers had already registered a domain name earlier (between 1995 and 1998) (Weltevreden, 2007a). In the final map (2004 – 05) the diffusion of domain registration slows down, with only a few adopters (mainly in the large and medium-sized cities).

5.2 Multivariate results of domain name registration and Internet adoption

In this section we present the estimation results for the joint effects of location, product, and organization on domain registration and Internet strategy adoption, respectively. Linear regression was chosen for domain registration, as it is a continuous variable that measures the number of days that independent retailers have had a domain name (see model 1 in table 5).[6]

[5] Convenience goods are frequently purchased items available at many locations. For experience goods it holds that information cannot be known without direct experience or is very costly, while for search goods this information can be obtained more easily (Copeland, 1923; Nelson, 1970).

[6] The reader should note that hazard modeling is more often used in innovation diffusion studies. However, our data do not permit hazard model estimation for two reasons. First, we do not have information about the characteristics of independent retailers at the time that they were first able to register a domain name—that is, 1994. Second, it is likely that a considerable number of retail businesses were founded after 1994.

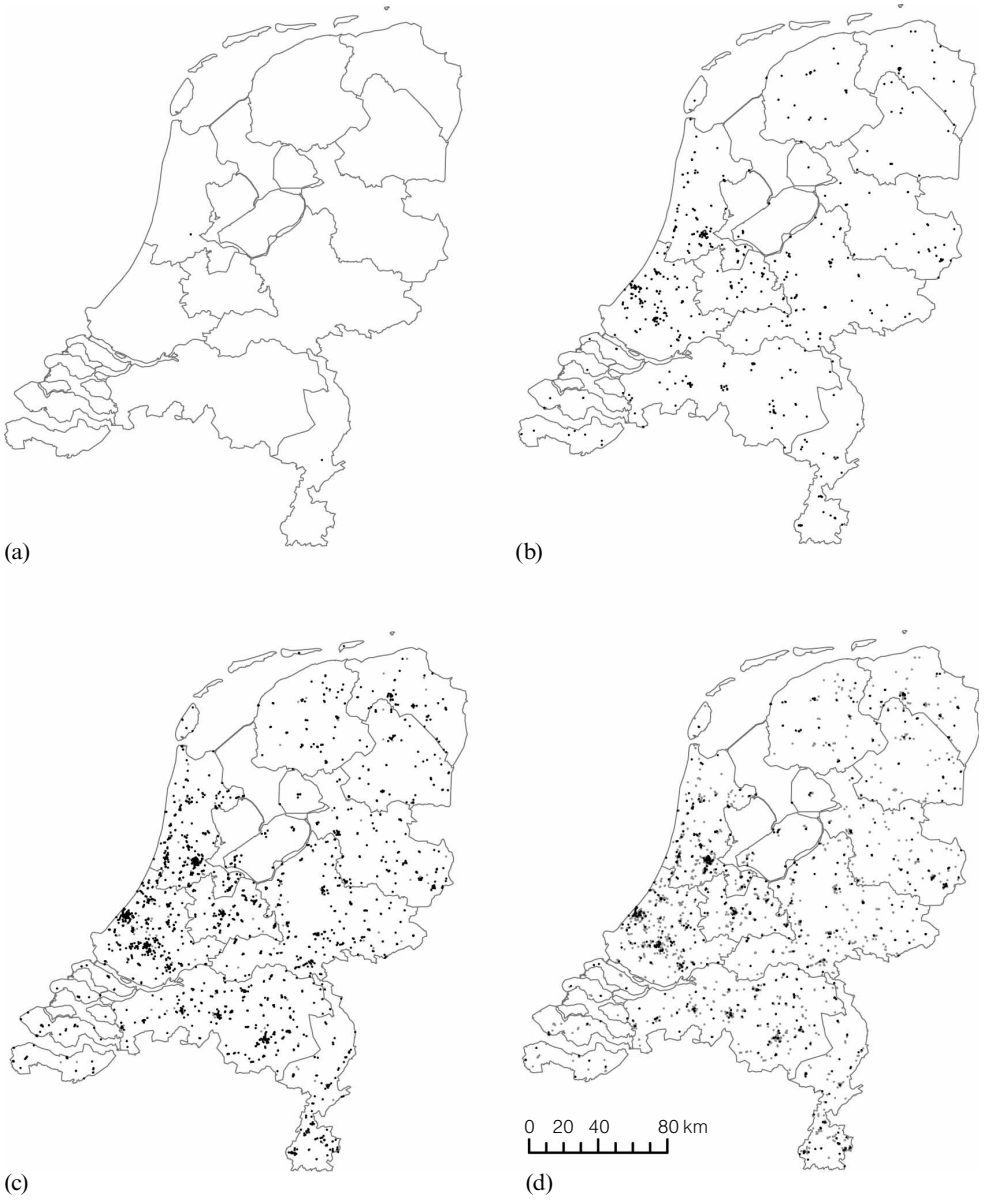

Figure 2. Geographical diffusion of domain name registration by independent retailers in the Netherlands (1994 – 2005): (a) 1994; (b) 1995 – 98; (c) 1999 – 2002; (d) 2003 – 05.

For Internet strategy adoption, we used multinomial logistic regression (see model 2 in table 5), as the dependent variable consists of more than two categories (ie pre-Internet strategy, information-only strategy, and online sales strategy).[7] The multinomial logistic regression model estimates the effect of the explanatory variables on the probability (differential odds) that one of three strategies will be selected (Wrigley, 1985). In our models we use the pre-Internet category as the baseline by

[7] We did not apply a nested model, because we consider the three alternatives to be independent. Many retailers have never used an information-only strategy before applying an online sales strategy (and vice versa).

Table 5. Linear regression of domain registration and multinomial logistic regression of Internet strategy adoption.

	Model 1 domain registration (in days) B(SE)		Model 2 (reference category = pre-Internet strategy)			
			information-only strategy B(SE)		online sales strategy B(SE)	
Shopping center hierarchy						
Small neighborhood/convenience centers	0		0		0	
City district/large neighborhood centers	−39.225	(62.364)	−0.094	(0.125)	0.142	(0.240)
City/village centers	56.897	(53.300)	0.223**	(0.107)	0.592***	(0.207)
Solitary urban locations	57.510	(61.999)	0.030	(0.127)	0.501**	(0.237)
Peripheral/large-scale retail locations	121.452*	(62.404)	0.321**	(0.127)	0.687***	(0.262)
Urban hierarchy						
Small-sized cities	0		0		0	
Medium-sized cities	65.184**	(26.730)	0.142***	(0.054)	0.487***	(0.107)
Large-sized cities	250.757***	(45.486)	0.212**	(0.095)	0.459***	(0.176)
Regional hierarchy						
Periphery	0		0		0	
Intermediary zone	53.375*	(28.911)	0.207***	(0.057)	0.074	(0.118)
Core (Randstad)	70.731**	(36.050)	0.277***	(0.074)	0.451***	(0.142)
Retail category						
Supermarkets	0		0		0	
Delicatessen stores	132.433	(134.491)	1.895***	(0.234)	2.718***	(0.557)
Drug stores	285.270*	(150.454)	0.070	(0.251)	1.112*	(0.580)
Perfume and cosmetics stores	186.486	(162.358)	1.236***	(0.288)	1.877***	(0.648)
Ladies-wear stores	70.259	(123.828)	0.486**	(0.202)	−0.700	(0.572)
Family-wear stores	277.220*	(123.156)	0.863***	(0.202)	0.607	(0.538)
Men's fashion stores	267.248**	(125.140)	1.367***	(0.207)	0.575	(0.572)
Sport shops	192.906	(128.411)	1.619***	(0.218)	1.758***	(0.557)
Furniture stores	26.411	(120.056)	1.334***	(0.200)	−0.107	(0.566)
Toy stores	212.843*	(128.068)	1.932***	(0.221)	2.943***	(0.537)
Computer stores	737.926***	(122.503)	3.340***	(0.215)	4.725***	(0.527)
Book stores	462.315***	(125.682)	1.650***	(0.221)	3.970***	(0.523)
CD shops	399.029***	(131.515)	1.597***	(0.228)	2.941***	(0.539)
Size						
Log (floor space) (m^2)	376.795***	(33.227)	1.025***	(0.072)	1.070***	(0.156)
Constant/intercept	368.649**	(152.766)	−4.728***	(0.278)	−7.482***	(0.663)
F	19.965***		–			
χ^2	–		2 628.477***			
−2 log likelihood intercept only	–		15 079.751			
−2 log likelihood final	–		12 451.274			
R^2	0.335		–			
Adjusted R^2	0.112		–			
Pseudo Nagelkerke R^2	–		0.261			
N	3 334		11 627			

* $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$.

which to compare the estimated parameter of the other two categories. These estimates should be interpreted as representing the marginal utility of choosing an information-only strategy or online sales strategy over a pre-Internet strategy. Thus, a positive coefficient indicates that the greater the independent variable, the more likely the alternative will be chosen. Furthermore, three other multinomial logistic regression models have been estimated to investigate the regional impact on the online sales adoption of three types of goods that differ in terms of logistic intensity (table 6).

Table 6. Estimation results for online sales strategies, differentiated by logistic goods type (the reference category is pre-Internet strategy) [a].

	Mail goods *B* (SE)		Parcel goods *B* (SE)		Freight goods *B* (SE)	
Regional hierarchy						
Periphery	0		0		0	
Intermediary zone	0.263	(0.225)	−0.081	(0.153)	0.437	(0.416)
Core (Randstad)	0.498*	(0.289)	0.390**	(0.181)	0.977**	(0.447)
Urban hierarchy						
Small-sized cities	0		0		0	
Medium-sized cities	0.564***	(0.207)	0.533***	(0.139)	0.513	(0.359)
Large-sized cities	0.549*	(0.325)	0.715***	(0.238)	−0.493	(0.542)
Shopping center hierarchy						
Small neighborhood/ convenience centers	0		0		0	
City district/large neighborhood centers	0.878*	(0.524)	0.052	(0.307)	−0.414	(0.665)
City/village centers	1.361***	(0.472)	0.648**	(0.260)	−0.199	(0.544)
Solitary urban locations	1.790***	(0.549)	0.372	(0.293)	−0.223	(0.689)
Peripheral/large-scale retail locations	1.142	(0.750)	0.693**	(0.322)	0.890	(0.652)
Retail category						
Supermarkets	–		–		0	
Delicatessen stores	–		–		2.033***	(0.620)
Drug stores	–		0		–	
Perfume and cosmetic stores	–		0.730	(0.480)	–	
Ladies-wear stores	–		−1.823	(0.372)	–	
Family-wear stores	–		−0.456	(0.324)	–	
Men's fashion stores	–		−0.501	(0.375)	–	
Sport shops	–		0.777	(0.360)	–	
Furniture stores	–		–		0.072	(0.579)
Toy stores	–		1.833	(0.314)	–	
Computer stores	–		3.610	(0.297)	–	
Book stores	0		–		–	
CD shops	−0.977***	(0.192)	–		–	
Size						
Log (floor space) (m^2)	2.240***	(0.295)	0.709***	(0.228)	−0.526	(0.451)
Intercept	−6.660***	(0.782)	−5.702***	(0.572)	−3.499***	(1.270)
χ^2	155.592***		1 798.238***		220.765***	
−2 log likelihood intercept only	1 853.159		9 886.779		2 759.623	
−2 log likelihood final	1 697.557		8 088.541		2 538.858	
Pseudo Nagelkerke R^2 square	0.166		0.252		0.137	
N	997		8 678		1 952	

[a] The estimation results for information-only strategies are not shown in this table.
* $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$.

5.2.1 *Shopping center hierarchy* (*hypotheses 1a to 2b*)
There is no significant difference in the time of Internet adoption between independent retailers in city and village centers and their counterparts at shopping centers lower in the hierarchy (see model 1, table 5). As such, hypothesis 1a is not supported by our data. However, independents in city and village centers do have a higher probability of following an information-only and, even more so, an online sales strategy than their counterparts in city district, neighborhood, and convenience centers (see model 2, table 5). This is in line with hypothesis 1b.

According to hypothesis 2a and 2b, there is no significant difference in the *time* of adoption and the *probability* of adopting an Internet strategy among independent retailers in city or village centers, solitary urban independents, and independents in peripheral or large-scale retail locations. Hypothesis 2a needs to be rejected, as independent retailers in peripheral and large-scale retail locations registered domain names much earlier than their counterparts in central and solitary urban locations. Hypothesis 2b largely holds, as independent retailers in peripheral or large-scale retail locations, in city and village centers, and in solitary urban locations have about the same probability of following an online sales strategy (given the overlap in the value ranges in model 2). However, for the adoption of an information-only strategy there are significant differences between solitary urban retailers and their counterparts at the other two localities, as the former is less likely to adopt this strategy.

5.2.2 *Urban hierarchy* (*hypotheses 3a and 3b*)
With regard to the urban hierarchy we assumed that the *time* (hypothesis 3a) and the *probability* (hypothesis 3b) of Internet adoption by shops positively depends on the size of the city in which a shop is located. Results indicate that independent retailers located in large(r) cities were the first to register a domain name. They also have a higher likelihood of choosing an Internet strategy over a pre-Internet strategy, as compared with independents in small cities (see table 5). This substantiates hypotheses 3a and 3b.

5.2.3 *Regional hierarchy* (*hypotheses 4a to 5b*)
On the regional level we also assumed a spatial pattern in the diffusion of Internet adoption by independent retailers: independents in the core region (Randstad) are more likely to have registered an Internet domain *earlier* (hypothesis 4a) and to have a higher *probability* of Internet strategy adoption than their counterparts in less urbanized areas (hypothesis 4b). Hypothesis 4a is supported by our data, as independents in the core region registered their domain names earliest, followed by their counterparts in the intermediary zone (see model 1, table 5). Furthermore, independent retailers in peripheral areas have a lower probability of adopting an information-only strategy, as compared with independents in the intermediary and the core region. In addition, independents in the core region are more likely to follow an online strategy than their counterparts in the intermediary and peripheral regions (see model 2, table 5). Thus hypothesis 4b is, by and large, also supported by our data.

We also expected the regional diffusion of online sales strategies to vary among retail categories depending on the logistic costs involved. First, we assumed that independents in the periphery that sell goods that are distributed by mail or parcel services are more likely to follow an online sales strategy than their counterparts in the core area (hypothesis 5a). Second, independent retailers in the core region that sell freight goods are more likely to adopt an online sales strategy than independents in the periphery (hypothesis 5b). To test these hypotheses, separate multinomial logistic regression models were estimated, one for each type of logistical good (see table 6). Note that the estimation results for information-only strategies are not shown in this table, as hypotheses 5a and 5b concern only online sales strategies.

The results of these additional analyses show that, for all three types of logistical goods, independent retailers in the core region have the highest probability of adopting an online sales strategy over a pre-Internet strategy. Despite the fact that the price of postal and parcel services is independent of distance in the Netherlands, the probability of online sales adoption is nevertheless highest among the independents in the core region. As such, hypothesis 5a needs to be rejected, while hypothesis 5b is supported.

5.2.4 *Control variables*: *product and size*

We close this section with a brief description of the results for our two control variables in the models in table 5. As expected, independent retailers selling search goods have been on the Internet for a longer period and have a higher probability of choosing an information-only or online sales strategy over no website than do independents selling experience of convenience goods. Furthermore, in general, independent retailers selling experience goods have a lower probability of adopting an online sales strategy than independents selling convenience goods. Concerning organization size, results indicate that the larger the floor space of independent retailers, the higher the probability that they registered a domain name early and that they follow an information-only or online sales strategy. These outcomes are in accordance with the findings of other empirical studies mentioned in the preceding discussion.

One should note that we also conducted two analyses in which we investigated the explanatory value of spatial variables without accounting for organizational variables. In these models—not included in this paper—the spatial outcomes were somewhat less clear-cut (mainly the results of the shopping center hierarchy). This can be explained by the fact that retail categories are not equally distributed among the types of shopping locations. Thus, to avoid composition effects when studying the geographical diffusion of retail Internet adoption, one should always account for organizational variables.

6 Conclusions

In this paper we investigated the geographical diffusion of Internet adoption among approximately 12 000 independent retailers in the Netherlands. Results indicate that independents in city or village centers and peripheral or large-scale retail locations are more likely to follow an information-only or online sales strategy than their counterparts in centers at the bottom of the shopping center hierarchy. At the urban level a hierarchical diffusion pattern is also visible. Independents in large(r) cities were online earlier and have a higher probability to adopt an Internet strategy than their counterparts in small(er) cities. At the regional level the likelihood of adopting an information-only or online sales strategy is higher for independent retailers in the core region (Randstad) than for independents in the periphery. Thus, agglomeration economies matter for retail Internet adoption at the level of shopping centers, cities, and regions.

As the rapid expansion of online sales in the Netherlands is expected to continue in the future (see Thuiswinkel.org, 2006), we predict that independent retailers in rural areas (in the periphery) will be most adversely affected by b2c e-commerce. Studies concerning the spatial diffusion of online shopping in the Netherlands revealed that consumers in rural areas—although having a lower probability of shopping online—shop most frequently online and are most likely to substitute in-store shopping with online shopping (Farag et al, 2006; Weltevreden, 2007a). Given the fact that the probability of adopting an Internet strategy is lower in smaller cities and in peripheral regions, we expect independents at these localities to become the most likely victims of the further growth of b2c e-commerce in the Netherlands.

Regarding the importance of geography for understanding Internet adoption by (independent) retailers, progress in future research lies in two areas. First, given the

exceptional retail and transport structure in the Netherlands, the outcomes presented in this paper do not necessarily apply to other developed countries. In other developed countries, such as France or the USA, with more spread-out populations, more out-of-town and large-scale retail developments, and a different transport structure (more car use), the spatial pattern of Internet adoption by retailers may be different. As such, future research should try to conduct similar studies in other countries or to feature a comparison among countries.

Second, studying the adoption of Internet strategies does not provide insights into the success of those strategies. For example, adopting an online sales strategy does not necessarily imply that incumbent retailers are successful in selling online (Weltevreden, 2007b). As such, future research should analyze the effects of adopting a certain Internet strategy on the performance of retailers at different shopping locations. This will further enhance our understanding of the impacts of b2c e-commerce on retailing and urban form.

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