

Creating an electronic map of GB pharmacy locations

**OFT Pharmacy
Investigation Study 1**

*A report prepared for the
Office of Fair Trading*

November 2002



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1. Introduction

The Office of Fair Trading (OFT) is carrying out an investigation into the regulations pertaining to the award of NHS dispensing contracts to pharmacies. This investigation aims to determine whether the regulations have detrimental effects for competition and consumers. To help to successfully carry out this investigation, the OFT has developed an evidence base on pharmacy behaviour and location.

The OFT asked Frontier Economics to carry out two studies. Study 1 was to produce an electronic map showing the location of community pharmacies (CPs) throughout Great Britain¹. The OFT also requested that the locations of factors that might influence the demand for pharmacy services (such as GPs) and the location of potential competitors to CPs (such as supermarkets) were to be included. Using the map, Frontier was asked to develop a set of measures which summarised the conditions of local concentration faced by each CP. Study 2 was to investigate how pharmacy prices varied with local concentration, and how the entry of new pharmacies affected existing pharmacies in their locality. The outputs from Study 1 were used as inputs into the analysis carried out in Study 2.

This report outlines the steps involved in the creation of the electronic map, and provides an overview of the local concentration measures that were created. It is structured as follows.

- Section 2 describes the role of the electronic map in the Pharmacy Investigation.
- Section 3 describes the software used and data sources employed in the study.
- Section 4 describes the local concentration measures that have been formed.
- Section 5 summarises some of the key results from the concentration measures.

The Annexes contain supporting material.

¹ Through this report we refer exclusively to community pharmacies (as distinguished from hospital pharmacies).

2. The rationale for the electronic map

The OFT Pharmacy Investigation aims to investigate “*the statutory arrangements for pharmacy licensing and their consequences for competition and for consumers throughout the UK*”². In particular, these arrangements relate to the regulations surrounding the award of NHS dispensing contracts to pharmacies. There are a large number of elements to the Pharmacy Investigation, and Frontier Economics has been asked to provide inputs to some of these elements. The role of this Study – the creation of the electronic map of pharmacy locations and other relevant objects – is to provide background information and a data source that can be exploited by subsequent work.

The electronic map provides important inputs to a number of areas of interest to the Pharmacy Investigation.

- *Exploring the relationship between price and local competition.* The electronic map is used to develop proxy measures for conditions of local competition through the analysis of local concentration. Analysis of the link between local concentration and prices may be found in a separate report³.
- *The selection of case studies for further investigation:* The electronic map is used to help inform the selection of case studies and develop an initial picture of the competitive conditions found in particular locations⁴.
- *The link between local concentration and quality:* Using the same concentration measures as developed for the price and local competition study, the outputs of the electronic map may also be linked to quality measures, to determine whether there is any particular relationship between quality and local concentration⁵.
- *The exploration of current consumer access to pharmacies:* The electronic map allows one to analyse the distances that consumers currently have

² Source: OFT Invitation to Tender, Study 2, 19 December 2001.

³ Frontier Economics, The relationship between prices and local concentration, OFT Pharmacy Investigation Study 2, 2002.

⁴ Frontier Economics, The impact of pharmacy entry: three case studies, OFT Pharmacy Investigation Study 2, 2002.

⁵ Frontier Economics, The relationship between quality and local concentration, OFT Pharmacy Investigation Additional Work Contract, 2002.

to travel to reach their nearest CP, and the choice of CPs in their local area⁶.

- *The exploration of the scope for “leapfrogging” following potential deregulation:* The electronic map allows the estimation of the possibilities, in the event of deregulation, for CP ‘leapfrogging’ towards the location of a GP⁷.
- *The exploration of potential future changes in access to CPs, with respect to various scenarios of the impact of deregulation:* Again, in the event that there were deregulation, the electronic map provides an input into the estimation of the implications for consumer access if particular scenarios on the number of pharmacies that were to enter and to exit were to occur⁸.

Further details may be found in the relevant reports.

⁶ Frontier Economics, Consumer access to pharmacies, OFT Pharmacy Investigation Additional Work Contract, 2002.

⁷ Frontier Economics, Leapfrogging and entry, OFT Pharmacy Investigation Additional Work Contract, 2002.

⁸ Frontier Economics, Consumer access to pharmacies, OFT Pharmacy Investigation Additional Work Contract 2002.

3. Data sources and software

This study aims to develop an electronic map showing the location of CPs in Great Britain, and other relevant locations that affect the demand for and supply of products sold by CPs, such as the locations of GPs and supermarkets. To develop this map involves the use of Geographic Information System (GIS) techniques.⁹ This section describes the use of GIS techniques and the data sources and software employed in the study.

3.1 A brief introduction to geographic mapping techniques

3.1.1 *Geocoding*

To represent points on a map, and to be able to compute distances between those points, it is necessary to have a geographic co-ordinate for each point. These co-ordinates are not available as standard in most data sets so must be derived using a method known as “geocoding”.¹⁰ Geocoding is the process of assigning (x,y) co-ordinates (e.g. latitude, longitude) to data using some form of “location” information, such as address or postcode information.

3.1.2 *Defining distance measures*

Two possible measures of ‘distance’ can potentially be employed:

- on-the-road distance; and
- linear distance (as-the-crow-flies).¹¹

The linear distance between two points is always less than or equal to the on-the-road distance between those points.

⁹ A GIS is “a special case of information system where the database consists of observations on spatially distributed features, activities or events, which are definable in space as points, lines or areas. A geographic information system manipulates data about these points, lines and areas to retrieve data for ad hoc queries and analyses.” D.J. Duecker “Land resource information systems: a review of fifteen years experience”. *Geo-processing*, vol.1, no. 2, 1979 (pp.105-128).

¹⁰ The majority of the data employed in this report does not possess geographic coordinates and has therefore been geocoded.

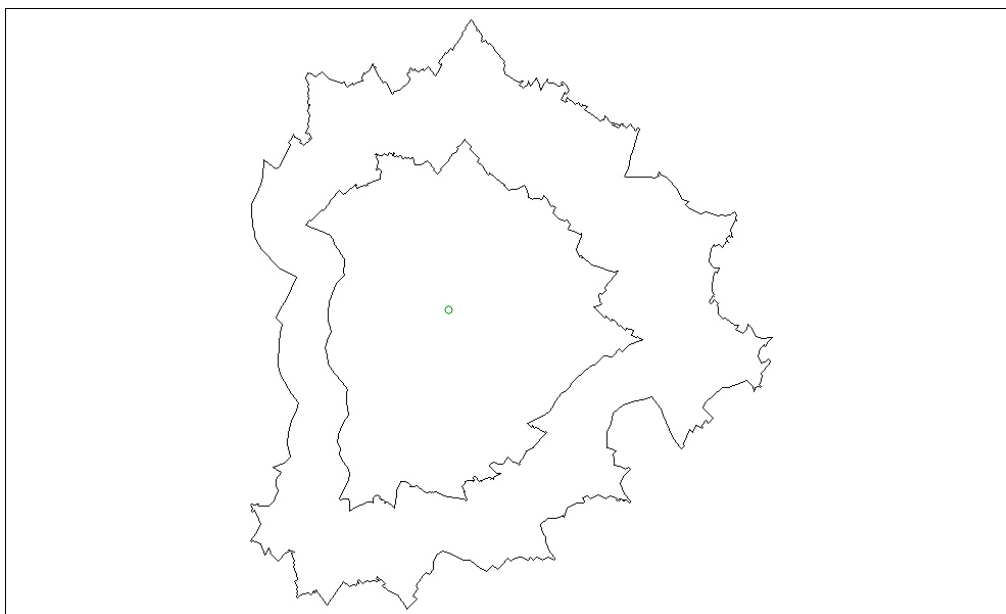
¹¹ Linear distance can be measured as “Cartesian” distance (i.e. assuming the Earth is flat) or “spherical” distance (i.e. taking into account the curvature of the Earth). In our analysis, we used spherical distance. In reality, the impact on our results of using either measure is minimal, since we are dealing with relatively short distances.

Distance on-the-road: isochrone boundaries

On-the-road distance is measured as the *time* (in minutes) required to travel by car between two points. Software packages can be used to calculate “isochrone boundaries” around individual points, such as population centres. Given a starting point, an isochrone bounds the region covering all the points that can be reached by car within a certain time from that starting point. For example, a 10 minute isochrone boundary around a population centre includes all the points which can be reached by car from that population centre in all directions within 10 minutes.

Figure 1 shows typical 10 minute and 15 minute isochrone boundaries around a population centre. The irregular shape of the boundaries reflects the variable characteristics of the road network. For example, in a densely populated area with small roads and intense traffic, a 10 minute journey by car generally covers a smaller distance than a journey of the same duration in a rural area.

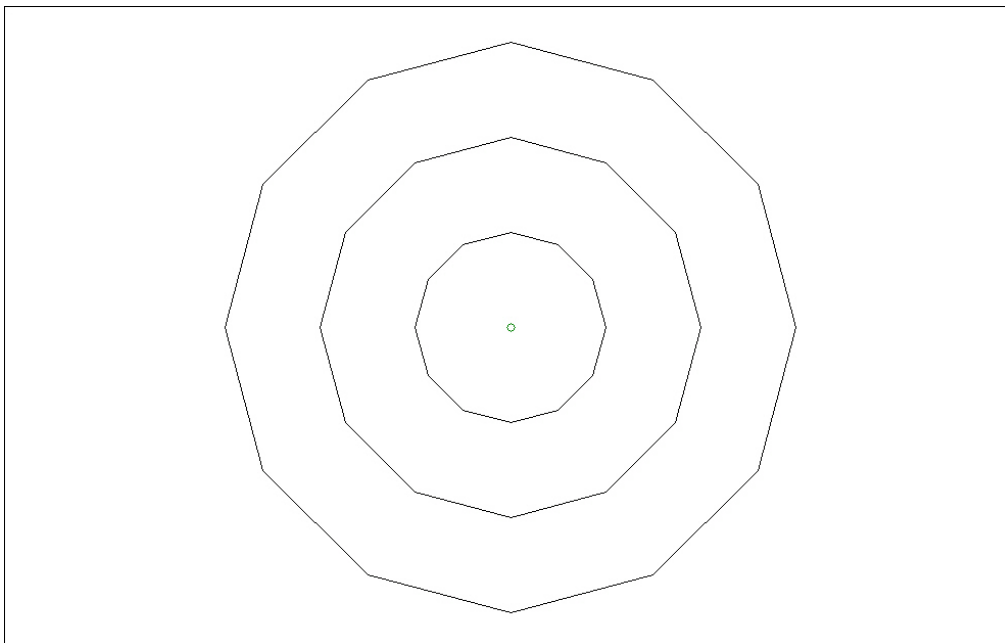
Figure 1: 10 and 15 minute isochrone boundaries around a population centre



Buffers and linear distances

“Buffers” are analogous to isochrone boundaries, but are calculated using linear (as-the-crow-flies) distances. Since they rely on linear distances, buffers are easier to calculate than isochrones and they allow the specific distance from a point (such as 0.5km, 1km and 1.5km buffers) to be derived. Typical 0.5km, 1km and 1.5km buffers around a point (such as a store or a population centre) are depicted in Figure 2. Buffers have a more regular shape than isochrone boundaries because they do not rely on the road network.

Figure 2: 0.5km, 1km and 1.5 km buffers around a population centre



Buffers are formed as regular polygons of a particular number of sections. The greater the number of sections, the more the buffer approaches a circle and the more accurate it is. The trade-off is that a greater number of sections increase the computing time. This study uses buffers with 12 sections.

3.1.3 Software used in the study

Various GIS software packages are currently available on the market. This study employs software from MapInfo. To calculate isochrones the study employs a software package called Drivetime. This takes into account the time taken to get on to the road network as well as the time travelled on the network. In calculating drivetimes, speed is adjusted to allow for

different types of roads (motorways, double carriageways, local roads, etc.). As the isochrones get smaller (e.g. below 10 minutes) Drivetime produces less reliable results¹².

For geocoding, this study used a database called Codepoint, containing geographical co-ordinates for every geographically referenced postcode in Great Britain (1.6 million records). Codepoint assigns co-ordinates to points with a very high degree of accuracy, to within one metre of a property near the centre of the postcode.

Postcodes change over time and the Codepoint software only provides geographical coordinates for the most up to date postcodes. Where data employed in the study features out-of-date postcodes, it is necessary to make these compatible with Codepoint using postcode update software, which tracks changes in postcodes over time¹³.

3.2 Data employed in the study

The electronic map has been populated with a variety of data points. Primarily, these are the locations of CPs, the locations of potential competitors of those CPs, and other relevant locations (such as GPs' surgeries). Data sources are described below.

3.2.1 *Locations of community pharmacies*

Table 1 shows the sources of the names and addresses of CPs in Great Britain, by country¹⁴.

¹² The Drivetime software uses the major road network but many minor roads are excluded. Consequently in a rural area a small drivetime of 5 minutes may result in a major road being impossible to reach in any direction so an isochrone will not be computed for that observation. When Drivetime calculates the time it takes to drive between two points, it uses the minimum off-peak travel time for the road type using a suitable straight line ambient speed. Default ambient speeds suitable for the selected network are set automatically within the Drivetime software. For example, a single carriageway in Central London is allocated a speed of 15km/hour compared to a single carriageway in a rural area which is allocated a speed of 70km/hour.

¹³ Data received from Royal Mail.

¹⁴ It was not possible to obtain information for Northern Ireland for all necessary datasets (e.g. the supermarket dataset covers GB only). Consequently, attention was therefore restricted to creating an electronic map for Great Britain alone.

Table 1: Description of community pharmacies datasets

Country	Source	Date	No of CPs
England	Department of Health	September 2001	9760
Wales	Department of Health	March 2001	706
Scotland	Scottish National Health Service	1980*	2479 since 1980 1141 from 30 September 2001

* The Scottish data contains information on all pharmacies in existence between 1980 and 2001, together with opening and closing dates.

In total there were 11,607 CPs in existence in GB in 2001¹⁵.

3.2.2 *Locations of dispensing doctors*

Table 2 shows the sources of the names and addresses of dispensing doctors in Great Britain, by country. Dispensing doctors are GPs who both prescribe and dispense.

Table 2: Description of dispensing doctors datasets

Country	Source	Date	Number of dispensing doctors
England	Department of Health	September 2001	1242
Wales	Health Solutions Wales	March 2001	97
Scotland	Scottish National Health Service	1980*	567 since 1980 218 since 30 September 2001

* The Scottish data contains information on all dispensing doctors in existence between 1980 and 2001, together with opening and closing dates.

¹⁵ Not all datasets refer to the same time period in 2001. See Section 3.3.3 for details.

There were 1,557 dispensing doctors in existence in GB in 2001.

3.2.3 *Locations of non dispensing doctors*

Table 3 shows the sources of the names and addresses of non-dispensing doctors (GPs) in Great Britain, by country.

Table 3: Non dispensing doctors dataset			
Country	Source	Date	Number of non dispensing doctors
England	Department of Health	September 2001	7,575
Wales	Health Solutions Wales	March 2001	420
Scotland	Scottish National Health Service	March 2002	1,059

There were 9,054 non-dispensing doctors surgeries in existence in GB in 2001.

3.2.4 *Locations of supermarkets*

Institute of Grocery Distribution (IGD) data was purchased for March 2001 on the locations and some characteristics of all supermarkets. The number of stores in this dataset is broken down by store size as shown in Table 4.

Table 4: Size breakdown of stores in IGD dataset		
Size – square feet	Number of stores	Classification
25,000	1196	N/A
10,000 – 25,000	1422	N/A
< 10,000	1358	Multiples
<10,000	699	Co-ops

3.2.5 Locations of non-dispensing drugstores

A non-dispensing drugstore is a store that sells primarily Health & Beauty and OTC products, but does not have an NHS dispensing contract. It proved difficult to develop a full list of such stores, as there is no industry association or central source of information. It was decided to employ a definition of Boots and Superdrug stores without NHS dispensing contracts, and Wilkinson drugstores. Data on the location of such stores was received from Boots (data for December 2001), Superdrug (data for May 2002), and Wilkinson (data for May 2002). There are 23 Boots stores, 475 Superdrug stores, and 205 Wilkinson drugstores in the dataset.

3.2.6 Non-contract pharmacies

A non-contract pharmacy has no NHS dispensing contract, but employs a pharmacist and is able to dispense some non-NHS prescriptions and sell P-only medicines. There is no central database of non-contract pharmacies, so instead various firms were asked to give details of their non-contract pharmacies¹⁶. The only firm to respond promptly was Boots, and consequently the definition employed in the study includes only Boots stores known to be non-contract pharmacies. There were 92 stores in the dataset (the data is for December 2001)¹⁷.

3.2.7 Census data

Population data was obtained from the 1991 Census (the figures for “usually resident population per ward”). Whilst the 2001 Census has been carried out, statistical information is will not be available from this study until 2003, and hence the population data the study employs is somewhat out of date. Nevertheless, this is still the most comprehensive and accurate data available.

¹⁶ The RPSGB collects some data on the number of pharmacies in GB, and this dataset contains a field for whether the pharmacy is a contract or non-contract pharmacy. Unfortunately, the data appears to be of poor quality, as the number of contract pharmacies they record is less than 3,000, compared to the greater than 11,000 in our dataset. It is not therefore possible to employ this data as a cross-check on the number of non-contract pharmacies.

¹⁷ Data was also received from some large supermarkets on the names of stores that had non-contract pharmacies. This data was not possible to geocode straightforwardly and was therefore not employed. It accounted for only a minimal number of data points (1 from J. Sainsbury, 2 from Asda). Moreover, these data points are likely to have been captured in the IGD dataset as “large supermarkets”.

3.3 Data issues

Some difficulties were encountered in using these data sources for the purposes of the study.

3.3.1 *Geocoding*

As described above, it is necessary to geocode the data to place locations of particular types of store on the electronic map – to create a link between a postcode and a grid location. Unfortunately, not all postcodes geocode directly either because they have been incorrectly recorded in the dataset or because the postcode recorded is out of date. For this reason the geocoding of the stores involved several steps.

1. An initial attempt at geocoding each dataset was made within Mapinfo.
2. The stores that did not initially geocode were checked using the postcode update files provided by the Office of Fair Trading (OFT).
3. The stores that did not initially geocode were also checked for obvious recording mistakes by:
 - trimming the postcodes to eliminate any extra spaces within the postcodes;
 - checking to ensure there was one space within the postcode;
 - checking the length of the postcodes to make sure they were only 6, 7, or 8 characters long (including spaces);
 - checking that the 1st character was a letter;
 - checking the 3rd character was not a letter;
 - checking the 1st character of the last group of three characters was a number;
 - checking the 2nd character of the last group of three characters was a letter; and
 - checking the 3rd character was a letter.

Postcodes that did not comply with these checks were identified and where possible appropriate changes were made so that the postcodes were in the correct format.

4. The checked and updated postcodes from steps 2 and 3 were used for a second attempt at geocoding.
5. Some stores remained ungeocoded after this second attempt. One explanation of this was that postcodes were extremely out of date. These were sent to the OFT, who used the Postcode Address File provided by the Royal Mail to find out up-to-date postcodes on the basis of the address of that store.

The number of stores that were geocoded after each of these steps is shown in Table 5 below:

Table 5: Proportion of observations geocoded at each stage and for each store type					
Data	Number of observations	Number initially geocoded	Number geocoded after initial cleaning	Number geocoded after OFT postcode updates	% of observations geocoded
English CPs	9760	9373	9492	9492	97.3%
English DDs	1242	1180	1196	1196	96.3%
English GPs	7575	7324	7375	7375	97.4%
Welsh CPs	706	609	614	683	96.7%
Welsh DDs	97	97	97	97	100.0%
Welsh GPs	420	97	397	416	99.0%
Scottish CPs	1141	1077	1083	1134	99.4%
Scottish DDs	218	208	208	208	95.4%
Scottish GPs	1059	625	1035	1055	99.6%
IGD supermarkets	4675	4344	4399	4577	97.9%
Boots non-dispensing drugstores	23	18	18	22	95.7%
Boots non-contract pharmacies	93	78	80	92	98.9%
Superdrug non-dispensing drugstores	475	458	461	475	100.0%
Wilkinson drugstores	205	200	205	205	100.0%

Source: Frontier Economics

Further efforts could have been made to increase the proportion of stores geocoded at the expense of further time investment. It was decided that in all categories a cut-off point of 95% of stores successfully geocoded was sufficient for the purposes of the study.

3.3.2 *Duplicates*

In geocoding the various datasets, it was observed that some stores had the same postcode and were consequently assigned the same geographical coordinates by Mapinfo. A postcode covers more than a single address so in some cases different stores are genuinely located at the same postcode. However, in others the assignment of more than one store to a postcode is the result of that store having a duplicate entry within the dataset. In order to ensure that all duplicate entries were genuine the postcodes with multiple entries were checked visually. If they were identical in terms of other characteristics, only one such store was retained in the dataset.

This process was carried out for CPs, supermarkets and drugstores. The checks for dispensing doctors and non-dispensing doctors were more extensive as there was, in general, much greater duplication as frequently more than one doctor based at the same surgery was included in the dataset. Where the number of duplicate observations was low, the names and addresses of each surgery were checked visually. Where the number of duplicate observations was high, the surgeries were ordered and the equivalence of the first line of the address was tested. As the spelling of the addresses was subject to some inconsistency, the equivalence of the first five letters of the address was also investigated. Finally, those duplicates remaining were checked visually and on the NHS website to ensure they were genuinely individual entries.

The results of removing the duplicate entries from each of the datasets can be seen in Table 6.

Table 6: Number of observations remaining in each dataset after duplicates had been removed

Data	Total initial observations	Number geocoded	Number remaining after duplicates removed	Proportion of total observations employed
English CPs	9760	9492	9492	97.3%
English DDs	1242	1196	1181	95.1%
English GPs	7575	7375	6581	86.9%
Welsh CPs	706	683	704	99.7%
Welsh DDs	97	97	96	99.0%
Welsh GPs	420	416	390	92.9%
Scottish CPs	1141	1134	1134	99.4%
Scottish DDs	218	208	144	66.1%
Scottish GPs	1059	1055	822	77.6%
IGD supermarkets	4678	4577	4575	97.8%
Boots non-dispensing drugstores	23	22	22	95.7%
Boots non-contract pharmacies	93	92	92	98.9%
Superdrug non-dispensing drugstores	475	475	475	100.0%
Wilkinson drugstores	205	205	205	100.0%

Source: Frontier Economics

3.3.3 Different time periods

The data used for each type of store is not consistent across periods. The study has endeavoured to employ a consistent set of data for September 2001. However, many data sets are only available for slightly different time periods, as shown in Table 7.

Table 7: Dates of data sources	
Data source	Data to which data relates
English CPs	September 2001
Welsh CPs	March 2001
Scottish CPs	September 2001
English DDs	September 2001
Welsh DDs	March 2001
Scottish DDs	September 2001
English non-DDs	September 2001
Welsh non-DDs	March 2001
Scottish non-DDs	March 2002
IGD supermarkets	March 2001
Boots non-contract pharmacies	December 2001
Superdrug non-dispensing drug-stores	May 2002
Boots non-dispensing drug-stores	December 2001
Wilkinson non-dispensing drug-stores	May 2002

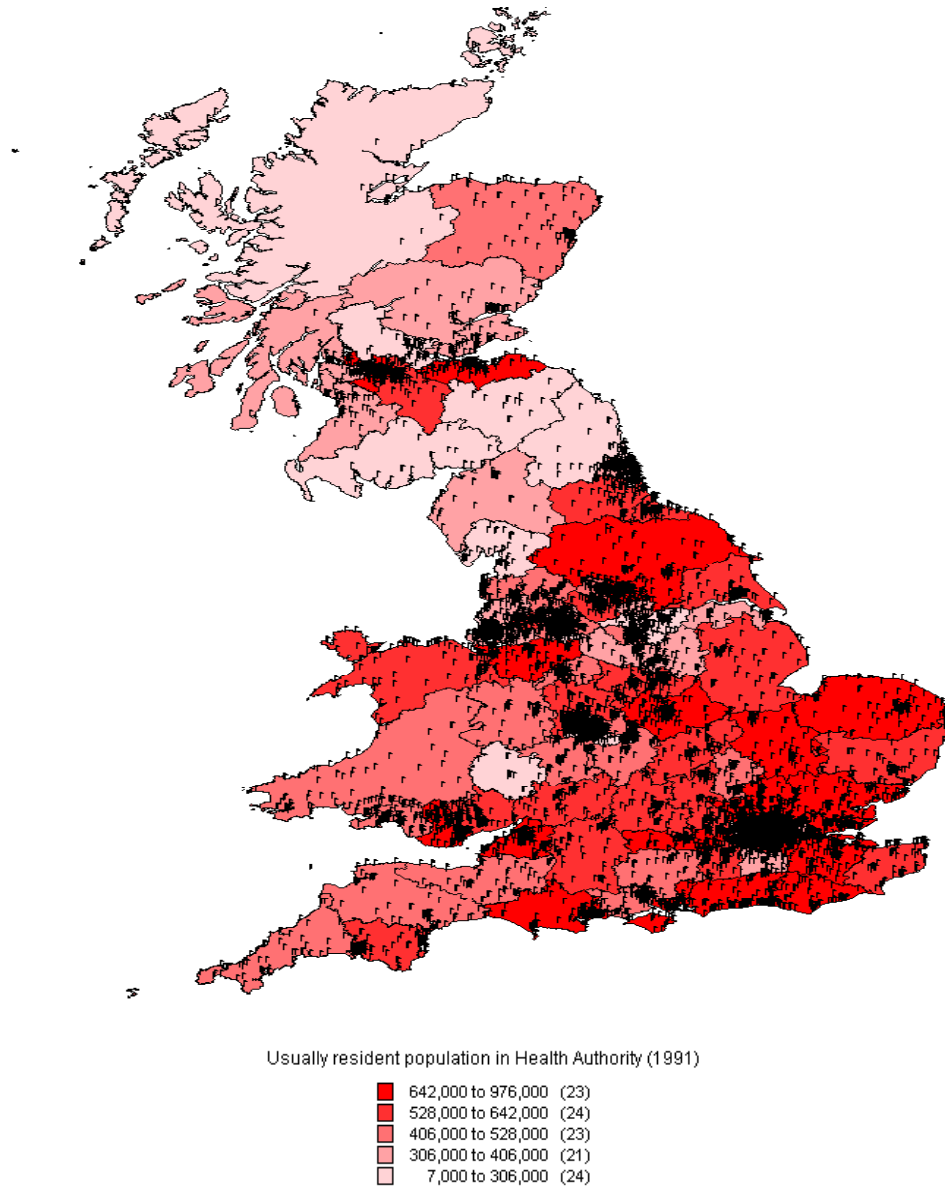
Source: Frontier Economics

Whilst these discrepancies may occasionally result in some estimates of local concentration and numbers of competitors being biased upward or downward in particular locations (as there will have been some entry or exit during that time), it is unlikely that there is any systematic bias introduced as a result. Moreover, the number of locations in which entry or exit takes place in a six month period is relatively small. For example,

Department of Health statistics show that there were 36 new CPs opening in England and Wales in the year ending March 2001¹⁸.

Figure 3 shows a map of CPs in the dataset in England, Scotland and Wales.

Figure 3: Locations of CPs in England, Scotland and Wales



¹⁸ Source: Department of Health, Community Pharmacies in England and Wales, 31 March 2001.

4. Measures of local concentration

One output of this study is a set of measures of local concentration. These measures will be employed in subsequent studies as proxies for the competitiveness of local markets. This Section describes the various local concentration measures that were developed.

4.1 Measures of local concentration

The measures of local concentration employed are defined over a particular geographical area. Six different measures of local areas were investigated:

- 500m buffers;
- 1000m buffers;
- 1500m buffers;
- 5 minute drivetimes;
- 10 minute drivetimes; and
- 15 minute drivetimes.

For each English, Welsh and Scottish CP, and for each of the above areas, a number of measures of concentration were calculated. These aim to capture factors which influence either the demand conditions faced by pharmacies in the area (e.g. the number of GPs) or the supply conditions (e.g. measures describing the number and type of potential competitors to CPs). The measures calculated include:

- number of other CPs in area;
- number of other GPs in area;
- number of CPs per GP;
- number of other CPs and DDs;
- number of supermarkets with pharmacies;
- number of supermarkets without a pharmacy over 10 thousand square feet;

- number of supermarkets without a pharmacy over 25 thousand square feet;
- number of non dispensing drugstores (defined as the total of Boots, Superdrug, and Wilkinson non-dispensing stores); and
- number of Boots non-contract pharmacies.

All of the measures above were also calculated per thousand population in the relevant area. The population within a buffer or drivetime is calculated as the sum of all the ward populations in the relevant area¹⁹. Each measures was calculated as the ratio of the concentration measure (e.g. number of CPs) divided by the relevant population, and multiplied by 1,000 to aid interpretation.

In addition, the following distances were calculated:

- the distance to the nearest 5 CPs from each CP;
- the distance of the nearest GP from each CP; and
- the distance of the nearest CP from each GP.

These further statistics were defined on the basis of 5000m buffers²⁰ as not all CPs have (for example) 5 CPs within 5000m. If a CP did not have 5 CPs within 5000m, this absence was recorded.

¹⁹ The population within a ward is allocated to a particular point in the ward called the ward centroid. The position of the ward centroid is weighted to reflect population. As the population within a ward is allocated to a single point, the calculation of the total population within a drivetime or buffer is a close approximation to the actual.

²⁰ Distance based measures are only possible to draw within buffers rather than drivetime measures of area.

5. Analysis of concentration measures

The previous section described the concentration measures that were developed. This section presents some key summary statistics for these measures reported. In particular:

1. There is considerable variation across CPs for a number of measures. For example, the number of rival CPs faced by a particular CP in a 15 minute drivetime ranged from 0 to 270.
2. CPs are generally located close to other CPs and to GPs.
3. CPs appear to be in areas with different levels of local concentration according to which measure is used. The correlation coefficients between measures varied, and these correlations were sometimes small.

With these factors in mind, composite concentration measures were formed. These aim to give an overall indication of the conditions of local concentration faced by individual CPs.

Further summary statistics for concentration measures are reported in Annex 1.

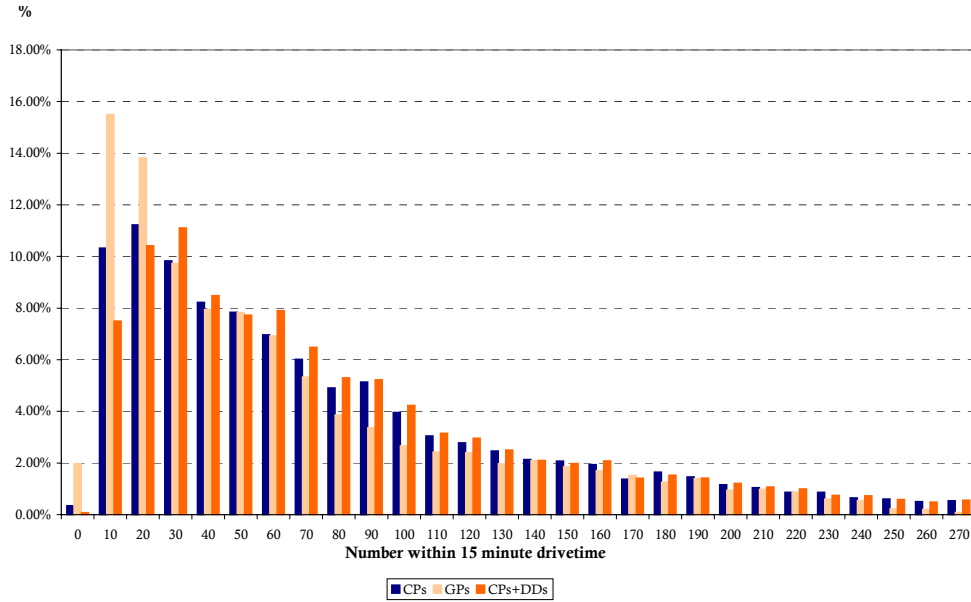
5.1 Variation in average values across area definitions

The average number of other CPs in the vicinity of each CP ranges from 1.15 for a 500m buffer to 77.66 for a 15 minute drivetime. Similarly, the average number of GPs in the vicinity of a CP range from 1.27 for a 500m buffer to 60.35 for a 15 minute drivetime. However, the number of CPs per GP is fairly consistent across different buffer and drivetime measures, ranging between 1.54 and 1.61.

The distribution of the number of other CPs, GPs and CPs and DDs within a 15 minute drivetime is shown in Figure 4²¹.

²¹ These figures refer to the number of rival CPs. The CP around which the drivetime or buffer is calculated is removed from the figures.

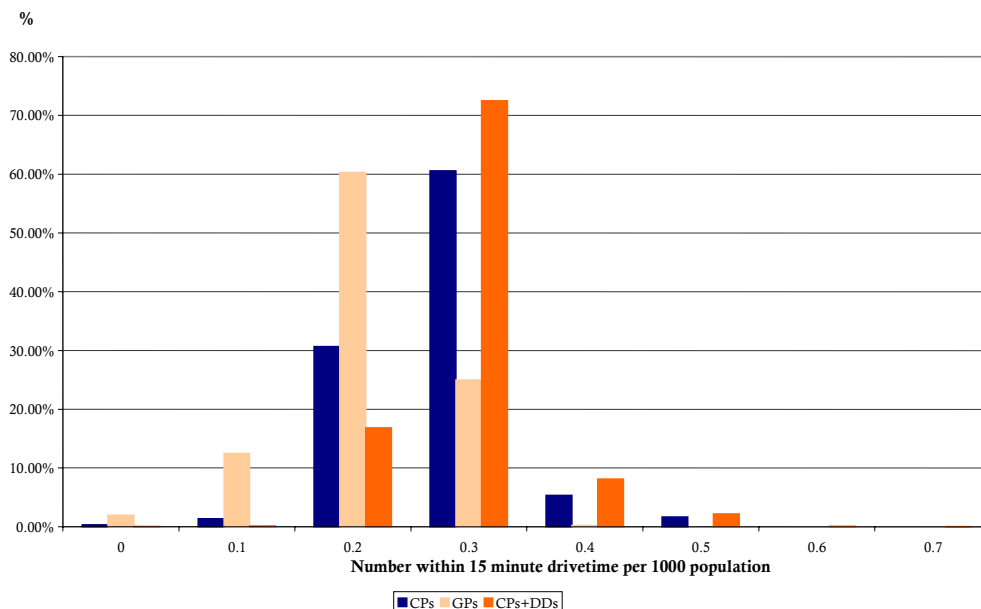
Figure 4: The number of other CPs, GPs & CPs and DDs in 15 minutes drivetime



Source: Frontier Economics

When the number of CPs, GPs and CPs and DDs is normalised by dividing by the resident population (per thousand) in the drivetime, the variation is substantially reduced. This is shown in Figure 5.

Figure 5: The number of other CPs, GPs & CPs and DDs in a 15 minute drivetime per 1000 population



Source: Frontier Economics

This pattern can also be seen in some of the other buffer and drivetime measures but is less obvious in the smallest buffer measures as there are a much greater number of CPs who face no other CP within that range.

5.2 Distance measures

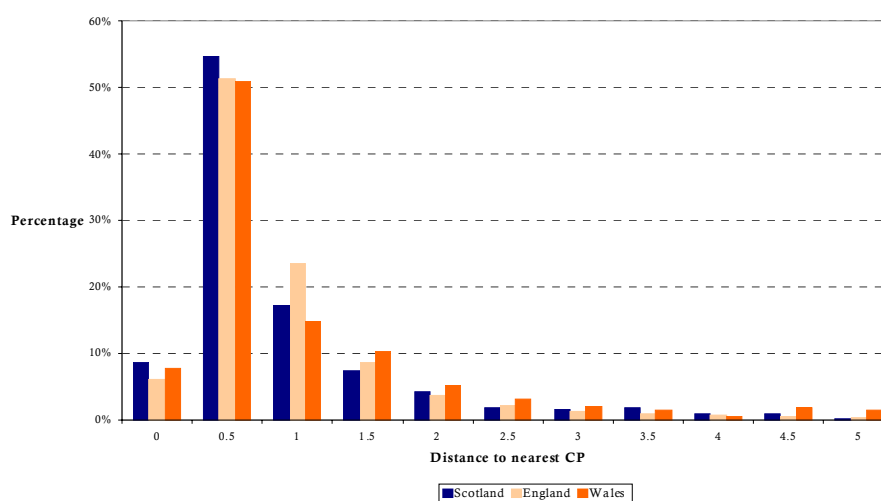
Table 8 shows that the nearest competitor CP is on average located at 0.65km from each CP in England, 0.77km from each CP in Wales, and 0.64km from each CP in Scotland.

Table 8: Distance to nearest competitor CP, km, by country

	Average	Standard Deviation	Minimum	Maximum
CPs in England	0.65	0.795	0.00	4.95
CPs in Wales	0.77	1.029	0.00	4.98
CPs in Scotland	0.64	0.865	0.00	4.81
CPs – GB as a whole	0.65	0.818	0.00	4.98

Source: Frontier Economics

Figure 6 shows that around 60% of all CPs have a rival CP within 0.5km.

Figure 6: Distance from each CP to the next nearest CP, km

Source: Frontier Economics

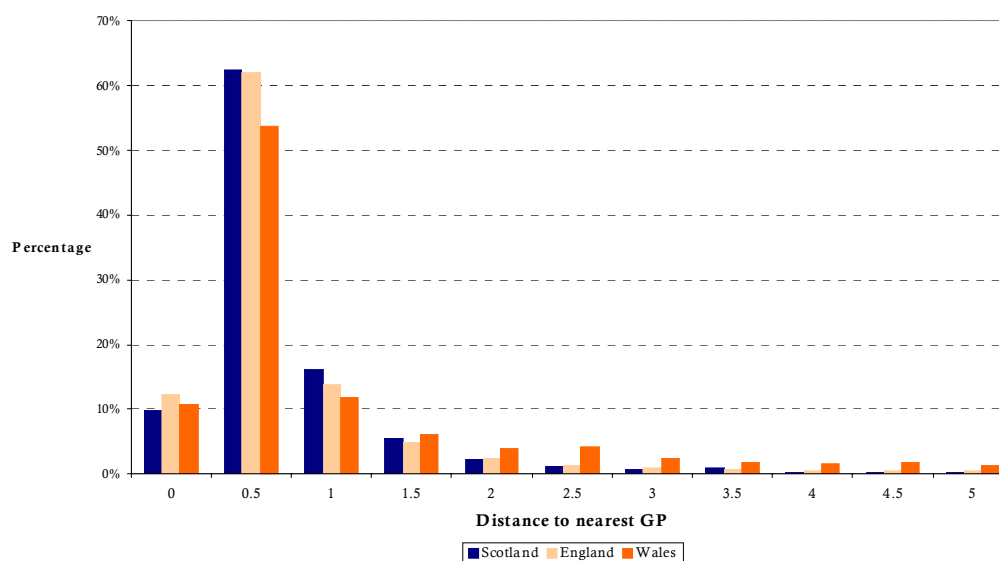
The majority of CPs are located in close proximity to a GP and also to a rival CP. Table 9 shows that the average distance to the nearest GP to each CP is 0.47km in England and Scotland and slightly higher at 0.76km in Wales.

Table 9: Distance to nearest GP, by country

	Average	Standard Deviation	Minimum	Maximum	Count
CPs in England	0.47	0.665	0.00	4.81	8,996
CPs in Wales	0.76	1.097	0.00	4.83	628
CPs in Scotland	0.47	0.715	0.00	4.93	1,114

Source: Frontier Economics

Furthermore, Figure 7 shows that over 60% of CPs are 0.5km or less from a GP.

Figure 7: Distance from each CP to its nearest GP

Source: Frontier Economics

5.3 Correlation between concentration measures

The various concentration measures do not give a consistent picture as to the overall level of concentration faced by each CP. Table 10 shows that for a 10 minute drivetime, for example, there is a high correlation between

the number of GPs and the number of CPs in an area, but the correlation between the number of GPs and the number of supermarkets with pharmacies is relatively low.

This indicates that the different concentration measures are picking up genuinely different aspects of local concentration with respect to each CP, rather than duplicating each other and hence providing no extra information. As a result, most measures potentially provide separate information which can be exploited in subsequent studies.

Table 10: Correlation coefficients between local concentration measures

	CPs	GPs	CPs per GP	CPs & DDs	SM with pharm.	SM w/o pharm. over 25k sq. ft	SM w/o pharm. over 10k sq. ft.	Non disp. drug-stores	Non contract pharm.
CPs	***								
GPs	0.94	***							
CPs per GP	-0.23	-0.37	***						
CPs & DDs	1.00	0.94	-0.22	***					
SM with pharmacy	0.41	0.43	-0.14	0.41	***				
SM without pharmacy over 25 thousand square feet	0.53	0.60	-0.27	0.53	0.57	***			
SM without pharmacy over 10 thousand square feet	0.76	0.79	-0.29	0.76	0.53	0.81	***		
Non dispensing drugstores	0.68	0.61	-0.16	0.67	0.31	0.51	0.63	***	
Non contract pharmacies	0.29	0.26	-0.06	0.29	0.22	0.24	0.31	0.32	***

Source: Frontier Economics

5.4 Composite concentration measures

In addition to there being only moderate correlation between different concentration variables, there is also substantial variability in the concentration measures across different measures of local catchment. For example, a CP in a small rural town may appear to have a high population density within a 5 minute drivetime (contained within the boundaries of the town), but a low population density within a 15 minute drivetime, as this would include a large rural area.

To develop a more general picture of the competitive conditions faced by pharmacies, composite measures of local concentration were formed for some variables. Such measures were formed for:

- number of CPs per population;
- number of CPs per GP; and
- population density.

The aim of these measures is to try to come up with a more consistent picture of the overall demand and supply conditions faced by a particular CP in its local catchment.

Each composite measure was formed using the following method. Taking population density as an example, each CP was ranked for each of the buffer and drivetime measures according to its population density (the population per hectare). For each buffer and drivetime, each CP was allocated to one of four quartiles on the basis of population density, and given a rank from one to four accordingly. The combined index was created by adding the ranks for population density of each CP across all the buffer and drivetime measures, and re-ranking the CPs into quartiles on this composite index. In this way, CPs that are located in high population density areas across different definitions of local catchment, on average, would be placed in the top quartile on this composite measure.

The success of this method in developing a more consistent picture may be seen by investigating the correlation coefficients between the individual measures (by local catchment), and the composite measure. It is found that, in general, the correlations between the composite measure and the individual area definition measures are higher than the correlation coefficients between the individual area definition measures themselves.

The correlation coefficients for each of the three indexes across all buffer and drivetime measures, can be seen in Table 11 (for CPs per GP), Table 12 (for CPs per population), and Table 13 (for population density).

Table 11: CP per GP correlation between drivetime and buffer measures							
	500m buffer	1000m buffer	1500m buffer	5 minute drivetime	10 minute drivetime	15 minute drivetime	Combined measure
500m buffer	***						
1000m buffer	0.70	***					
1500m buffer	0.57	0.79	***				
5 minute drivetime	0.51	0.72	0.77	***			
10 minute drivetime	0.32	0.47	0.54	0.54	***		
15 minute drivetime	0.26	0.37	0.43	0.41	0.72	***	
Combined measure	0.67	0.83	0.84	0.81	0.74	0.66	***

Source: Frontier Economics

Table 11 shows that the correlation between the relative ranks of CPs, in terms of the number of CPs per GP in the local area, varies across measures and can be low. For example, the correlation between the 15 minute drivetime and 1500m buffer ranks is only 0.43. The correlations generally range between 0.26 and 0.79. However, the composite measure has a higher set of correlations (up to 0.84) and might therefore be considered to give a more general picture of the local concentration in the area surrounding that CP.

Table 12: CP per population correlation between drivetime and buffer measures

	500m buffer	1000m buffer	1500m buffer	5 minute drivetime	10 minute drivetime	15 minute drivetime	Combined measure
500m buffer	***						
1000m buffer	0.24	***					
1500m buffer	0.08	0.39	***				
5 minute drivetime	0.06	0.44	0.54	***			
10 minute drivetime	0.04	0.23	0.09	0.23	***		
15 minute drivetime	-0.06	0.06	0.25	0.25	0.33	***	
Combined measure	0.31	0.61	0.63	0.68	0.52	0.56	***

Source: Frontier Economics

Table 12 shows that the correlation between the relative ranks of CPs, in terms of the number of CPs per population in the local area, again varies across measures and is lower than for the CPs per GP measure. For example, the correlation between the 15 minute drivetime and 1500m buffer ranks is only 0.25. The correlations generally range between -0.06 and 0.54. Here, the composite measure has a substantially higher set of correlations (between 0.31 and 0.68). Again, it may be considered to give a more general picture of the number of CPs per population.

Table 13: Population density rank correlation between drivetime and buffer measures

	500m buffer	1000m buffer	1500m buffer	5 minute drivetime	10 minute drivetime	15 minute drivetime	Combined measure
500m buffer	***						
1000m buffer	1	***					
1500m buffer	0.56	0.56	***				
5 minute drivetime	0.69	0.69	0.68	***			
10 minute drivetime	0.56	0.56	0.63	0.73	***		
15 minute drivetime	0.51	0.51	0.56	0.66	0.89	***	
Combined measure	0.85	0.85	0.75	0.85	0.82	0.77	***

Source: Frontier Economics

The correlations between the population density measures in different areas are higher than for the previous measures (between 0.51 and 1). The composite population density measure generally increases this correlation across the different area measures to between 0.75 and 0.85.

Annex 1

Descriptive statistics: local concentration measures

Annex 1: Descriptive statistics

A large number of local concentration measures were developed in the study for each of the six different areas set out in Section 4. This Annex reports in detail some of the most relevant summary statistics for each area measure. These are presented initially for 15 minute drivetimes, then for ever-decreasing areas.

The data presented for each area refers for the most part to 2001 (see the discussion in Section 3 above). The information shown relates to:

- summary statistics for numbers of CPs, GPs, CPs per GP, CPs plus DDs, supermarkets with pharmacies, supermarkets without pharmacies above 25,000 and 10,000 square foot, non-dispensing drugstores, and non-contract pharmacies;
- summary statistics for each of the above measures per 1,000 population;
- distribution of the numbers of rival CPs, GPs and CPs plus DDs across CPs;
- distribution across CPs of each of the above measures per 1,000 population; and
- distribution of the population in that area around that CP.

15 minute drivetime**FigureA8: Summary statistics, 15 minute drivetime**

	Average	St. Dev	Minimum	Maximum
No. of CPs	77.66	71.44	0	381
No. of GPs	60.35	57.96	0	282
No. of CPs per GP	1.57	0.78	1	14
No. of CPs and DDs	79.94	71.05	0	386
Supermkts with ph	2.57	2.26	0	12
Supermkts w/o ph 25	7.01	4.64	0	31
Supermkts w/o ph 10	13.79	9.04	0	59
Non dispensing drugst.	4.74	4.08	0	24
Non contract pharmacy	0.61	1.10	0	10

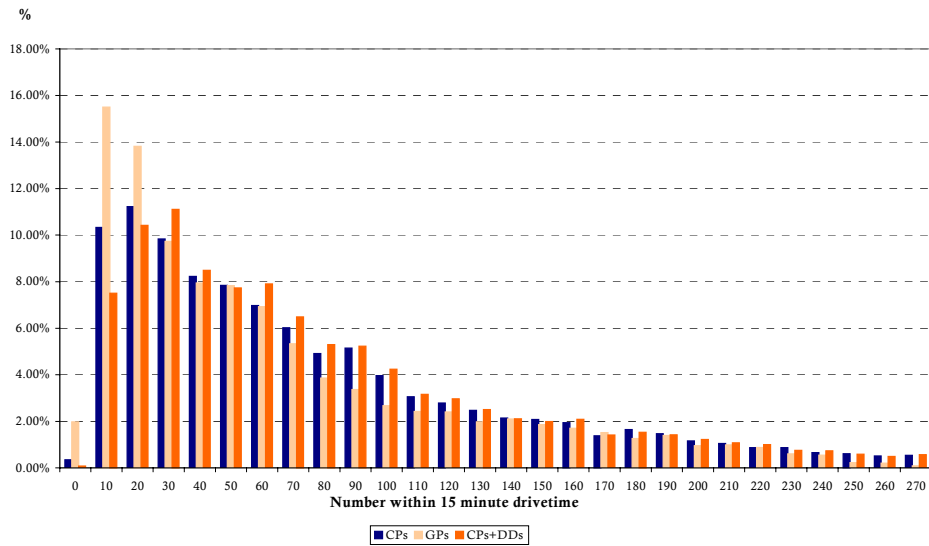
Source: Frontier Economics

Figure A9: Summary statistics per 1,000 population, 15 minute drivetime

	Average	St. Dev	Minimum	Maximum
No. of CPs	0.22	0.06	0	0.46
No. of GPs	0.16	0.06	0	0.53
No. of CPs per GP	0.01	0.03	0	0.53
No. of CPs and DDs	0.24	0.05	0	0.76
Supermkts with ph	0.01	0.01	0	0.09
Supermkts w/o ph 25	0.03	0.01	0	0.15
Supermkts w/o ph 10	0.05	0.02	0	0.34
Non dispensing drugst.	0.02	0.01	0	0.13
Non contract pharmacy	0.00	0.00	0	0.10

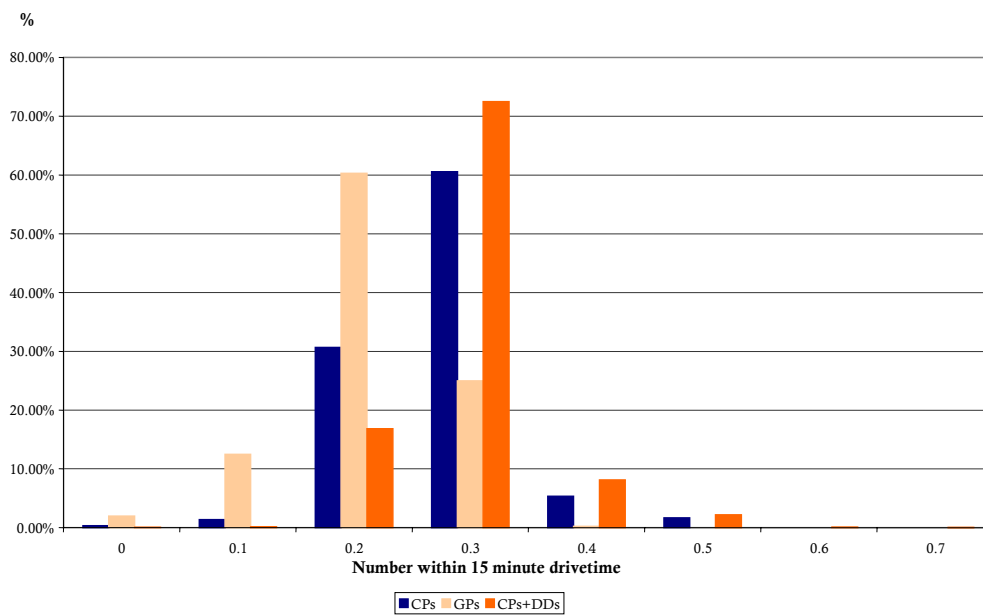
Source: Frontier Economics

Figure A10: Number of CPs, GPs and CPs and DDs in 15 min drivetime



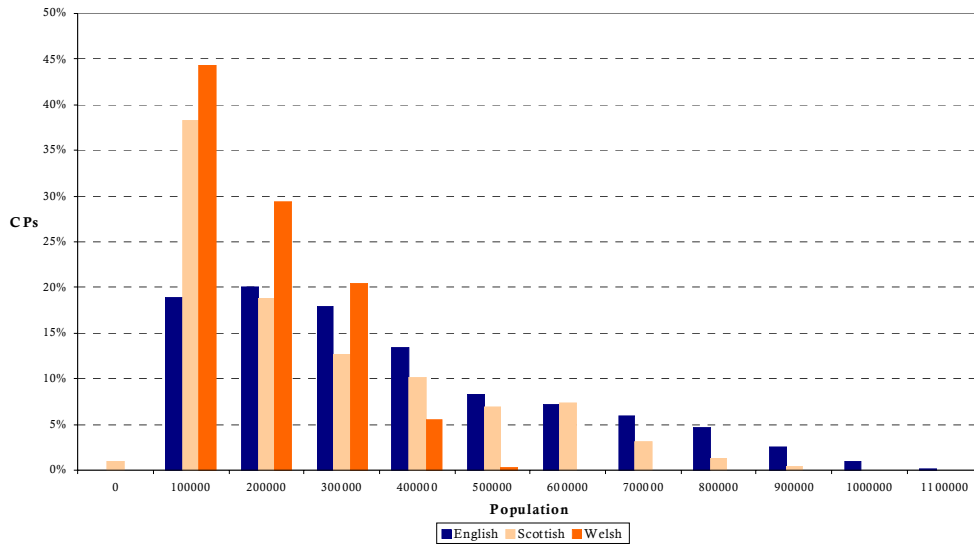
Source: Frontier Economics

Figure A11: Number of CPs, GPs and CPs & DDs per 1,000 population in 15 min drivetime



Source: Frontier Economics

Figure A12: Population in 15 minute drivetime around each CP



Source: Frontier Economics

10 minute drivetime**Figure A13: Summary statistics, 10 minute drivetime**

	Average	St. Dev	Minimum	Maximum
No. of CPs	29.87	28.03	0	185
No. of GPs	23.29	22.19	0	128
No. of CPs per GP	1.57	0.74	0	11
No. of CPs and DDs	30.65	27.90	0	186
Supermkts with ph	1.02	1.15	0	8
Supermkts w/o ph 25	2.82	2.09	0	13
Supermkts w/o ph 10	5.53	3.63	0	24
Non dispensing drugst.	2.01	1.92	0	12
Non contract pharmacy	0.23	0.55	0	8

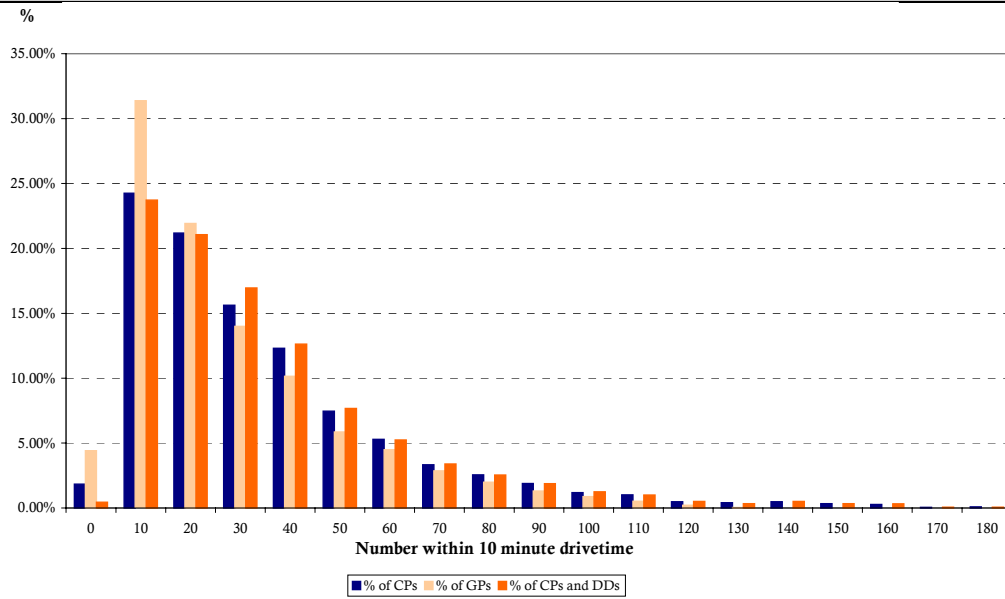
Source: Frontier Economics

Figure A14: Summary statistics per 1,000 population, 10 minute drivetime

	Average	St. Dev	Minimum	Maximum
No. of CPs	0.23	0.09	0	0.84
No. of GPs	0.17	0.08	0	1.45
No. of CPs per GP	0.03	0.06	0	1.03
No. of CPs and DDs	0.25	0.09	0	1.03
Supermkts with ph	0.01	0.01	0	0.26
Supermkts w/o ph 25	0.03	0.02	0	0.49
Supermkts w/o ph 10	0.05	0.03	0	0.49
Non dispensing drugst.	0.02	0.02	0	0.36
Non contract pharmacy	0.00	0.01	0	0.14

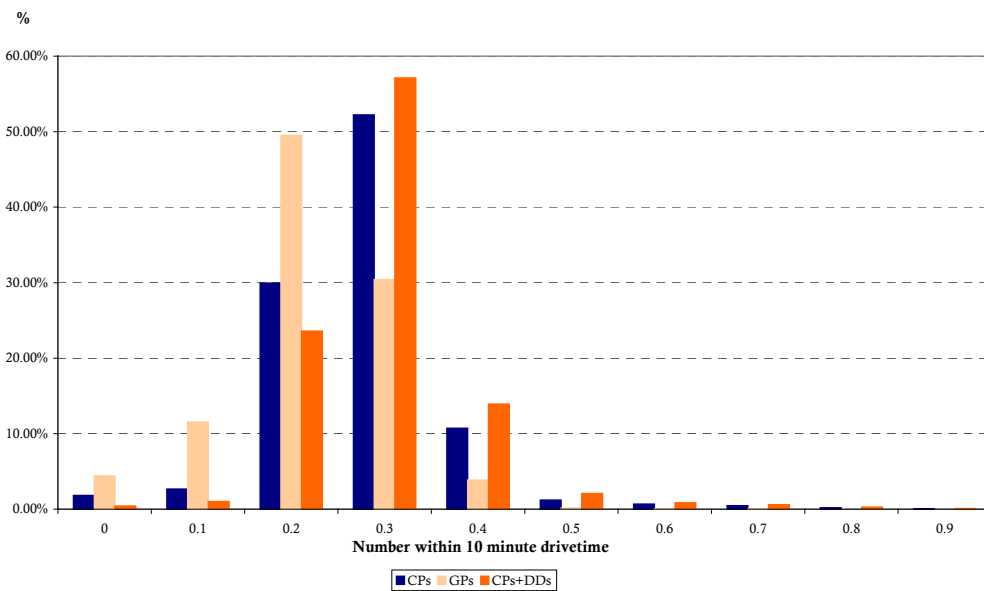
Source: Frontier Economics

Figure A15: Number of CPs, GPs and CPs & DDs in 10 min drivetime



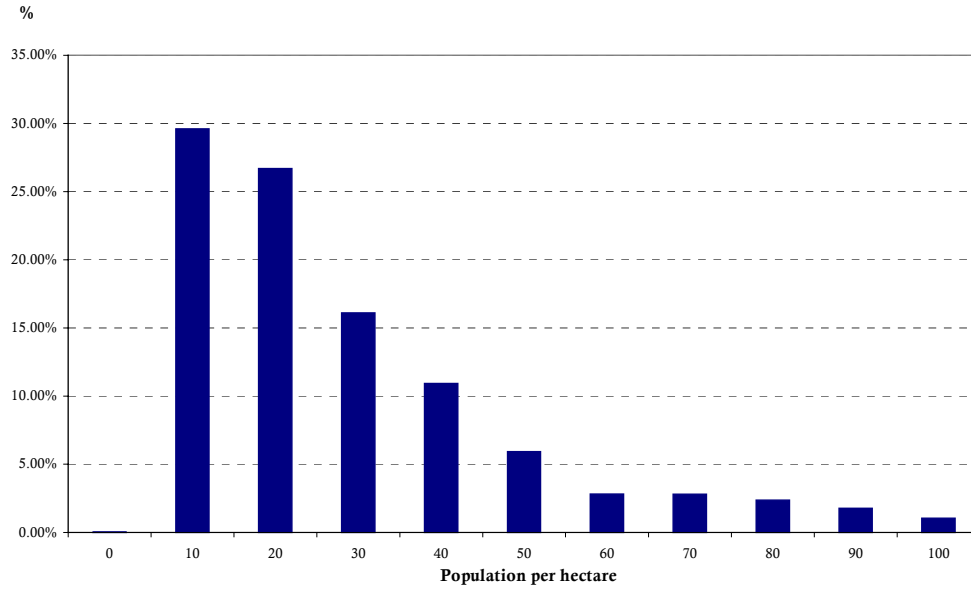
Source: Frontier Economics

Figure A16: Number of CPs, GPs and CPs & DDs per 1,000 population in 10 min drivetime



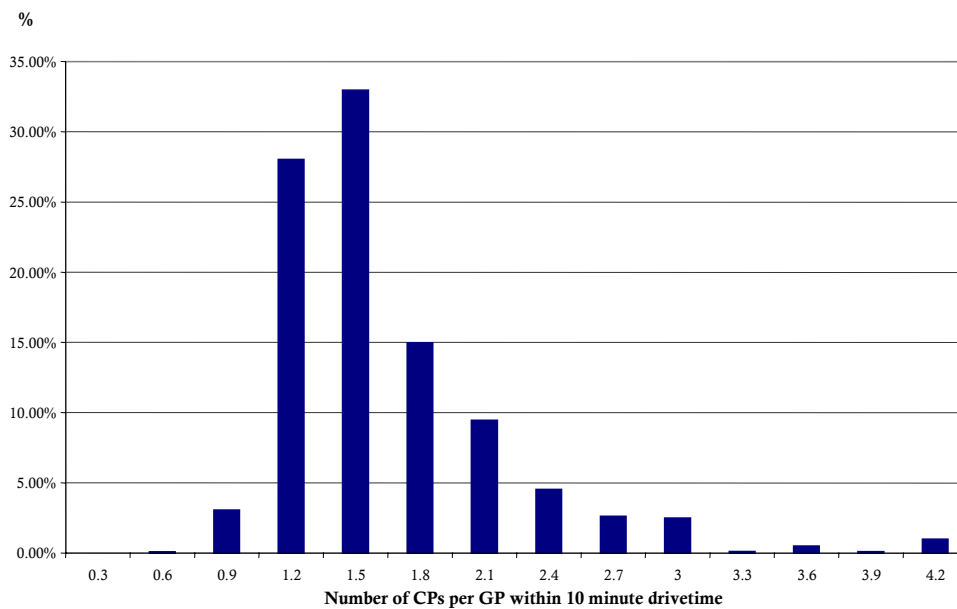
Source: Frontier Economics

Figure A16: Population per hectare, 10 min drivetime



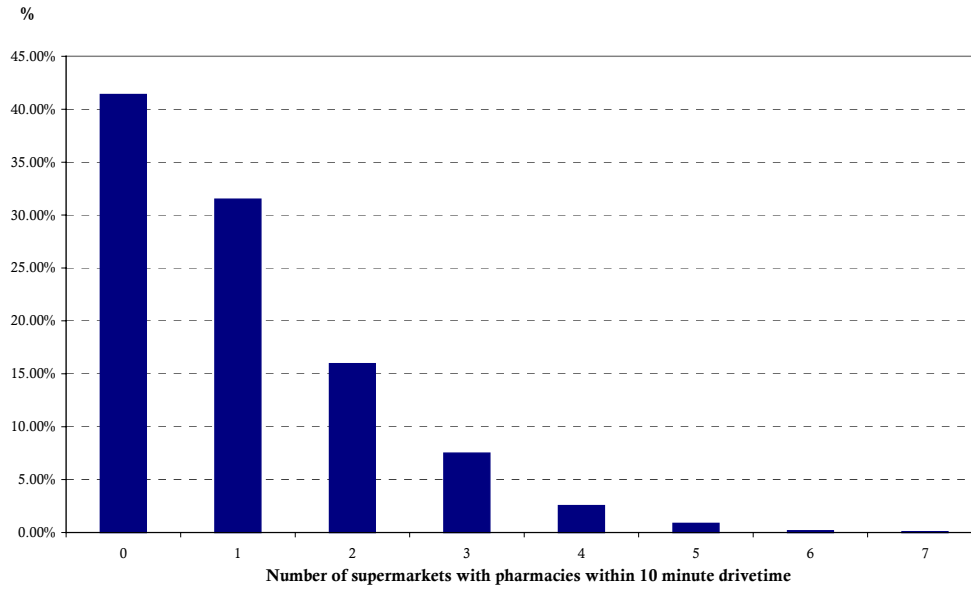
Source: Frontier Economics

Figure A17: Number of CPs per GP, 10 min drivetime



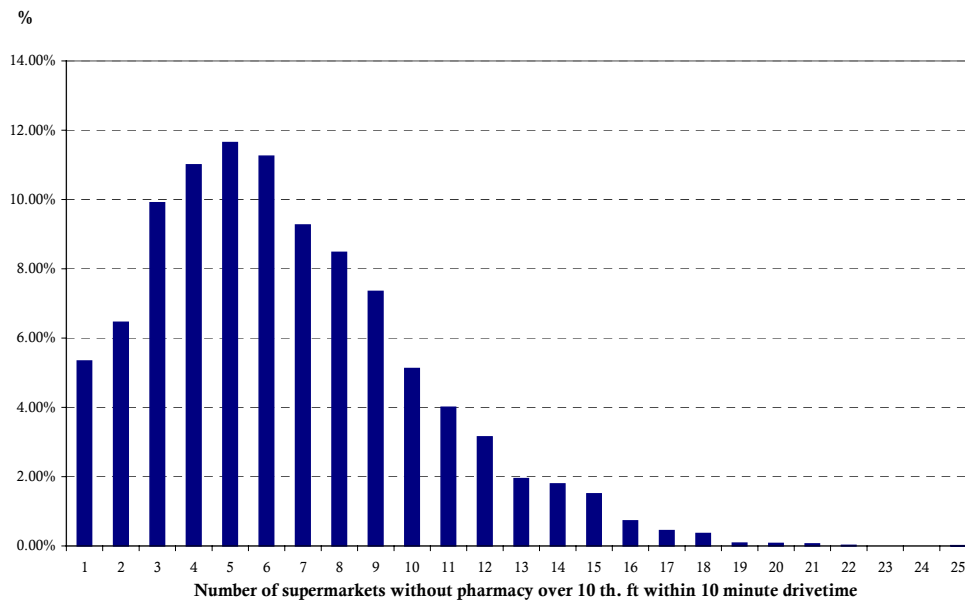
Source: Frontier Economics

Figure A18: Number of supermarkets with pharmacies, 10 min drivetime



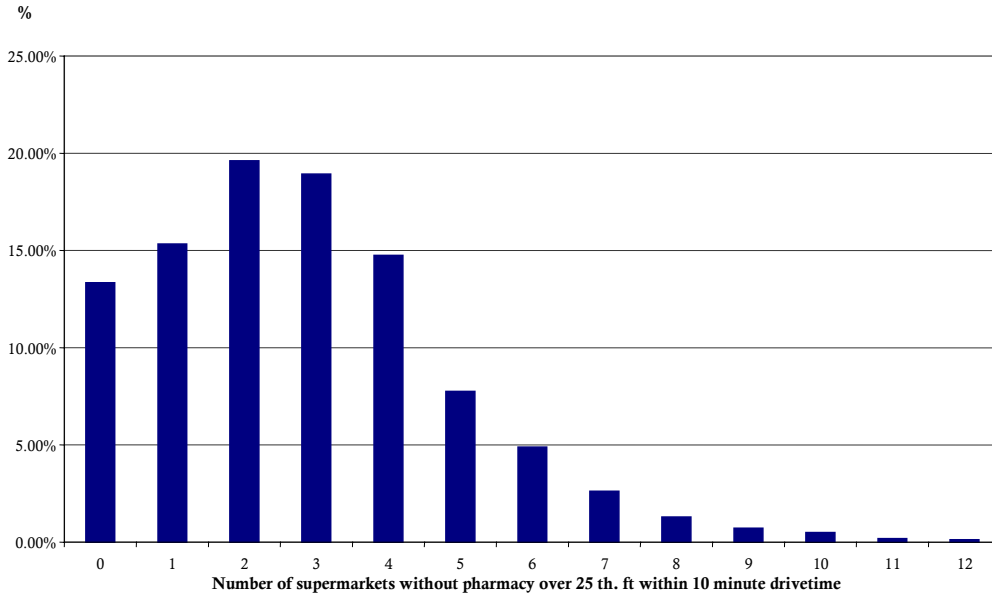
Source: Frontier Economics

Figure A19: Supermarkets without pharmacies over 10 thousand square feet in 10 min drivetime



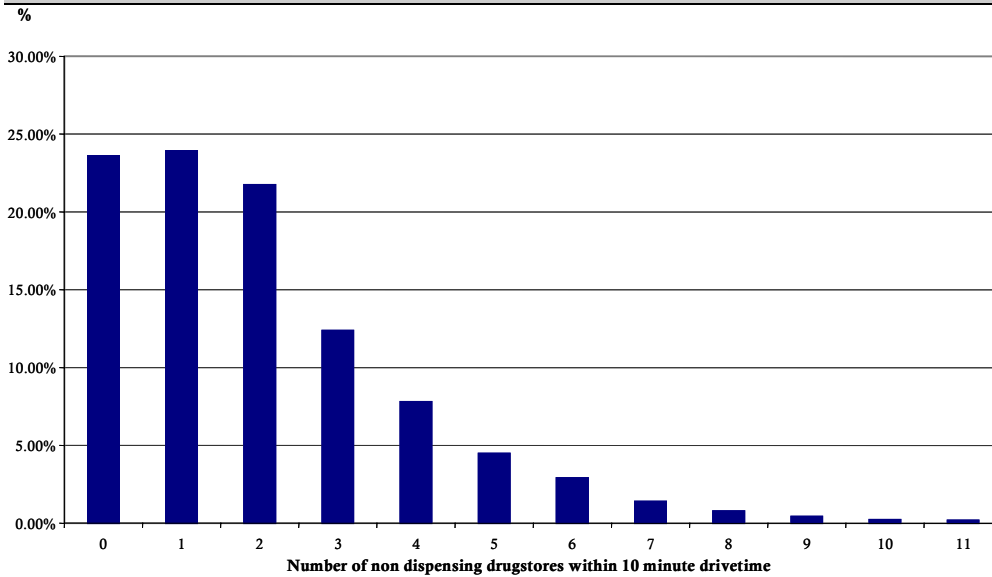
Source: Frontier Economics

Figure A20: Supermarkets without pharmacies over 25 thousand square feet in 10 min drivetime



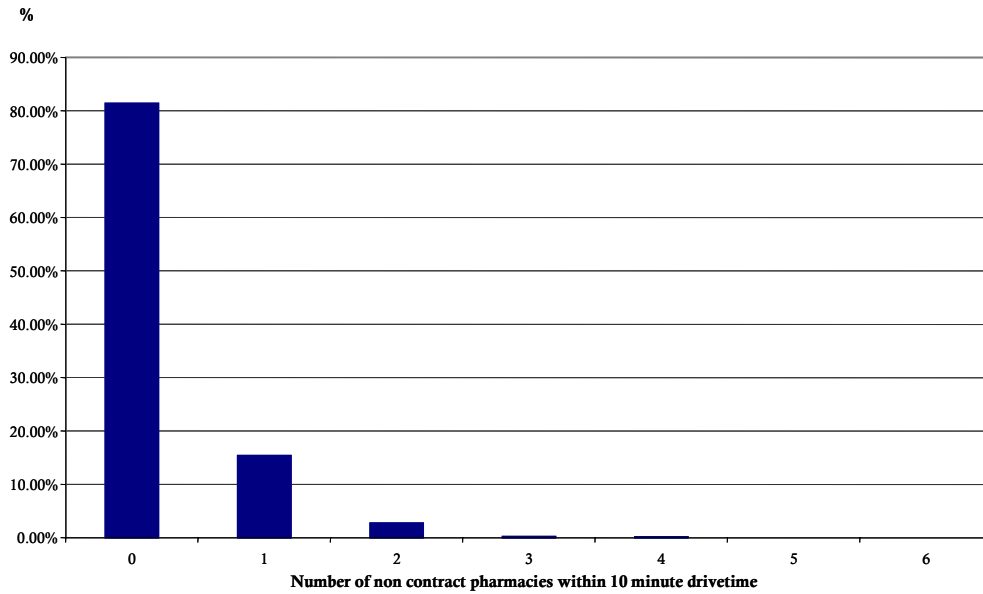
Source: Frontier Economics

Figure A21: Non dispensing drugstores in 10 min drivetime



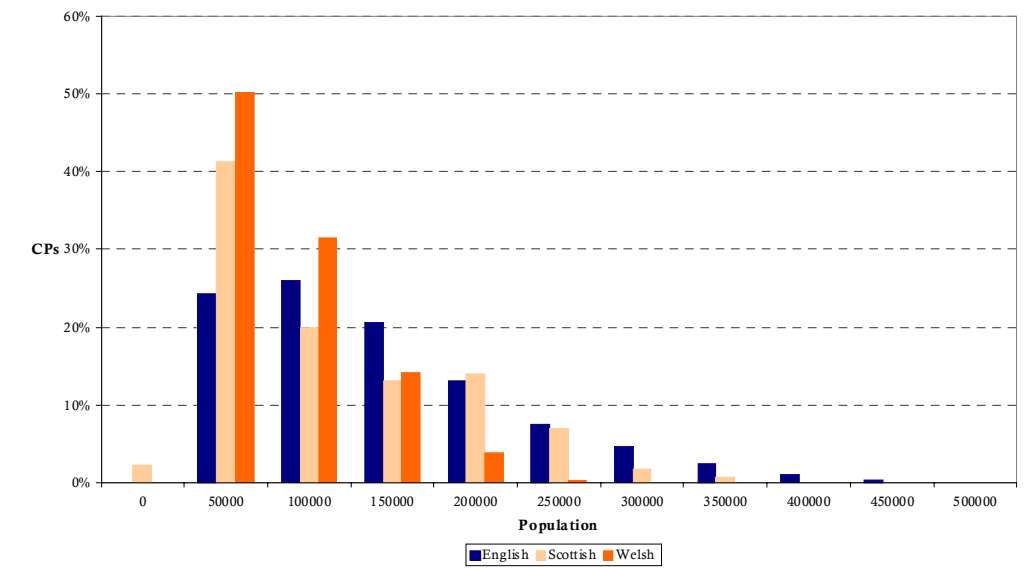
Source: Frontier Economics

Figure A22 Non-contract pharmacies in 10 min drivetime



Source: Frontier Economics

Figure A23: Population in 10 minute drivetime around each CP



Source: Frontier Economics

5 minute drivetime**Figure A24: Summary statistics, 5 minute drivetime**

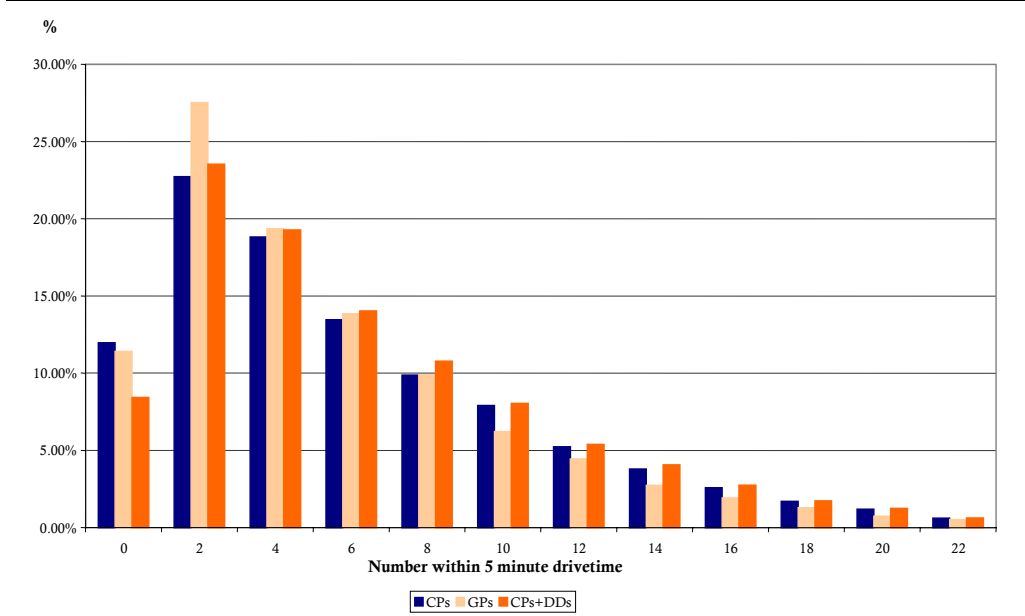
	Average	St. Dev	Minimum	Maximum
No. of CPs	5.97	6.18	0	58
No. of GPs	5.01	4.86	0	41
No. of CPs per GP	1.61	0.96	0.17	22
No. of CPs and DDs	6.20	6.16	0	59
Supermkts with ph	0.23	0.50	0	4
Supermkts w/o ph 25	0.64	0.81	0	5
Supermkts w/o ph 10	1.35	1.26	0	7
Non dispensing drugst.	0.57	0.85	0	6
Non contract pharmacy	0.04	0.21	0	2

*Source: Frontier Economics***Figure A25: Summary statistics per 1,000 population, 5 minute drivetime**

	Average	St. Dev	Minimum	Maximum
No. of CPs	0.24	0.24	0	6.47
No. of GPs	0.21	0.15	0	1.63
No. of CPs per GP	0.10	0.11	0.01	1.85
No. of CPs and DDs	0.27	0.24	0	6.47
Supermkts with ph	0.01	0.03	0	0.64
Supermkts w/o ph 25	0.03	0.05	0	0.64
Supermkts w/o ph 10	0.07	0.07	0	0.78
Non dispensing drugst.	0.03	0.04	0	0.78
Non contract pharmacy	0.00	0.02	0	0.52

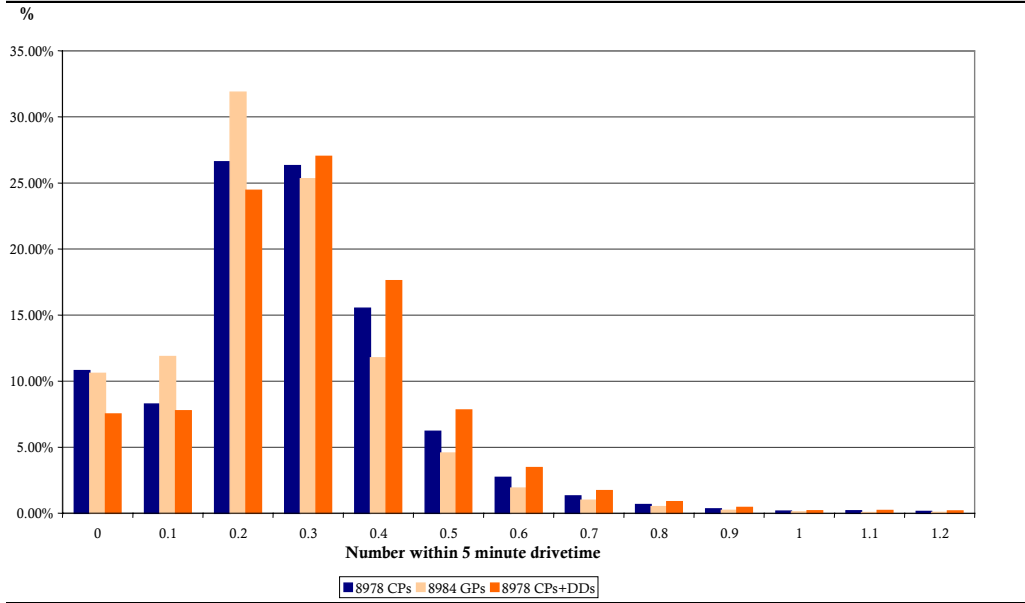
Source: Frontier Economics

Figure A26: Number of CPs, GPs and CPs & DDs in 5 min drivetime



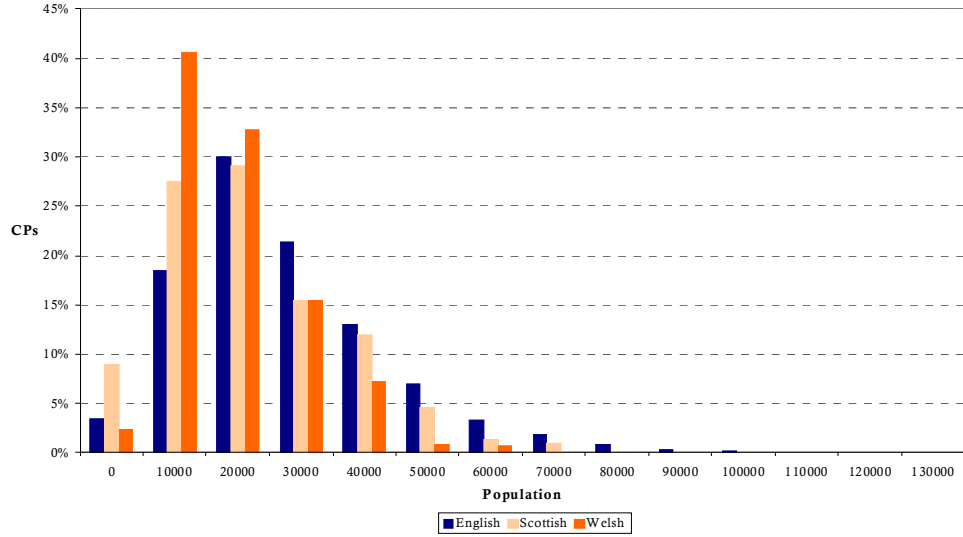
Source: Frontier Economics

Figure A27: Number of CPs, GPs and CPs & DDs per 1,000 population in drivetime



Source: Frontier Economics

Figure A28: Population in 5 minute drivetime around each CP



Source: Frontier Economics

1500 metre buffer**Figure A29: Summary statistics, 1500m buffer**

	Average	St. Dev	Minimum	Maximum
No. of CPs	5.43	6.09	0	57
No. of GPs	4.73	4.67	0	35
No. of CPs per GP	1.55	0.90	0	14
No. of CPs and DDs	5.64	6.09	0	57
Supermkts with ph	0.19	0.44	0	4
Supermkts w/o ph 25	0.53	0.71	0	4
Supermkts w/o ph 10	1.15	1.08	0	6
Non dispensing drugst.	0.50	0.80	0	5
Non contract pharmacy	0.03	0.19	0	3

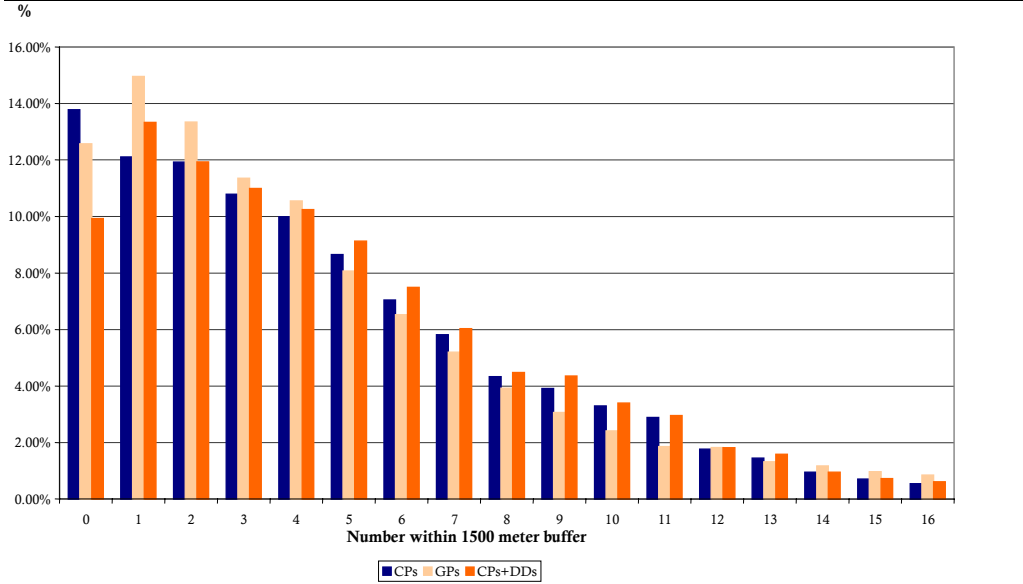
Source: Frontier Economics

Figure A30: Summary statistics per 1,000 population, 1500m buffer

	Average	St. Dev	Minimum	Maximum
No. of CPs	0.22	0.19	0	3
No. of GPs	0.19	0.14	0	2
No. of CPs per GP	0.10	0.10	0	1.44
No. of CPs and DDs	0.24	0.20	0	3.27
Supermkts with ph	0.01	0.03	0	0.35
Supermkts w/o ph 25	0.03	0.05	0	0.52
Supermkts w/o ph 10	0.06	0.07	0	0.94
Non dispensing drugst.	0.02	0.04	0	0.36
Non contract pharmacy	0.00	0.01	0	0.25

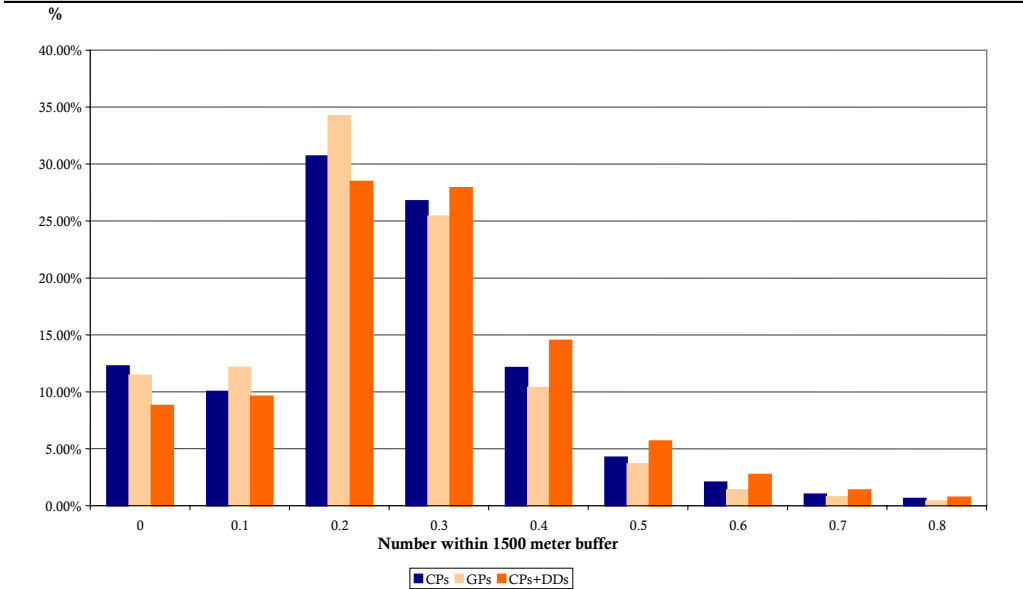
Source: Frontier Economics

Figure A31: Number of CPs, GPs and CPs & DDs in 1500m buffer



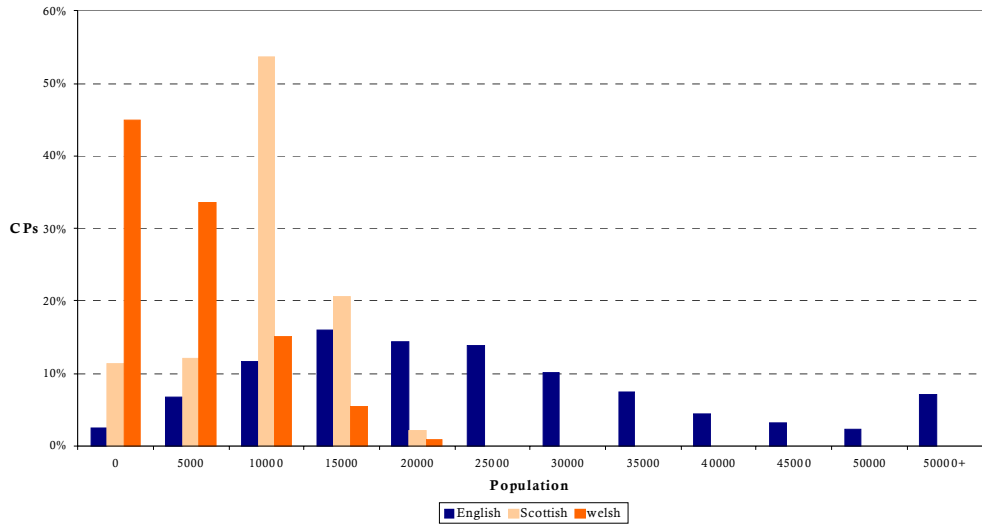
Source: Frontier Economics

Figure A32: Number of CPs, GPs and CPs & DDs in 1500m buffer per 1000 population



Source: Frontier Economics

Figure A33: Population in 1500m buffer around each CP



Source: Frontier Economics

1000 metre buffer**Figure A34: Summary statistics, 1000m buffer**

	Average	St. Dev	Minimum	Maximum
No. of CPs	2.86	3.25	0	38
No. of GPs	2.71	2.55	0	19
No. of CPs per GP	1.55	1.00	0	17
No. of CPs and DDs	3.03	3.27	0	38
Supermkts with ph	0.12	0.36	0	4
Supermkts w/o ph 25	0.31	0.56	0	4
Supermkts w/o ph 10	0.73	0.87	0	5
Non dispensing drugst.	0.35	0.66	0	4
Non contract pharmacy	0.02	0.14	0	2

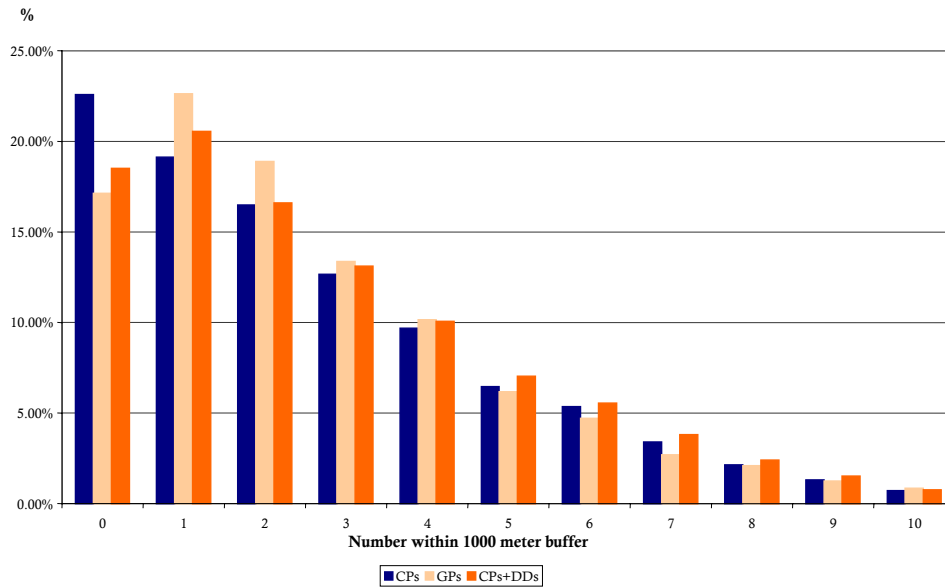
Source: Frontier Economics

Figure A35: Summary statistics per 1,000 population, 1000m buffer

	Average	St. Dev	Minimum	Maximum
No. of CPs	0.26	0.68	0	28.42
No. of GPs	0.22	0.20	0	1.75
No. of CPs per GP	0.16	0.19	0	4.89
No. of CPs and DDs	0.28	0.68	0	28.42
Supermkts with ph	0.01	0.04	0	0.90
Supermkts w/o ph 25	0.03	0.08	0	1.55
Supermkts w/o ph 10	0.08	0.13	0	1.79
Non dispensing drugst.	0.04	0.12	0	3.58
Non contract pharmacy	0.00	0.05	0	1.79

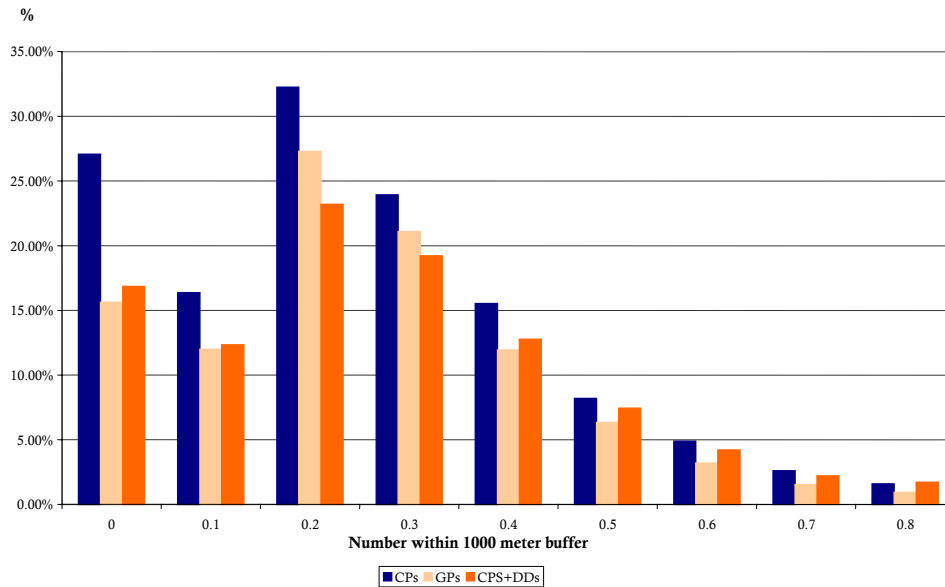
Source: Frontier Economics

Figure A36: Number of CPs, GPs and CPs & DDs in 1000m buffer



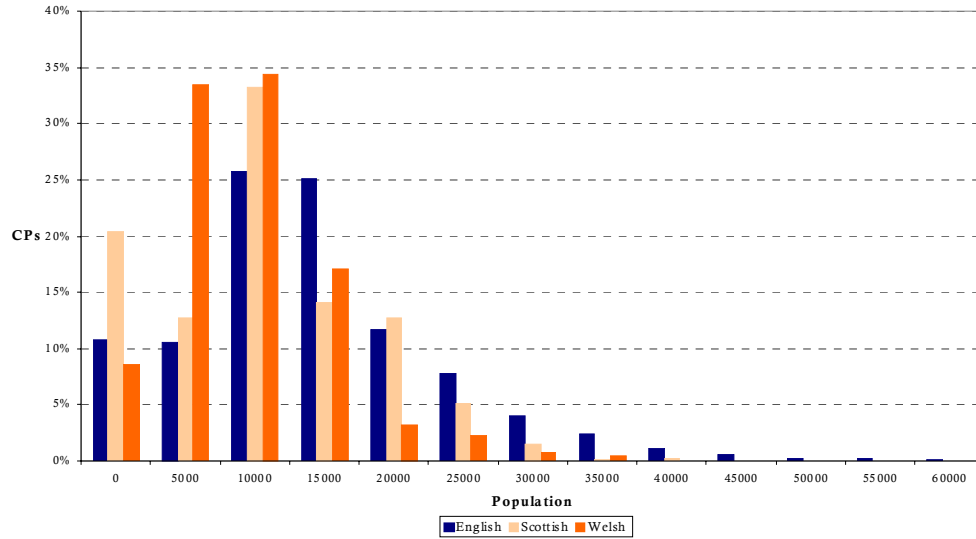
Source: Frontier Economics

Figure A37: Number of CPs, GPs and CPs & DDs in buffer per 1000m population



Source: Frontier Economics

Figure A38: Population in 1000m buffer around CP



Source: Frontier Economics

500 metre buffer**Figure A39: Summary statistics, 500m buffer**

	Average	St. Dev	Minimum	Maximum
No. of CPs	1.15	1.42	0	12
No. of GPs	1.27	1.23	0	9
No. of CPs per GP	1.54	0.98	0	12
No. of CPs and DDs	1.27	1.48	0	12
Supermkts with ph	0.07	0.28	0	4
Supermkts w/o ph 25	0.15	0.39	0	3
Supermkts w/o ph 10	0.40	0.66	0	4
Non dispensing drugst.	0.22	0.53	0	4
Non contract pharmacy	0.01	0.11	0	2

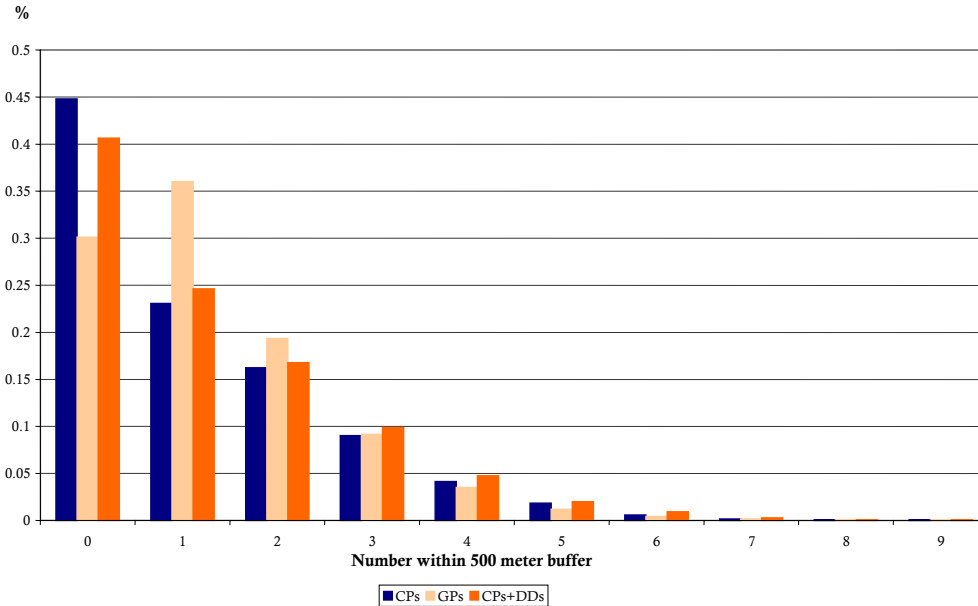
Source: Frontier Economics

Figure A40: Summary statistics per 1,000 population, 500m buffer

	Average	St. Dev	Minimum	Maximum
No. of CPs	0.33	3.10	0	106.06
No. of GPs	0.20	0.24	0	3.46
No. of CPs per GP	0.25	0.26	0	3.47
No. of CPs and DDs	0.37	3.10	0	106.06
Supermkts with ph	0.01	0.04	0	0.58
Supermkts w/o ph 25	0.02	0.08	0	1.39
Supermkts w/o ph 10	0.07	0.20	0	7.09
Non dispensing drugst.	0.07	0.18	0	44.44
Non contract pharmacy	0.02	0.58	0	22.22

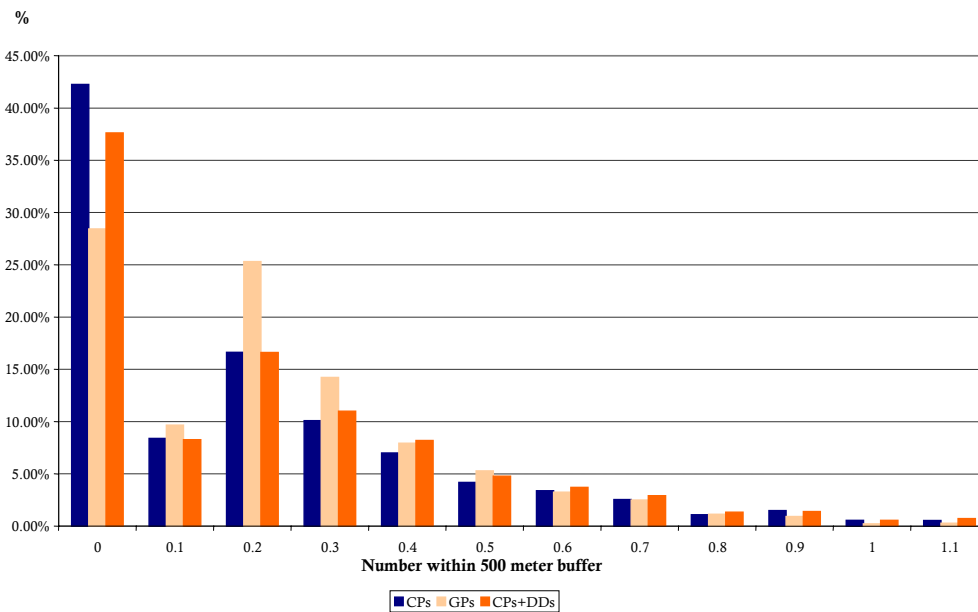
Source: Frontier Economics

Figure A41: Number of CPs, GPs and CPs & DDs in 500m buffer



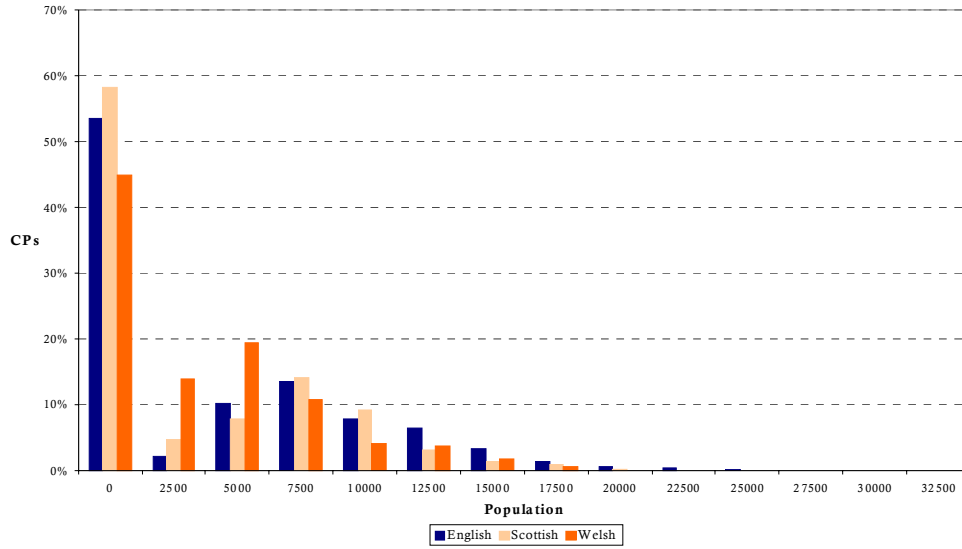
Source: Frontier Economics

Figure A42: Number of CPs, GPs and CPs & DDs in 500m buffer per 1000 population



Source: Frontier Economics

Figure A43: Population in 500m buffer around CP



Annex 2
Glossary

Annex 2: Glossary

This glossary provides further details on some of the technical terms contained in the report.

Standard deviation: The standard deviation of a sample is a measure of the spread of the observations in the sample. It is defined as the square root of the variance of a set of observations, where the variance is equal to the average squared deviation of the observation from the mean.

Correlation coefficient: The correlation coefficient measures whether two sets of variables move in the same direction, independently, or in the opposite direction. A correlation coefficient between two variables of 1 indicates that positive (negative) changes in one variable always correspond to positive (negative) changes in the second variable. A correlation coefficient between two variables of -1 indicates that positive (negative) changes in one variable always correspond to negative (positive) changes in the second variable. A correlation coefficient between two variables of 0 indicates no systematic relationship.

Buffer: From a starting point, the boundary of points in every direction that are exactly X kilometres from the starting point.

Drivetime: The time taken in minutes to travel between two points on the road network, with account taken for the type of road used for the journey and the average speed travelled along that type of road in the relevant area of the country.

Isochrone: From a starting point, the boundary of points in every direction that can be reached in X minutes (in this case drivetime) from the starting point.

GIS: A GIS (geographic information system) is a software program for analysing data about points, lines and areas.

Geocoding: Geocoding is the process by which data points are assigned geographical coordinates so that they can be placed on a geographical map for use in further analysis.

MapInfo: A GIS software package used in this study.

Dispensing Doctor: A doctor who has an NHS contract to dispense medicines to patients, in addition to prescribing medicines. Generally, dispensing doctors are located in rural areas where there is no alternative pharmaceutical provision.

Non-contract pharmacy: A pharmacy that does not have an NHS contract and can not therefore dispense NHS prescriptions. Such pharmacies can still dispense non-NHS prescriptions and sell P-only medicines.

Population-weighted ward centroid: The centroid of an area is the geographic midpoint of that area (in this case a ward). Population-weighted centroids (as employed in this study) take each geographic point in an area and weight according to the population at that point, so will be closer to population centres than the genuine geographic midpoint.