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Abstract

Up till now, the literature on Internet adoption by retailers paid little attention to spatial variables. Using data on 27,000 retail outlets in the Netherlands, we investigate the geographical diffusion of Internet adoption by Dutch retailers. More precise, we examine to what extent retail Internet adoption differs between shopping centers, cities, and regions, while controlling for product and organizational variables. Results of the linear and multinomial logistic regressions suggest that shops at city centers are more likely to adopt the Internet than shops located at shopping centers at the bottom of the retail hierarchy. Furthermore, shops in large cities have a higher probability to adopt the Internet than shops in small cities. On the regional level, the likelihood of Internet adoption is higher for shops in core regions than for retail outlets in the periphery. In conclusion, geography seems to matter for retail Internet adoption.

Keywords: innovation, Internet adoption, retailing, geography, the Netherlands

INTRODUCTION

Business-to-consumer (b2c) e-commerce can be regarded as a disruptive innovation that can make existing business models obsolete (Burt and Sparks, 2003). B2c e-commerce provides retailers the possibility of a new service concept, a new client interface and, in some cases, a new delivery system. The history of retailing is replete of such innovations, like the introduction of department stores, mail order, and other.

Up till now, the impacts of b2c e-commerce on physical shops and shopping centers are still poorly understood. Yet, there is a growing interest in the factors that determine the adoption of the Internet in the retail literature. Few exceptions aside (see e.g., Currah, 2002; Atzema and Weltevreden, 2004), the majority of those empirical studies primarily focus on organizational factors, ignoring the role of spatial variables. Moreover, systematic empirical research analyzing Internet adoption by retailers at different shopping locations and urban settings is virtually non-existent.

In this article we aim to fill this gap in knowledge by examining the geographical diffusion of b2c e-commerce adoption among 27,000 retail outlets in the Netherlands. More precise, while controlling for product and organizational variables, we investigate to what extent retail Internet adoption differs between shopping centers, cities, and regions. Using insights from both the retail literature and spatial diffusion theories, three general hypotheses can be developed. First, on the shopping center level we expect that the size of the catchment area of a shopping centre, will positively affect the likelihood of Internet adoption. Second, on the urban level the size of the city where a shop is located, will positively affect the probability of Internet adoption. Finally, on the regional level differences in urban density between regions will lead to the diffusion of Internet adoption from core to peripheral regions.

The outline of this article 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. Linear and multinomial logistic regression models testing our hypotheses are presented in Section 5. We close with conclusions and directions for further research.

THE DUTCH RETAIL CONTEXT AND PLANNING SYSTEM

Compared to other high-income countries, like France and the United States, 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. Similar to the United Kingdom, fully enclosed shopping malls have emerged mainly in Dutch city centers, but to a lesser extent and at a smaller scale (Guy, 1994). The exceptional retail structure in the Netherlands can be attributed to a restrictive retail planning policy for more than five decades that prevented uncontrolled retail growth at the fringes of urban areas and protected traditional shopping centers and the functional retail hierarchy (Evers, 2002). City centers are, therefore, still at the top of the retail hierarchy in the Netherlands.

Historically, Dutch land use policy forced large-scale retailers to locate in or adjacent to existing retail concentrations. As an exception to this rule, only a few sectors were allowed to locate outside existing shopping areas on locations specifically designated as so-called "PDV-locations" (i.e., peripheral retail locations). In 1973, only retailers selling explosive or flammable merchandise, cars, boats and

caravans were permitted at PDV-locations. In 1984, shops selling furniture and do-it-yourself materials were added to the list of products, which, like cars, boats and caravans, require a considerable amount of floor space. Thus far, the PDV policy has had variable success. On the one hand, it prevented unwanted retail settlement in peripheral areas. On the other hand, due to the convergence of retail segments, more types of merchandise were sold at peripheral locations, which led to increased competition with the city centre (Borchert, 1998; Van de Wiel, 1996). In 1993, the restrictive policies were relaxed by the introduction of so-called "GDV-locations" (i.e., locations for large-scale retailing) for stores exceeding 1500 square meters of gross floor space. Permission to create this new type of retail location has only been granted to 13 of the larger cities. As one might expect these new opportunities for large-scale peripheral retailing were met with enthusiastic response from real estate developers and some retail firms. Further "GDV-development" can, therefore, influence the future spatial distribution of retail trade in the Netherlands (Evers, 2002).

It should also be reminded that the Netherlands is a small and highly urbanized country, where even in rural areas consumers have relatively good shop accessibility in comparison with larger countries such as Germany, Canada, or the USA. As a result, the Netherlands differs from other West-European countries and the USA 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 article thus should

be interpreted with the Dutch retail context in mind, though the conceptual framework and research methodology can be applied to any country or region.

THEORETICAL FRAMEWORK

From the empirical studies that have been conducted so far, we already know that Internet adoption differs by the size, the product, and the organizational structure of retailers (Morganosky, 1997; Ellis-Chadwick et al., 2002; Worzala et al., 2002; Atzema and Weltevreden, 2004). Yet, little is known about the impact of spatial variables on retail Internet adoption. When studying the adoption of the Internet by traditional retailers from a geographical perspective, we employ three spatial hierarchies. First, we will use the concept of retail hierarchy to underline the different shopping locations within cities, with higher-order shopping centers having larger catchment areas and thus being conducive for innovation adoption. Second, on the urban level, a spatial pattern of Internet diffusion can be largely attributed by differences in city size better known as the urban hierarchy concept. Third, on the regional level both agglomeration economies, as well as differences in efficiency gains by engaging in online sales play a role.

Retail 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 lower order convenience 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 intra-urban shopping locations resulting in an urban shopping centre hierarchy. Berry defined five categories, ranging from the convenience centre 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 centers are only important for the provision of daily goods to the surrounding population of those centers. As a fifth level, we introduce solitary shops within cities. The larger a city, the more levels in the shopping hierarchy are present. Berry's retail hierarchy also exists in the Netherlands. Note that, because of the restrictive retail planning policy in the Netherlands, a large part of retailing is still accommodated in the shopping centre 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 Internet commerce. However, after controlling for the type of product, we still expect that shops in these localities show lower levels adoption than outlets in higher order centers for two reasons. First, higher-order centers have larger catchment areas and thus serving large numbers of consumers of which the majority is not resided in the vicinity of the centre. As the Internet provides a medium to communicate over any distance and at relatively low costs, shops with many distant and dispersed costumers 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. Internet adoption is more likely in higher-order centers simply because the number

and variety of shops is larger in these localities, than in lower-order centers. Furthermore, assuming that retailers within the same shopping area are part of a communication network, or are able to learn by imitation, an innovation will spread faster in higher-order centers than in lower-order centers, due to differences in inter-firm competition.

Hypothesis 1a: Shops in shopping centers at the top of the retail hierarchy adopted the Internet earlier than shops located in shopping centers at the bottom of the retail hierarchy.

Hypothesis 1b: Shops in shopping centers at the top of the retail hierarchy are more likely to adopt an Internet strategy than shops located in shopping centers at the bottom of the retail hierarchy.

Besides the hierarchy of shopping centers, Berry (1967) also identified three other types of shopping locations that do not fit in the hierarchy: (1) highway-oriented ribbons, (2) urban arterial commercial developments, and (3) specialized functional areas. The growth of these non-hierarchical shopping locations is fostered by the rise of large-scale retailing, suburbanization, and increasing mobility of consumers, breaking down the traditional retail hierarchy (Berry, 1967). Often traditional shopping centers have the same catchment area as the non-hierarchical shopping locations.

Recall that in the Netherlands — apart from PDV and GDV locations — restrictive retail planning policy largely prevented the rise of shopping centers outside the retail hierarchy within cities. Highway-oriented ribbons are virtually non-existent

in the Netherlands (Borchert, 1998). Like city centers, the specialized PDV and GDV locations have a large catchment area. 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 resided far from the shopping centre at an easy and inexpensive way. Therefore, we assume that shops at PDV and GDV locations have the same likelihood to adopt the Internet as city centers.

Hypothesis 2a: Shops at PDV/GDV locations adopted the Internet as early as shops at city centers.

Hypothesis 2b: Shops at PDV/GDV locations are as likely to adopt an Internet strategy as shops at city centers.

Urban hierarchy

Like any other innovation, the adoption of b2c e-commerce can be considered as a diffusion process that takes place in space and time. Apart from individual shop characteristics, diffusion theories explain the time of adoption of a new innovation by the position of the individual shop in the communication network in which information about the innovation is exchanged (Hägerstrand, 1967). Because the density of the contacts included in a single person's private information field decrease with increasing distance, a person in proximity to the adopter of an innovation is more likely to adopt the innovation at an early stage. Pred (1977) also stresses the importance of networks by emphasizing the role of information density for innovation diffusion. He states that information density is highest in the largest cities, making

them likely starting points for innovation diffusion. Furthermore, Brown (1981) argues that "whether the early adopters are large or medium-size firms, large cities are most likely to contain the earlier adopters since they will have most firms of every size, as well as higher levels of information and inter-firm competition" (p. 164). Ceteris paribus, shops in larger cities will adopt b2c e-commerce earlier, because bigger cities are better connected by communication networks than smaller cities. New innovations thus flow directly from one large city to another, bypassing smaller cities located between them (Richardson, 1973). This hypothesis has become known as the *hierarchical diffusion hypothesis*, with urban hierarchy referring to differences in city size.

Besides information density, large cities provide important advantages for the adopters as large cities have better infrastructure (both in terms of roads and in terms of Internet connectivity), more human capital associated with Internet technology (Moss, 1998) and more specialized and competing Web design companies. Finally, consumers in larger cities are expected to be more open to explore new consumption opportunities. This is because they are relatively younger, more open-minded towards technology, and tend to have a more modern lifestyle (e.g., time-constrained), which all encourage Internet shopping (Anderson et al., 2003; Farag et al., 2005).

Hypothesis 3a: The larger the city in which a shop is located, the earlier it adopted the Internet.

Hypothesis 3b: The larger the city in which a shop is located, the higher the probability of adoption of an Internet strategy.

Regional hierarchy

Internet adoption is not only expected to vary between cities of different size, but also between densely populated (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 consecutively are 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 set up costs of the innovation decline and the regional demand for the innovation increases. Thus, following Thompson on the regional level a geographical diffusion pattern from core regions to peripheral regions is likely to occur. Nonetheless, the core regions remain 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 adopted 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 an Internet strategy.

The hypotheses formulated so far are all based on spatial diffusion theories. Importantly, these hypotheses refer to many different innovations as these hypotheses

are based on general diffusion mechanisms. However, what is specific for Internet adoption — in the form of online sales — is that additional logistic costs are involved in the distribution of purchased goods to the consumer. In this context, the distinction between core urbanized areas and peripheral rural areas is also of great 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; Sinai and Waldfogel, 2004; Farag et al., 2005). 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 (e.g., book, CDs etc.) or parcel services (e.g., cosmetics, clothes etc.), since the delivery costs of mail and packages are independent of the distance in most countries (including the Netherlands). Shops selling 'mail and parcel goods' in peripheral regions may be more inclined to engage in online sales than their counterparts in core areas to better service their customers, leading to the following hypothesis.

Hypothesis 5a: Shops located 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.

By contrast, for 'freight goods' that cannot be distributed by mail and parcel services (e.g., groceries, furniture etc.), shops 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. According to Murphy (2003), efficient routing is a matter of minimizing driving time and thus costs, and

largely depends on the density of 'customer drops', which is highest in core areas and lowest in peripheral areas. Visser and Lanzendorf (2004) also stress that a critical mass of clients and order size in a relatively small area is required for online grocery retailing. To summarize, the likelihood of the adoption of an online sales strategy will be different in core and peripheral areas, yet that the effect depends on the type of good that is transported:

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

Control variables: product, size, and organization type

As said before, the adoption of b2c e-commerce by retail outlets to a large extent depends on the characteristics of their product and their organization structure. To investigate the impact of location on the Internet adoption of shops, we need to control for product and organizational variables. If not, composition effects of retail locations may distort the empirical results. The following organizational characteristics are included, which we discuss in more detail below: product, size, and organization type.

Product

The adoption of b2c e-commerce is expected to differ between products. B2c e-commerce adoption varies between retailers of different products because consumers' shopping efforts vary with respect to the type of product (Peterson et al., 1997). In the literature one uses frequently the distinction made by Copeland (1923) between convenience goods, shopping goods, and specialty goods. Convenience

goods are bought most frequently, shopping goods less frequently, and specialty goods only rarely. However, the product classification made by Copeland in the 1920s is not fully appropriate anymore in the Internet era. According to Klein (1998, p. 195), we need another measurement system, because media like the Internet "have the potential to alter consumer behavior through direct impact on both the prepurchase and ongoing consumer information acquisition process". She brings consumers' information search to the fore and links her ideas to the classical distinction between experience goods and search goods made by Nelson (1970, 1974). Nelson defines goods as search goods when full information for dominant product attributes can be known prior to purchase. Goods are defined as experience goods when full information on dominant attributes cannot be known without direct experience or when information search for dominant attributes is more costly and difficult than direct product purchase.

In this article, we combine Copeland's and Nelson's classifications by distinguishing between convenience goods, search goods and experience goods. Particularly for search goods the Internet has the potential to provide information in a more accessible, less costly and more customizable way (Klein, 1998). This makes search goods more suitable to selling online than experience goods. Search goods sectors — like books, videos & DVDs, and CDs — are among the most popular products bought online by Dutch consumers (Weltevreden and Van Rietbergen, 2004). Therefore, it is among shops selling these kinds of products that we expect the largest b2c e-commerce penetration. Furthermore, we expect that shops selling experience goods are more likely to adopt information strategy than shops selling convenience goods. For convenience goods, which are frequently purchased and 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. However, we expect that shops selling experience goods are less likely to adopt an online sales strategy than shops selling convenience goods. Experience goods require more physical evaluation by consumers and often come in collections that change regularly, than convenience goods.

Size

The Internet adoption of retail outlets may also be influenced by the size of the retail organization. Brown (1981) identifies several advantages large firms have over smaller firms regarding the adoption of technological innovations, like the Internet. Compared to small firms, large firms have a greater ability to raise capital, to bear the costs of the innovation, and bear the risk of failure. Furthermore, larger firms can better afford the specialists needed to develop the website. Ellis-Chadwick and colleagues (2002) add that retailers with the largest store network may have most to loose should they be left as observers, rather than active participants, in b2c e-commerce. However, larger firms not always take the lead in the adoption of new innovations, as the firm size threshold seems to vary for different technologies (Brown, 1981). Nonetheless, studies regarding the Internet adoption by UK and US retailers revealed that the larger its size, the more likely a retailer is to have a website and to offer online selling opportunities (Morganosky, 1997; Ellis-Chadwick et al., 2002; Worzala et al., 2002).

Organization type

The adoption of b2c e-commerce is also expected to differ between types of retail organizations. There is a distinction between independent and multiple retailers.

A definition of multiples commonly used in the UK is a retail organization with more than ten branches (Cox and Britain, 2000). In the Netherlands, multiples are usually defined as organizations with more than seven outlets (Locatus, 2003). One may expect, that independent retailers will react differently to b2c e-commerce than multiple retailers. The former may be less able to adopt an Internet strategy due to cognitive incapacity, and the lack of financial and other resources (Boschma and Weltevreden, forthcoming).

A distinction should also be made between multiple retailers that have full control over their outlets (i.e., corporate chains), and those that make use of franchising or other forms of cooperation (e.g., voluntary chains, retail cooperatives, et cetera). For franchise organizations and other cooperatives the Internet is not only a channel to service their customers, but also an excellent tool to communicate with their current members and to recruit new ones. Because of this extra advantage franchisors and other cooperatives are more like to establish an information strategy than corporate chains. Regarding online sales, franchisors and other cooperatives are less likely to adopt, because an important interest group (i.e., the associated independent retailers) may feel threatened by selling online (cf., Watson et al., 2002). A collective website with online sales poses the threat of cannibalizing the in-store sales of individual members.

METHODOLOGY

Data collection

For this article we used a subset of the 2004 retail location database of Locatus with data of all shops in the Netherlands. The subset contains data about more than

27,000 shops in 14 retail categories representing 20% of all retail outlets in the Netherlands. The following variables are included in the dataset: name; address; formula, sector; floor space; and shopping centre type. Some remarks about Locatus' 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 a result, Locatus attempts to update the data of each individual shop at least once in every four years. Many shopping locations, however, are visited more frequently (once a year or more) as customers of Locatus demand accurate data. With respect to our dataset, 23 percent of the shops were last visited by Locatus in 2004, 72 percent in 2003, 4 percent in 2002, and 1 percent 2001. We will deal with the implications of this data collection method in the results section.

By a time-consuming procedure (December 2004 to March 2005), we searched for the websites of the individual shops in our dataset via Google. 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 recently 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 shop owners largely choose domain names that are closely related with the name of their business. In some cases this strategy resulted in 'hits' that we could not find via the search engine. To further improve the accuracy, the data was re-examined by three trained coders. After we obtained the web addresses of the retail outlets in our dataset, we used the Whois database on the Internet to find the registration date of each domain. We use the

registration date of a domain name as the date of Internet adoption of the respective shop.

It is important to state that in this article we have taken a shop as the unit of analysis and not a retail organization, which enabled us to investigate the Internet adoption of retailers across different shopping centers and urban settings. This means that, for example, a large, international multiple retailer like Hennes & Mauritz is recorded 61 times in our dataset, because it has outlets at 61 locations in the Netherlands.

Dependent variables

We use two dependent variables to investigate the geographical diffusion of retail Internet adoption. First, looking at the date of domain name registration we investigate the *adoption time* of retail outlets. This 'dynamic analysis' is truly an innovation diffusion analysis as the dependent variable measures the number of days retail outlets have a registered domain (Table 1). Note that retail outlets without an Internet domain have been left out of this analysis. This analysis, however, does not give any insight in what kind of Internet strategy shops have chosen. Second, we therefore also collected data on the *type* of Internet strategy that shops adopted at a particular moment in time (early 2005). In this 'static analysis', we are able to distinguish between shops with *no Internet strategy*, shops with an *information strategy* (i.e., a website but without online sales), and outlets with an *online sales strategy* (see Table 1). Since retailers can have more than one website, we decided to include the most developed one in our analyses. Shops that have a website "under construction" were considered to have an information strategy, while shops that have an empty domain name were not considered to have an informative website.

Furthermore, we speak of an online sales strategy when consumers can order products via the website. The payment need not necessarily be conducted online. Therefore, online photo services are also valued as online sales. By conducting both types of analysis we are not only able to investigate which type of retail outlets at which locations were the first on the Internet, but also to what extent they use the new commercial possibilities provided by the Internet.

<Insert Table 1 here>

Independent variables

The descriptive statistics of the independent variables are displayed in Table 1. There are six independent variables three spatial variables and three control variables, which we will describe in more detail below. The following spatial variables are included: a shopping center hierarchy, an urban hierarchy, and a regional hierarchy. The control variables are product, size, and organization type.

First, the typology of shopping centers was also already present in our dataset (see Table 2). Note that city centers can be very small (5 to 50 stores in villages) or very large (more than 400 stores in, e.g., Amsterdam) and that other levels in the retail hierarchy are only present at a certain urban size. Besides the shopping centers presented in this table, also solitary urban shops, solitary shops at business parks, and solitary peripheral shops are distinguished. To have sufficient numbers of cases in each category to conduct analyses, some shopping locations were put together. We combined city district centers with large neighborhood centers and small neighborhood centers with convenience centers. Furthermore, solitary shops at

business parks, solitary peripheral shops, and special shopping centers were combined with PDV/GDV locations, resulting in the typology as presented in Table 1.

<Insert Table 2 here>

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

<Insert Figure 1 here>

Third, at the regional level one can make a distinction between the most urbanized parts of the Netherlands, also known as the Randstad Holland, and more rural parts (the periphery). Since the 1950s the Randstad expanded south- and eastwards to surrounding regions. On the base of employment gravity values, a distinction is made in the Netherlands 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).

<Insert Table 3 here>

Fourth, in this article two product typologies are discerned. The first distinguishes between three types of goods on the base of consumers' purchase

frequency and information demand: convenience goods, experience goods, and search goods. This classification is used as a control variable to test the general hypotheses concerning the geographical diffusion of retail Internet adoption. To test our two specific hypotheses (5a and 5b) concerning regional differences in online sales adoption, we use another typology. This second typology deals with the logistic intensity (i.e., delivery costs) of products and differentiates between mail goods (low costs, independent of distance), parcel goods (medium costs, independent of distance), and freight goods (high costs, dependent of distance). We assigned our 14 retail categories to one of the three product types of both classifications (see Table 3).

Fifth, we use the floor space of each retail outlet (measured in square meters), which was already present in the original dataset, as a proxy for the size of the organization. In our analyses we use the logarithmic of floor space as it led to a better model fit. Finally, since the original dataset only made a distinction between independents and multiples, we used retail guides (i.e., First Formula, 2004; Locatus, 2003) to obtain the organization type of each multiple retailer. In our analysis we distinguish between four organization types: independents, corporate chains, franchisors, and other retail cooperatives.

RESULTS

Descriptive results

In Figure 2 the cumulative adoption of Internet domains by retail outlets (measured in days) is displayed. Two important findings can be drawn from this figure. First, domain registration by retailers seems to follow an S-shaped curve

commonly found in innovation studies (Rogers, 2003). Second, domain registration by Dutch retailers seems to reach its saturation point in 2005, stabilizing around 60 percent of all outlets.

<Insert Figure 2 here>

One should note, however, that the majority of our retail data is collected in 2003 and 2004, while our domain name data is collected from December 2004 to March 2005. Between 2003 and 2005 some shops in our dataset may be closed of which we are unaware. Therefore, the total population used to develop our S-curve may be too large, resulting in an adoption percentage that is too low, as during this period the total number of shops decreased. However, this decrease occurred mainly in sectors not included in our analyses such as tobacco shops, bakeries and butchers. Furthermore, a more accurate investigation of Internet adoption by Dutch city centre retailers yields similar results (Weltevreden and Boschma, 2005). Note that the sudden increases at one day to be observed in the graph reflect the adoption time of large multiples, resulting in a sharp rise of the adoption curve.

<Insert Figure 3 here>

In Figure 3, four maps are displayed that show the geographical distribution of domain registration in the Netherlands for the period 1994 through 2005. The black dots on the maps represent new adopters in a specific year, while the grey dots represent shops that adopted an Internet domain in previous years. Like many other innovations domain registration in its early days (1994) seems to be randomly

distributed across space. Four years later (1998), just before the Internet hype, domain registration is largely concentrated in the core region (Randstad) and the large and medium sized cities (compare Figure 1 with Figure 3). In 2002, domain registration expands to small cities and peripheral regions, while retail outlets at the core region and large and medium size cities continue to adopt. In the final map (2005) the diffusion of domain registration largely has ended, with only a few new adopters (mainly in the large and medium sized cities).

Multivariate analyses

In this section we present the estimation results for the joint effects of location and organization on domain registration and Internet strategy choice respectively. Linear regression was chosen for domain registration, as it is a continuous variable that measures the number of days retail outlets have a domain name (see Model 1 in Table 4). Linear regression estimates the coefficients of the linear equation, involving one or more independent variables, that best predict the value of the dependent variable.

For the Internet strategy analyses, we used multinomial logistic regression (see Model 2 in Table 4). Multinomial logistic regression was chosen because the dependent variable consists of more than two categories (i.e., no website, information strategy, and online sales strategy). The multinomial logistic regression model estimates the effect of the explanatory variables on the probability (differential odds) that one of three alternatives will be selected. In our models, we use the 'no website' category as the baseline by which to compare the estimated parameter of the other two categories. The estimates should be interpreted as representing the marginal utility of choosing an information strategy or online sales strategy over no website. Thus, a

positive coefficient indicates that the greater the value of the independent variable, the more likely the alternative will be chosen. Furthermore, three other multinomial 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 5).

A first examination of Table 4 shows that the adjusted and pseudo-R square for both models are high. The adjusted R square for domain registration is 0.389 (Model 1). The pseudo-R square for Internet strategy adoption is even larger: 0.579 (Model 2). Thus, our independent variables offer a good explanation for retail outlets' decision to register a domain name and to adopt one of the three alternative Internet strategies.

<Insert Table 4 here>

Retail hierarchy (hypotheses 1a through 2b)

The results of Model 1 in Table 4 indicate that shops in city centers were the first to register an Internet domain, followed by retail outlets at shopping locations lower in the hierarchy. Furthermore, outlets at shopping centers higher up in the hierarchy are more likely to adopt an Internet strategy than shops at centers at the bottom of the retail hierarchy. Thus, both hypotheses 1a and 1b are supported by our data.

According to hypotheses 2a and 2b, there is no significant difference in the *time* of adoption and the *chance* to adopt an Internet strategy between shops in city centers and shops in peripheral/large scale retail locations. Hypotheses 2a is rejected,

since shops at peripheral/large scale retail locations registered a domain name much later than retail outlets at city centers (see Model 1). Hypothesis 2b is also rejected as both localities differ significantly from each other with respect to the likelihood of having an information or online sales strategy (see Model 2). Shops in peripheral/large scale retail locations are more likely to have an information strategy than shops in city centers. The latter, however, have a higher probability to engage in online sales. Thus, city centers are not only the most important shopping locations in the Netherlands, but also the most innovative ones, at least in terms of online sales adoption.

Urban hierarchy (hypothesis 3a and 3b)

With regards to the urban hierarchy we assumed that the *time* (hypothesis 3a) and the *likelihood* (hypothesis 3b) of Internet adoption by shops positively depends on the size of the city a shop is located. Both the outcomes of Model 1 and 2 in Table 4 show a hierarchical diffusion pattern of Internet adoption. Retail outlets located in large cities were the first to register a domain, followed by shops in medium sized cities. Furthermore, shops in large size cities have the highest chance of choosing an Internet strategy over no website, followed by medium size cities, though the standard errors indicate that there is little overlap in the value ranges. Shops in small size cities registered an Internet domain much later and also have the lowest chance to adopt the Internet, which is in line with hypotheses 3a and 3b.

Regional hierarchy (hypotheses 4a through 5b)

On the regional level we also assumed a spatial pattern in the diffusion of Internet adoption by retail outlets. Shops in core regions are expected to have

registered an Internet domain *earlier* (hypothesis 4a) and to have a higher *chance* of Internet strategy adoption than outlets in less urbanized areas (hypothesis 4b). Hypothesis 4a is not supported by our data as there is no significant difference in the time of domain registration between the three regions (see Model 1). However, shops in peripheral areas do have a lower probability to adopt the Internet, compared to shops in the intermediary and the core region (Randstad). Thus, hypothesis 4b is supported by our data (see Model 2). To summarize, agglomerations economies only matter for Internet strategy adoption of retail outlets at the regional level.

As explained before, we expected that the regional effect varies between sectors, depending on the logistic costs involved. Two hypotheses have been formulated. First, shops located in the periphery that sell goods that are distributed by mail or parcel services are more likely to adopt an online sales strategy than shops located in the core area (hypothesis 5a). Second, shops located in the core region that sell freight goods are more likely to adopt an online sales strategy than shops in the periphery (hypothesis 5b). To test these hypotheses three other models were estimated for different types of logistical goods.

<Insert Table 5 here>

In Table 5 we present the estimation results for the joint effects of location and organization on the Internet adoption of 3 types of logistic goods: mail goods, parcel goods, and freight goods. Because of insufficient numbers of cases, we had to replace the detailed organization typology 1 by a less detailed classification in Table 5. According to this table, there are no significant differences between regions regarding the adoption of online sales by shops selling mail and parcel goods. Hypothesis 5a is,

therefore, rejected. The regional hierarchy, evident in Model 2 of Table 4, does not apply for shops selling these types of goods, since the likelihood of having online sales is independent of the regional context. This can be explained by the fact that in the Netherlands the price of postal and parcel services is independent of distance.

Contrary to shops selling goods that are distributed by mail and parcel services, the regional hierarchy matters for shops selling freight goods. The chance of adopting an online sales strategy over no website is significantly higher for shops selling these logistic intensive goods located in core areas, compared to their colleagues located in peripheral areas. Hypotheses 5b is, therefore, supported.

Control variables: product, size and organization type

We end the result section with a brief description of the results for our control variables of Models 1 and 2 in Table 4. Most organizational variables are significant at the .01 level. With regards to the type of product, shops selling search goods are longer on the Internet and have a higher chance of choosing an information or online sales strategy over no website than shops selling experience or convenience goods. Furthermore, shops selling experience goods were later on the Internet and have a lower probability to adopt an online sales strategy than shops selling convenience goods.

Concerning organization size results indicate that larger shops registered their domain earlier than smaller shops. Furthermore, the likelihood of choosing an information or online sales strategy over no website significantly also increases with the size of shops. Even after controlling for organization type, size still matters. No matter the type of organization an outlet belongs to, larger shops are always longer on the Internet and have a higher chance of engaging in b2c e-commerce.

Shops belonging to one of the three multiple retail types all registered their domain earlier and have a higher chance to have an Internet strategy compared to outlets of independent retailers. Other retail cooperatives were the first to claim a domain name, followed by franchise organizations. Additionally, franchise organizations have the highest chance of adopting an informative website, followed by other retail cooperatives. Furthermore, franchise organizations have the highest likelihood to engage in online sales compared to the other organization types. Thus, franchisors have been able to solve conflicts with their franchisees that are likely to occur when they decide to sell online.

One should note that we also conducted two analyses in which we investigated the explanatory value of spatial variables without controlling for organizational variables. In these models, not included in this paper, the impact of geography strongly contradicts with our expectations or is even absent. For example, in one of these models shops at city centers have the lowest probability to adopt an Internet strategy, as compared to other shopping centers. This may be explained by the fact that Dutch city centers encompass large numbers of independent retailers (which are least likely to adopt), as compared to for example convenience centers. When we control for organization type, retail outlets at city centers are most likely to adopt an Internet strategy. Thus, to avoid composition effects when studying the geographical diffusion of retail Internet adoption one should always control for organizational variables.

CONCLUSIONS

In this article we investigated the geographical diffusion Internet adoption among 27,000 retail outlets in the Netherlands. Both a dynamic analysis focusing on

the *time* shops registered an Internet domain, and a static analysis focusing on the *type* of Internet strategy (i.e., no website, information strategy, and online sales) has been conducted. We combined a conventional innovation-adoption approach, focusing on organizational characteristics, with a comprehensive geographical analysis using information on the location and spatial context of retail outlets. The following geographical variables were discerned: a retail hierarchy, urban hierarchy, and regional hierarchy. After controlling for organizational characteristics, all geographical variables turned out to be significant determinants for retail Internet adoption.

Results indicate that shops in city centers registered a domain earlier and are more likely to choose an information or online sales strategy than shops located in centers at the bottom of the retail hierarchy. On the urban level, a hierarchical diffusion pattern is also visible. Shops in large cities were earlier online and have a higher probability to adopt the Internet than shops in small cities. On the regional level, the likelihood of adopting an information or online sales strategy is higher for shops in core regions than for retail outlets in the periphery. Thus, agglomerations economies matter for retail Internet adoption both at the shopping center, urban, and regional level. Overall, the geographical differences in Internet adoption are larger for the adoption of an online sales strategy than for the adoption of an information strategy. This is understandable, since online selling truly involves a new way of doing business for traditional retailers, which requires specific knowledge and competences. Shops located at central locations can benefit from the agglomeration economies present here, which facilitate the uptake of this radical innovation.

However, which regional context is most suitable for online sales also depends on the logistic characteristics of the product. The chance of adopting an

online sales strategy is significantly higher for shops selling freight goods located in core areas than for their colleagues located in peripheral areas. For shops selling mail and parcel goods, the chance of having online sales is independent of the region in the Netherlands where they are located. The latter result can be explained by the fact that the price of postal and parcel services is independent of distance in the Netherlands.

We would recall that in this article we have taken a shop as the unit of analysis and not a retail organization. This implies that retail organizations with more than one outlet are overrepresented in our data. Nonetheless, a shop level analysis is suitable to examine the geographical diffusion of Internet strategies among different shopping locations and geographical contexts.

Regarding the importance of geography for understanding retail Internet adoption, progress in future research lies in two areas. First, in this article we only investigated the b2c e-commerce adoption of shops in 14 retail categories. While geography seems to play a role in the uptake of Internet in these sectors, its impact on other retail categories may be different or even absent. Future research should, therefore, try to include other categories to investigate whether similar diffusion patterns can be observed.

Second, future research should feature a comparison between countries that vary in urbanization patterns. The Netherlands is a small, highly urbanized country, where even in peripheral areas shopping accessibility is high in comparison with larger countries such as Germany, Canada, or the USA. In these countries, with more spread out populations and high consumer Internet use, the impact of spatial variables on retail Internet adoption could be greater than in the Netherlands.

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TABLES & FIGURES

Table 1: Descriptive statistics

	Dynamic analysis			Static analysis		
	Min.	**Max.**	**Mean**	**Min.**	**Max.**	**Mean**
Internet adoption (Dependent)						
Domain registration in days	38	4,009	2,428.960	-	-	-
No website	-	-	-	0	1	0.394
Information strategy	-	-	-	0	1	0.432
Online sales strategy	-	-	-	0	1	0.174
Retail hierarchy						
Solitary urban shops	0	1	0.097	0	1	0.094
Small neighborhood / Convenience centers	0	1	0.088	0	1	0.076
City district / Large neighborhood centers	0	1	0.112	0	1	0.120
City centers	0	1	0.635	0	1	0.648
Peripheral / Large scale retail locations	0	1	0.068	0	1	0.063
Urban hierarchy						
Small size cities	0	1	0.462	0	1	0.475
Medium size cities	0	1	0.403	0	1	0.379
Large size cities	0	1	0.135	0	1	0.147
Regional hierarchy						
Periphery	0	1	0.358	0	1	0.365
Intermediary	0	1	0.347	0	1	0.334
Core (Randstad)	0	1	0.296	0	1	0.301
Product						
Convenience goods	0	1	0.420	0	1	0.300
Experience goods	0	1	0.413	0	1	0.556
Search goods	0	1	0.167	0	1	0.143
Size						
Log10 floor space (in m2)	0.602	4.470	2.370	0.602	4.470	2.216
Organization type 1						
Independents	0	1	0.288	0	1	0.545
Corporate chains	0	1	0.297	0	1	0.199
Franchise organizations	0	1	0.342	0	1	0.207
Other retail cooperatives	0	1	0.073	0	1	0.049
Organization type 2						
Independents	-	-	-	0	1	0.545
Multiples	-	-	-	0	1	0.455
Valid *N*	16,558			27,596		

Table 2: A typology of shopping centers

Type	Definition
City centers	The largest and central shopping location in a city (5 stores or more).
City districts	A shopping center with more than 50 stores operating next to a large city center (i.e., 100 stores or more).
Large neighborhood centers	A shopping center with 25 through 50 stores operating next to a city center.
Small neighborhood centers	A shopping center with 10 through 25 stores, or a center with 5 to 10 stores and 2 or more supermarkets operating next to a city center (and city districts/large neighborhood centers).
Convenience centers	A shopping center with 5 to 10 stores and 1 or no supermarket operating next to a city center (and city districts/neighborhood centers).
PDV/GDV concentrations	A shopping center with 5 or more stores with a mean floor space of 500 m² or more per shop. The sectors 'pets, flowers & plants', 'consumer electronics', 'bikes & car accessories', 'do-it-yourself', and 'furniture & home furnishing' must make up at least 50% of the total floor space in these centers.
Special shopping centers	A shopping center that does not belong to one of the other categories (e.g., factory outlet centers, shopping centers at airports, etc.).

Source: adapted from Locatus, 2004

Table 3: Sectors differentiated by product characteristics and logistic intensity

Product type	Mail	Parcel	Freight
Convenience goods	-	Drug stores, Perfume & Cosmetics	Supermarkets, Delicatessen
Experience goods	-	Ladies wear, Family wear, Men's wear, Fashion department stores, Sport shops	Furniture
Search goods	Books, CDs	Computers, Toy stores	-

Table 4: Linear regression of domain registration and multinomial logistic regression of Internet strategy adoption

	Model 1	Model 2 (ref. cat. = no website)	
	Domain registration (in days)	Information strategy	Online sales strategy
	B (s.e.)	*B* (s.e.)	*B* (s.e.)
Retail hierarchy			
Solitary urban shops	0	0	0
Small neighborhood / Convenience centers	136.279*** (23.244)	-0.003 (0.092)	0.555*** (0.115)
City district / Large neighborhood centers	152.943*** (23.087)	-0.065 (0.082)	0.755*** (0.109)
City centers	203.686*** (17.597)	0.245*** (0.063)	1.251*** (0.086)
Peripheral / Large scale retail locations	-50.431** (25.501)	0.425*** (0.088)	0.921*** (0.131)
Urban hierarchy			
Small size cities	0	0	0
Medium size cities	117.480*** (11.308)	0.293*** (0.039)	0.662*** (0.055)
Large size cities	185.167*** (20.649)	0.386*** (0.070)	0.799*** (0.097)
Regional hierarchy			
Periphery	0	0	0
Intermediary	6.286 (11.865)	0.156*** (0.042)	0.264*** (0.058)
Core (Randstad)	-4.905 (15.043)	0.213*** (0.053)	0.388*** (0.073)
Product			
Convenience goods	0	0	0
Experience goods	-213.269*** (13.257)	0.052 (0.055)	-2.493*** (0.075)
Search goods	107.013*** (16.789)	1.333*** (0.068)	1.580*** (0.078)
Size			
Log10 floor space (in m2)	328.522*** (12.772)	1.412*** (0.048)	1.257*** (0.067)
Organization type 1			
Independents	0	0	0
Corporate chains	792.051*** (14.335)	2.390*** (0.053)	3.330*** (0.076)
Franchise organizations	908.117*** (14.718)	4.910*** (0.151)	5.834*** (0.159)
Other retail cooperatives	1,016.475*** (21.887)	3.070*** (0.101)	2.027*** (0.141)
Constant / Intercept	872.420*** (36.574)	-4.533*** (0.130)	-6.114*** (0.179)
F	753.740***	-	
Chi-square	-	19,434.723***	
-2 log likelihood intercept only	-	48,904.765	
-2 log likelihood final	-	29,470.042	
R square	0.389	-	
Adjusted R square	0.389	-	
Pseudo Nagelkerke R square	-	0.579	
N	16,558	27,596	

** = p <0.05; *** = p <0.01

Table 5: Multinomial logistic regression logistic goods types (reference category = no website)

	Mail goods		Parcel goods		Freight goods	
	Information strategy *B* (s.e.)	**Online sales strategy** *B* (s.e.)	**Information strategy** *B* (s.e.)	**Online sales strategy** *B* (s.e.)	**Information strategy** *B* (s.e.)	**Online sales strategy** *B* (s.e.)
Size						
Log10 floor space (in m2)	0.921*** (0.239)	2.361*** (0.236)	1.123*** (0.065)	0.806*** (0.093)	0.923*** (0.084)	2.816*** (0.142)
Organization type 2						
Independents	0	0	0	0	0	0
Multiples	1.036*** (0.216)	3.004*** (0.184)	2.980*** (0.053)	4.157*** (0.074)	3.005*** (0.098)	4.558*** (0.164)
Retail hierarchy						
Solitary urban shops	0	0	0	0	0	0
Small neighborhood / Convenience centers	-0.745 (0.501)	-1.919*** (0.454)	-0.419*** (0.116)	-0.424*** (0.156)	0.698*** (0.164)	1.112*** (0.190)
City district / Large neighborhood centers	-0.111 (0.390)	-1.079*** (0.315)	-0.599*** (0.102)	-0.777*** (0.145)	0.731*** (0.161)	1.165*** (0.202)
City centers	0.644 (0.345)	-0.504 (0.267)	-0.278*** (0.082)	-0.925*** (0.121)	0.798*** (0.108)	1.469*** (0.137)
Peripheral / Large scale retail locations	-0.927 (0.832)	-0.144 (0.489)	0.499*** (0.129)	0.541*** (0.182)	0.641*** (0.119)	-0.542*** (0.191)
Urban hierarchy						
Small size cities	0	0	0	0	0	0
Medium size cities	0.633*** (0.160)	0.304** (0.155)	0.331*** (0.044)	0.236*** (0.061)	0.053 (0.090)	0.326*** (0.116)
Large size cities	0.169 (0.258)	0.502** (0.250)	0.575*** (0.080)	0.500*** (0.114)	-0.422*** (0.159)	0.072 (0.206)
Regional hierarchy						
Periphery	0	0	0	0	0	0
Intermediary	0.097 (0.176)	0.097 (0.168)	0.182*** (0.047)	-0.010 (0.066)	0.193** (0.095)	0.538*** (0.119)
Core (Randstad)	0.439** (0.216)	0.256 (0.214)	0.180*** (0.060)	0.015 (0.084)	0.313** (0.122)	0.923*** (0.152)
Intercept	-3.287*** (0.554)	-4.915*** (0.514)	-3.307*** (0.150)	-3.934*** (0.214)	-3.311*** (0.232)	-11.749*** (0.433)
Chi-square	774.531***		9,465.829***		3,672.293***	
-2 log likelihood intercept only	3,382.862		26,694.655		12,458.20	
-2 log likelihood final	2,608.331		17,228.827		8,785.91	
Pseudo Nagelkerke R square	0.395		0.454		0.489	
N	1,819		19,051		6,726	

** = p <0.05; *** = p <0.01

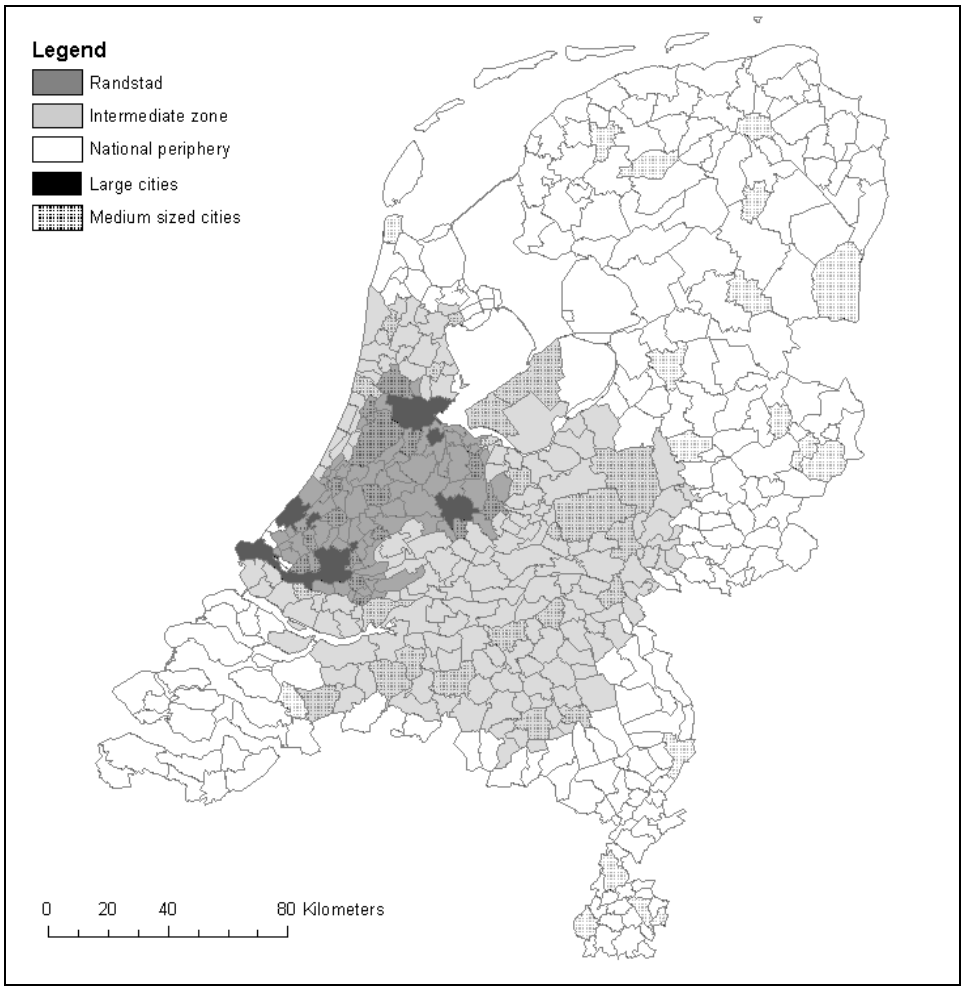

Figure 1: Urbanization map of the Netherlands including the three regions

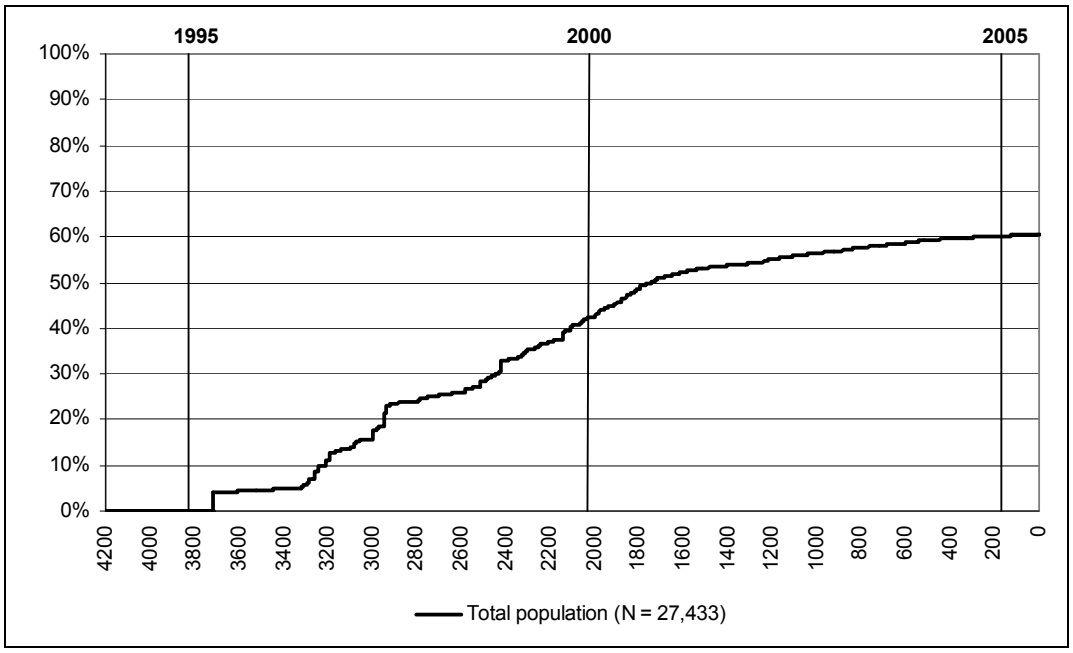

Figure 2: Domain registration by retail outlets in the Netherlands in days (cumulative %)

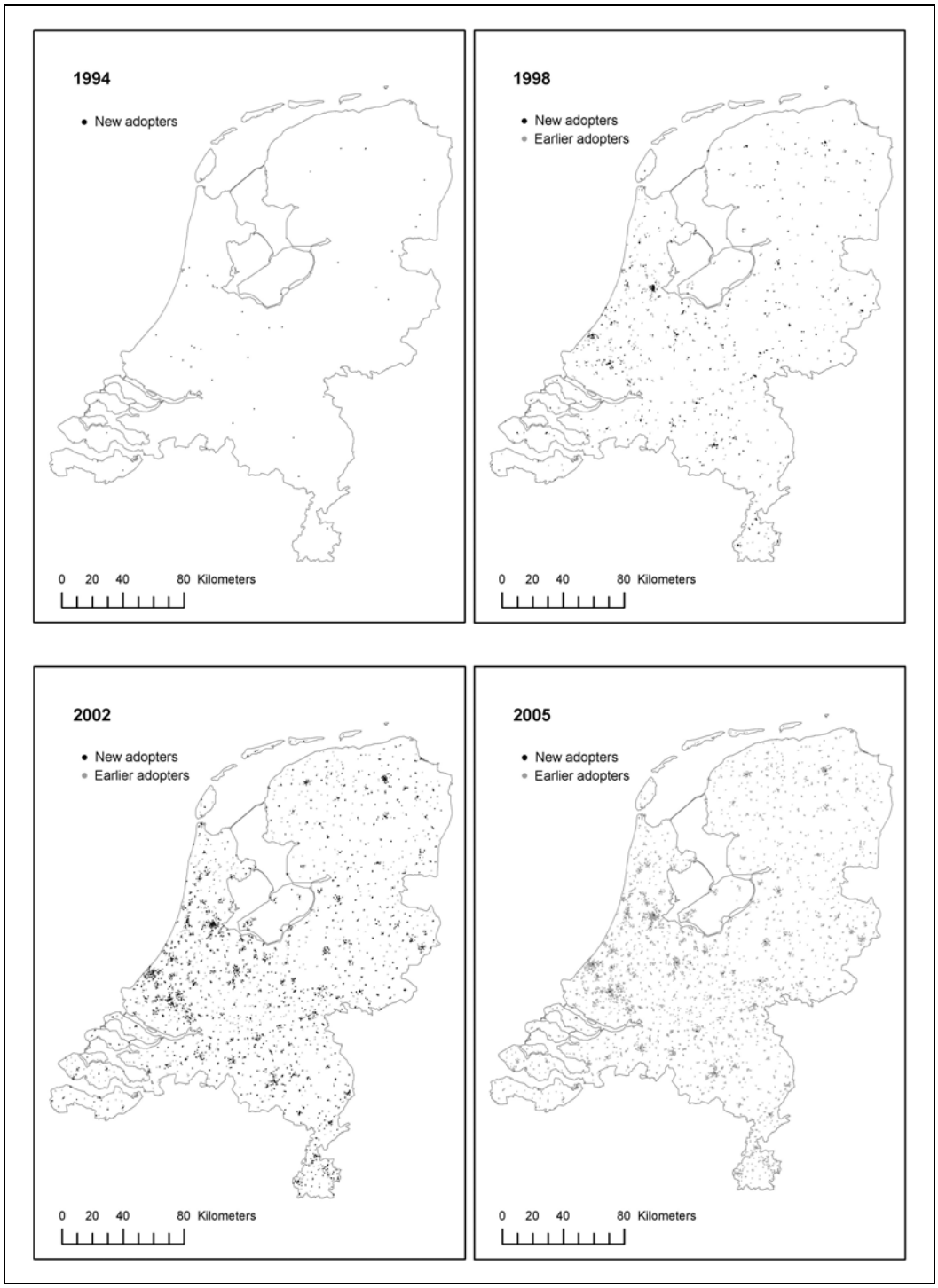

Figure 3: Geographical diffusion of domain registration by retail outlets in the Netherlands (1994-2005)