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Abstract
The availability of representative and disaggregate interaction data allows for a new range of "realistic" analysis with geographical information systems and spatial statistics. The paper uses the origin-destination commute data published from Census 1991 and 2001 to analyse interaction patterns generally within England and Wales and in more details around a number of cities. In the city "cases" specific attention is given to the "range of influence" of each metropolitan area, measured through the variation in commute distances and the directionality of commuting. The cities are London, Manchester and Birmingham. These are chosen for their size and differences in regional context. In the general analysis – at the country-wide scale – special emphasis is put on deriving a representation of the scale and the corridors of interaction from the relatively disaggregate data. A map of commuter flows in England and Wales drawn from the ward-based OD-data is presented. Similar methods have been used by the authors to assess the development trends in commuting in and around the largest urban areas in Denmark. The Danish data will be included in the paper for a comparison of commute distances and its dependence on location in the urban area – between Denmark and England.

1. Background

The Danish register based commute statistics was used in the recently completed project Town, Road and Landscape to map and analyse the developments in commuting over time in Denmark. The (almost) full count origins and destination for the working populations home and work address and the availability of time series provided an opportunity analyse the spatial distribution of commuting and to analyse development trends over a 20-year period. As the Origin-Destination statistics from the British census 2001 was recently made available free of charge this fuelled the inquiry presented here where some of the maps and indicators used to analyse on the Danish data is tested on the commute data for England and Wales. This point of departure also explains the title "Explorative mapping…" as the authors have limited knowledge of the English and Welsh geography and issues of debate when it comes to labour market structure and developments in commuting. We merely bring forward what the available data suggests based on maps and indicators related to the impact of cities/urban structure on commute patterns.

Commute data – and especially commute data for the development over time is especially well suited to assess the consequences of the changing urban form, such as de-concentration tendencies and sub-centring - on commuting. An interesting aspect is here the combined effect of de-

concentration and extended commuting or developments towards the formation of urban fields over time. Fore instance, an evaluation of the effect sub-centring on commute distances should also take the ongoing outward expansion of the influence of the largest urban areas into consideration. This type of inquiry will be dependent on "borderless" OD-data over time, such as the commute statistics, in order to allow analysis of the changing sphere of influence of cities.

There is also a special case for cross-national comparisons of the developments in commuting. Most studies of fore instance how urban form affects commuting are cross sectional. This means that it is difficult to reveal the importance of the conditions that is common to all today – but which may change in the future. Examples would be travel costs and regulations and norms related to the labour market. Despite the difficulties that is associated with the controlling of relevant factors across national contexts – cross country and cross city comparisons – is a way to gain knowledge of the impact of changing urban forms on commuting - in different contexts. Comparisons between countries and cities with respect to transportation has been conducted on a number of occasions (see fore instance: Cameron et. al., 2004; Giuliano and Narayan, 2003; Newman and Kenworthy, 1999) often however is it carried out at the most aggregate level ("one city one number"). It is suggested that more detailed/sensitive comparisons between countries and cities within these countries could be a highly valuable tool for strategic reflection on the long-term impacts of urban structure on commute patterns and the significance of differences in other structural factors that affects the commute pattern.

Such conclusions and reflections are of course of relevance within urban and regional planning. Partly at the strategic level where it is necessary to take a view at the nature of the functional interdependencies irrespective of administrative divisions in order to get the proper perspective and be able the respond to the future demands and problems imposed by developments in commute patterns. And to develop policies on urban form and the development of transport systems that are long term decisions - making some idea about the sensitivity of the commuters response to changing contextual and structural factors highly relevant. And of course for planning within a shorter time horizon where trends in commuting may change the need for transport services or the like.

This paper analyses the expanding scale of functional integration with GIS-based mapping of commuter flows in England and Wales and the relationship between centrality and commuting in selected Danish and English urban areas. Specifically the following chapters focuses on the commute data and the methodology/indicators used, mappings of the development in commuting in England and Wales, the development trend in commute distances - and lastly a comparison of urban areas in Denmark and England presented as a number of "city profiles" that focuses on the relationship between centrality and commuting in 2001. Especially this last chapter should be seen as a first step towards a comparative case study that should focus on the developments in urban form and commuting over time in cities in different countries.

2. Data and methodology

The main data source used in this paper is the commute statistics from England and Wales and Denmark containing information of place of residence as well as place of work.

English data

The analysis draws on the origin-destination statistics and special workplace statistics released from census 1991 and census 2001. In the census principally all households and household members are surveyed in their home. The survey includes the question: "What is the address of the place where

you work in your *main* job?" (National statistics, 2001, p. 8). Together with the home address this allows for creation of the origin-destination datasets to be created (including information on the number of persons that work from home). The way origins and destinations is registred changed for students in employment from 1991 to 2002 (Office for National statistics et. al., 2001). What is more a matter of concern for the comparability of commute patterns over time is for one thing the use of a 10% sample to construct the 1991 OD data – and the changes in survey methodology that was introduced from 1991 to 2001. The changes took place to increase the reliability of the census, but was not very successful in doing so (see: Boyle and Dorling, 2004; Simpson, 2003) and the consequences on the reliability of commute data is unknown. Thus comparisons between 1991 and 2001 commute data must be done cautiously. For the purpose of analysis a dyadic origin-destination matrice (Berry, 1968; Marble et. al., 1997), with number of commuters in 1991 and 2001, has been generated based on wards (though the data is also available for the very small output areas in 2001).

Danish data

The analysis draws on Statistics Denmark's commuter statistics (workforce statistics) where home and place of work is registered for the employed population at the end of each year (in 2002: 2, 6 mill.). The database has been kept since 1981 and therefore allows analysis of some 20 years of change in commute patterns. The handling of the data has developed over time especially with respect to the identification of workplaces for the individual employees. However in the latest ten year period no changes with a likely significant impact on the proper detection of origins and destinations has occurred. For persons with more than one job all jobs are registred in the statistics and sorted on the basis of the relative contribution to total income (in November). The primary occupation is the one that contributed the most. For the purpose of analysis a dyadic origin-destination matrice, with number of commuters from homes to primary occupations, in 1992 and 2002, has been generated based on parishes. Denmark is divided into parishes that today only have minor administrative responsibilities but are used as a geostatistical unit below the municipalities.

As the Danish as well as the English data registers relations between a home address and a main job/a primary occupation, there seems to be a basis for comparison of commute patterns between the two countries. Still of course a comparison must be done cautiously, as fore instance the reliance on employers information on actual place of work and the identification of primary job on the basis of income – in the Danish case – may perform somewhat differently than the individual employees image of what constitutes the "main job".

Mapping functional integration

As an important part of the analysis maps of commuter flows in England and Wales have been drawn. In this case flow is understood as a characteristic of a given area and is derived from the numbers of commuters passing through, originating or ending in the given area unit (for a similar conception see: Matthiessen and Andersson, 1993).

The flow maps were created in ArcGis/ArcView through a number of steps. First the origin/destination data was represented as desire lines. Second the desire lines were intersected with a superimposed 5x5 km grid. Third, and last, the flow was summarised for each individual grid-cell. The result is a series of maps that use colour codes to show the differences in commuter flows in 1991 and 2001 – and growth in the same period. The maps visualises the state and development of functional integration and allows for it to be placed in its geographical context.

The result can be compared to the delimitation of commuter regions. The main difference is that the flow maps would draw on levels of flow to do so – as opposed to the more common discrete categorisations of functional areas (see for example Berry 1968; Nielsen, 2001; Andersen, 2002). The result can also be interpreted as a mapping of centrality. That is, if centrality is taken to be the

place where the flow volumes are the greatest i.e. as the focal point of interaction. Through this, the flows of persons would be linked to the land market and developer interests.

City profiles

Two indicators are used to analyse the changes in commute patterns around three of the largest cities in England and Denmark respectively. These are commuting directionality and commute commute distances – as a function of distance to the centre. Both are likely to reveal differences in the the importance of location in explaining commute patterns and the relative importance of the core area.

A measure of commute-directionality vis-à-vis the Central business district (CBD) was for instance used by Christopher et. al (1995) to measure the state of development towards cross and reverse commuting in the Chicago area. Vandersmissen et. al. (2003) included the travel directionality to document the decreasing significance of the direction vis-à-vis the historical core for commuting duration. Among others Van der Laan (1998) effectively used a measure of the directionality (termed nodality) of commuting to describe the structure of daily urban systems in the Netherlands. The commute-directionality will reflect the dominance of the core and the internal structure of the urban area but it is also likely to reflect the range of influence of the city's labour market. If the broad interpretation of the monocentric model is taken for granted (see for instance Anas et.al. 1998) the assumption would then be that workplaces generally are more centrally located than residences and that the commutes generally take the direction towards the centre. Therefore, the movement over distance from one sphere of labour market influence towards another should leave an imprint on commuting directionality. Rain's (1999) concept of directionality where the average commute direction is represented as a vector could be seen as an attempt to rely on such an "imprint" to delimit functional regions. In this paper commute directionality is plotted as a function of distance to the centre of the urban area (equals the historical core or the CBD). Commute directionality is measured as the proportion of the resident employed population that commutes more than 5 km closer to – or further away from – the centre than their place of residence.

The second indicator is the commute distance and its correlation with the distance to the centre. From the literature on transportation and land use it should be expected that the commute distance (travel distance) for the resident population in a given area will rise with increasing distance to the centre of an urban area and then level off and possibly fall as the interaction with the urban area decreases and the areas become more independent (see for instance Næss and Johannsen, 2003; Christensen, 2001). The reason for this is that the amount of travel increases with the increasing distance to the total sum or a large part of the sum of attractions in the region (almost the same as distance to the centre), but levels off and drops as distance increases to a level where interaction with the urban area is low.

Commute distances as well as the directionality of commuting is calculated from the origin-destination datasets on the basis of airline distances between ward centroids in the English case and the centroids geographical zones derived from parishes in the Danish case. The main reason for the use of airline distances is the lack of access to an adequate road network covering England and Wales. To secure the comparability between the commute indicators between the two countries the Danish data has been handled in exactly the same way as the English data. As the Danish data is drawn from registers held at the person and address level - the same geographical divisions can easily be applied at different points in time. In the English case the data from the 1991 census first of all had to be converted into a dyadic interaction matrix and the ward names translated into 2001 wards before the development could be mapped and compared (Transportation planner Jesper Runge Madsen assisted with the assembly of the 1991 database).

3. Commuterflows in England and Wales

The commuterflows for England and Wales in 1991 and 2001 can be seen on figure 1 and 2 below. The number of commuters starting, ending or passing through each 5x5 km cell is summarised based on the censuses and shown as standard deviations above the mean each year (calculated on the basis of the cells that had any flow in 2001). Mean and standard-deviations was used instead of absolute numbers in for the purpose of a comparison between 1991 and 2001 – thus it is implicitly assumed that undercounts and incomparability of the results imposed by the new census methodology in 2001 is evenly distributed among the population and therefore also geographically. This assumption is probably not true but is likely to be less of a problem as long as analysis is at the aggregate level.

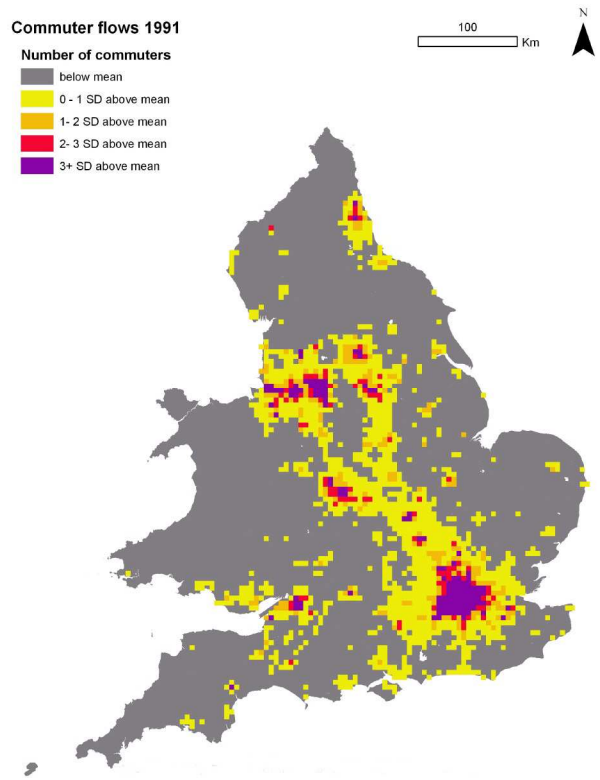


Figure 1: The flow of commuters through 5x5 km cells in England and Wales derived from the special workplace statistics from census 1991. Colour codes are set based on the mean flow among the cells that had any flow in 2001 – and standard deviations from this mean.

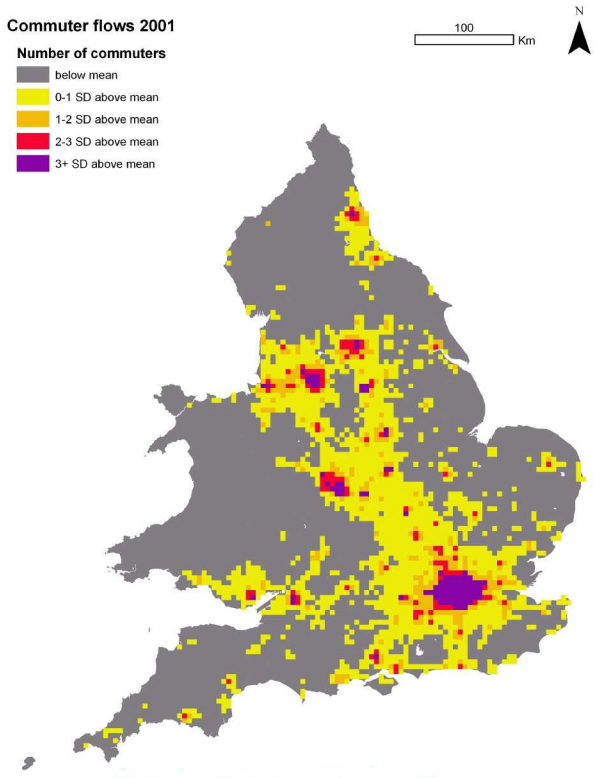


Figure 2: The flow of commuters through 5x5 km cells in England and Wales derived from the OD-tables from census 2001. Colour codes are set based on the mean flow among the cells that had any flow – and standard deviations from this mean.

The 5x5 km cell unit for summary and presentation of results is a pragmatic choice. To summarise the results on a grid seems to be necessary in order to highlight the patterns and changes on the maps. If one where to summarise on the wards for instance the visual interpretation would be made difficult by the many small areas with irregular boarders in the cities. Partly because the highest flows are extremely focussed in space. The grid "enlarges" the high flow areas on the map and makes it easier to detect the "centres" and the build up of commuting around them. The grid cells should of course be of a size where they would be a reasonable match to the area divisions on which the data is supplied (in this case wards). Besides they should not be too large as the commuter flow then would resemble population densities a lot and the mapping exercise as such meaningless. A map of human densities (sum of resident employed population and employed population by place of work, Fouchier, 1994) in 2001 can be seen on figure 4.

If the areas of high interaction in the form of commuting are described on the basis of the maps, a main corridor can be seen from London over Birmingham to Leeds, Manchester and Liverpool. The corridor was established in 1991 but has widened considerably from 1991 to 2001, especially around Birmingham and between Birmingham and London. The corridor has also been extended to the south where commuting between the coast and London has increased. Besides commuter flows has grown around a number of cities outside the "dominant" central corridor, fore instance Cardiff, Bristol and Newcastle. The development has been especially marked around Cardiff that seems to have increased its interactions with surrounding areas considerably.

Focussing directly on the changes from 1991 to 2001 measured as changes in each grid cells standard deviations, from the mean from the 1991 map to the 2001 map (figure 3), it becomes obvious that the development in commuting occurs on the edges and around the established interaction corridor that can be seen in figure 1 and 2. In the core of the corridor – in central London and to the north-west of London the commuter flow is declining. Thus commuting seems to be flattening and spreading with the dominant corridor of interaction linking the country's largest population centres as its offspring.

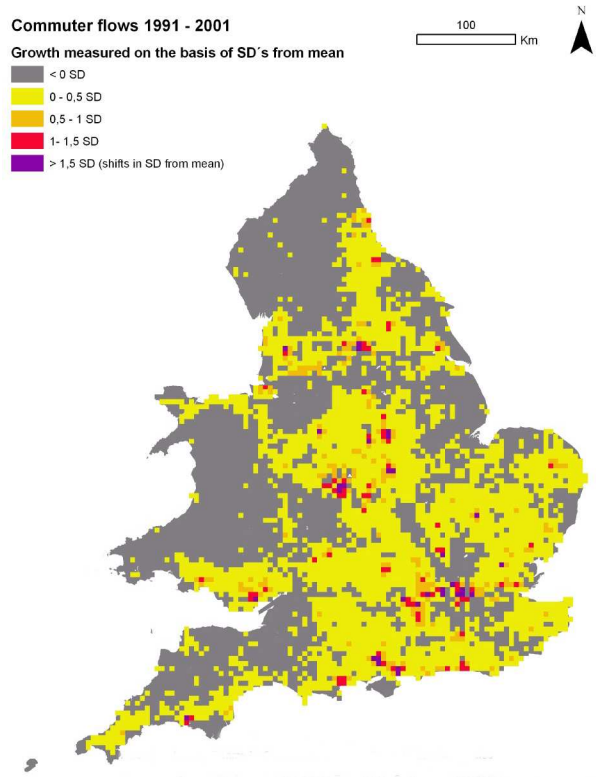


Figure 3: Change in commuter flow from 1991 to 2001 – measured as change in standard deviations from the mean from 1991 to 2001 (parallel to percentage-point change). Thus the map displays the development in the distributions as a direct comparison of absolute flows does not seem reasonable because of the changes in the census methodology.

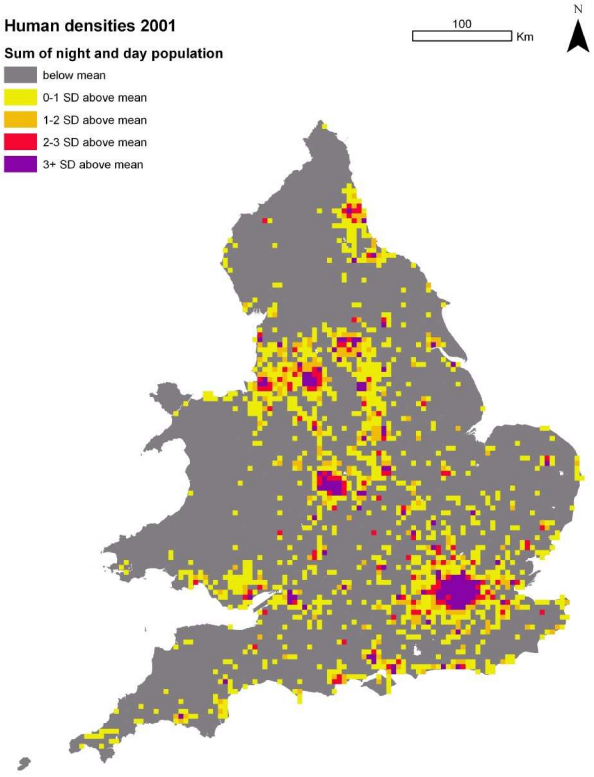


Figure 4: The distribution of human densities (sum of resident employees and employees by place of work) in 2001. The number of employees in the 5x5 km cells was summarised on the basis of employees in output areas. Colour codes are set based on the mean density in the area – calculated on the basis of the cells that had any commuter flow in 2001 – and standard deviations from the mean.

4. Commute distances

The increase in flows can for a large part be attributed to increasing commute distances. The distribution of the commuters on the distances they commute (figure 5), suggest that the number of commuters that commutes more than 20-30 km between home and work are increasing their share of the total number of commuters. The development is strongest within the category of commuters that commutes more than 50 km as they increased from 2,7% of all in 1991 to 3,5% in 2001 where they counted 825.000 employees in England and Wales. The growth in the number of long commutes seems to come from an upward shift from the 10-20 km category that declines in percent of all commuters from 1991 to 2001. The proportion of short commutes (0-10 km) seems to remain stable around 69-70% of all and may have increased slightly in the ten year period. However due to the differences in methodologies between census 1991 and 2001 – and the small difference – it is difficult to access whether the difference is real.

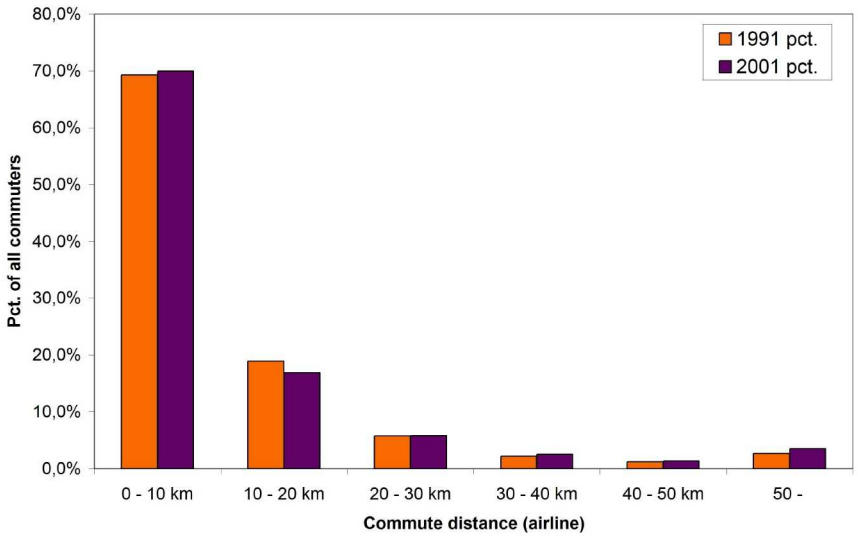


Figure 5: The relative distribution of commuters in **England and Wales** – on commute distances (10-km intervals) based on airline distances between ward of residence and the ward where the place of work is located. Locations of residences and workplaces are derived from Census 1991 and 2001.

Long distance commuting (> 50 km airline) seems to be strongly associated with especially London and to a smaller extend with the urban region that contains Manchester and Liverpool, and with rurality/remoteness. The long distance commuters reaches the highest proportions of the resident population in the areas surrounding London to the south and east – similarly the proportions of long distance commuters among the resident population are the lowest within London and on central locations in the Manchester, Liverpool region (see appendix).

Long distance commuting (> 50 km airline) also has a particular social profile. When the commute distances is distribution of occupations it becomes clear that there is a gradual change in the composition of the commuters from the shortest to the longest commute distances. The “Managers and Senior Officials” equals 13% of the short distance (< 10 km) commuters while they equals 30% of long distance commuters (> 50 km). Similarly the “Elementary occupations” equals 14% of the short distance commuters but only 7% of the long distance commuters.

Comparison with Danish commute distances
Comparison with Danish commute distances has to be undertaken cautiously as there are basic differences between the Census methodology and the Danish register based approach. The practical implication of this difference in methodologies is unknown and testing of the sensitivity of the result from potential sources of error or bias should be applied. This would fore example be the impact of long commutes on the result as the Danish commute statistics has often been criticised for exaggerating them.

At the general level the ward-based commute data for England and Wales can be translated into an average commute distance around 12 km (based on airline distances between ward centroids). The Danish commute data (based on 1390 geographical zones) can similarly be translated into an average commute distance of almost 14 km (airline). Thus commute distances in Denmark seems to be somewhat longer than in England and Wales. The difference is relatively general – as a larger proportion of the commuters in Denmark have commute distances over 10 km (figure 5 and figure 6). The difference in commute distances also seems to be robust towards the exclusion of very long commutes (>100 km) from the analysis.

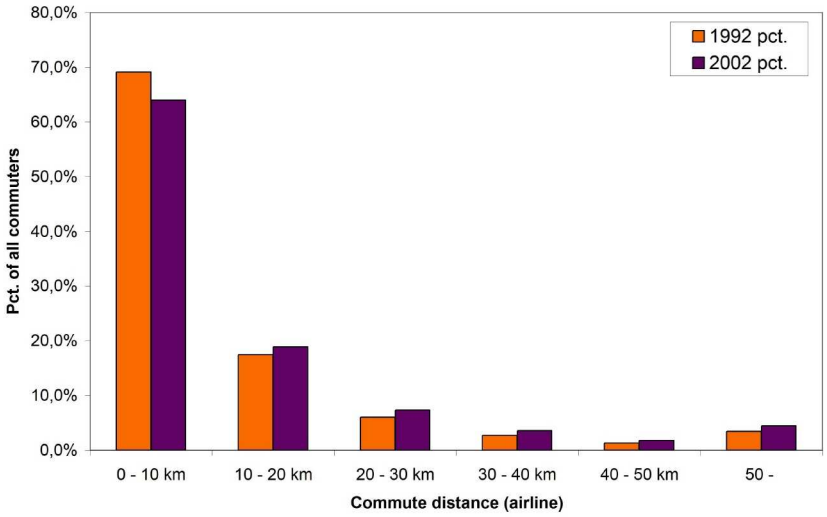


Figure 6: The relative distribution of commuters in **Denmark** – on commute distances (10-km intervals) based on airline distances between zone of residence and the zone where the place of work is located (a division of the country into 1390 geographical zones is used). Locations of residences and workplaces are derived from a workforce statistics (Registerbaseret arbejdsstyrkestatistik) based on public registers for 1992 and 2002.

It is noticeable that the development in commuting in Denmark has been "unidirectional" upwards. Thus the proportion and absolute number of short commutes has decreased in favour of longer commutes. The long distance commuters (> 50 km, airline) counted 3,4% of the commuters in 1992 and 4,5% in 2002 (corresponding to 122.000 persons). Measured on the basis of the percentages each year this corresponds to a 30% increase (or 39% when it is measured in number of commuters that commutes more than 50 km, airline).

Denmark had the same proportion of short commutes (< 10 km) as England and Wales in 1992. As these commuters shifted towards longer commutes from 1992 to 2002 – resulting in a decline of the proportion of commuters that travelled less than 10 km (airline) between home and work from 69% in 1992 to 64% in 2002 – the development in the nineties is likely to be responsible for a significant part of the difference in commute distances between Denmark and England and Wales.

The development in commute distances in England and Wales could witness an increasing polarisation of the commute pattern where the long commutes gets longer while the share of short commutes remain unchanged. In contrast the development in commute distances in Denmark suggests that commute distances generally increases, making all fragments of the labour market commute longer distances between home and work.

Likely contributors to the differences in commute distances and the development within them between the two countries can be summarised under these headings (1-6):

1. Transport system and congestion – the level of congestion within the Danish transport system is low compared to England and Wales, a factor that will allow Danish workers to travel longer within the same time budget.
2. Differences in urban form – many Danish cities have spread/sprawled less than English cites. Even though the impact on commute distances is less clear this will certainly affect the geography of commuting more generally.
3. Differences in wealth and distributions of wealth – the Danish labour market is highly regulated and secures relatively high minimum wages, and thus paves the way for commuting within most occupations.
4. Differences in labour market participation (the Scandinavian model) – there are more dual earner households in Denmark, a factor which makes it more difficult for Danish families to achieve short commute distances,
5. Differences in preferences with respect to living and commuting – the Danish population is accustomed to benefit from ample residential space, a factor that may speed up the spreading of the demand for housing around the large urban centres and thus extended commuting especially within the last 10 years where the largest urban areas have experiences dramatic increases in house prices.
6. Lower job and population densities in Denmark – if the degree of specialisation within many occupations is comparable between Denmark and England/Wales the lower overall densities within Denmark could be a factor that requires Danish workers to travel further to find a suitable job.

It lies outside the scope of the explorative study presented here to qualify the reasons for the differences in commute patterns and distances further. However the above questions will remain as working questions in the researcher's ongoing work with international comparisons of developments in commuting.

5. Commuting and centrality: City profiles

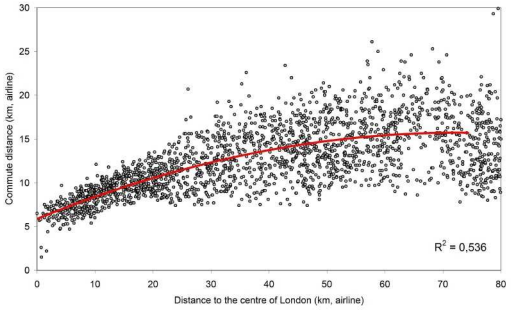
This section focuses on the relations between urban structure/location and commute distances and commuting directions in three English and three Danish cities. In both countries three of the largest cities have been selected for the analysis. From England: London (11 mill. inhabitants within larger urban zone, LUZ), Greater Manchester (2,5 mill. inhab. within LUZ) and Birmingham (2,3 mill. inhab. within LUZ). From Denmark: Greater Copenhagen (1,8 mill. inhabitants within the larger urban zone), Aarhus (600.000 inhab. within LUZ), and finally the city of Aalborg (220.000 inhab. within a larger urban zone that includes the neighbouring municipalities).

For each city the commute distances has been plotted as a function of distances to the city centre – and the regression line that explained the most variation in distances has been drawn. The highest regression explaining the highest degree of variation was found using different mathematical functions on different ranges of distance to the city centre: 0-25 km, 0-50 km, 0-75 km and 0-100 km. Thus the regressions gives an indication of when the distance to the city centre looses is effect on commute distances (see figure 7-12).

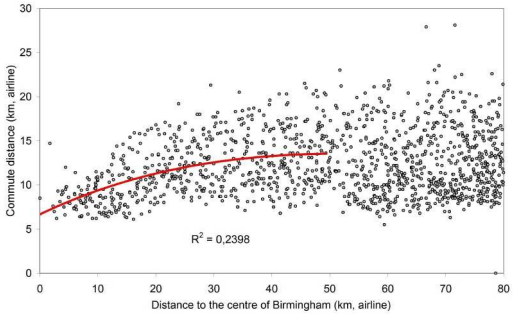
Figure 7- 12: Commuting distances in English wards and Danish parishes

Cities in England:

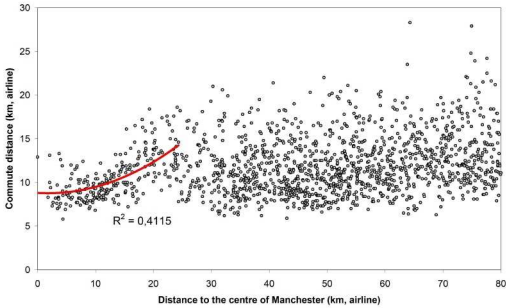
London



Birmingham

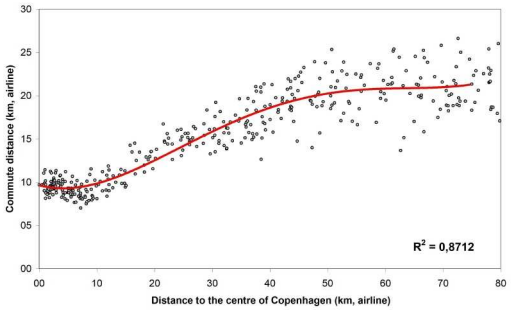


Manchester

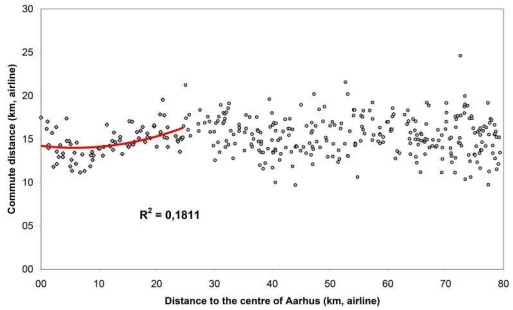


Cities in Denmark:

Copenhagen



Aarhus



Aalborg

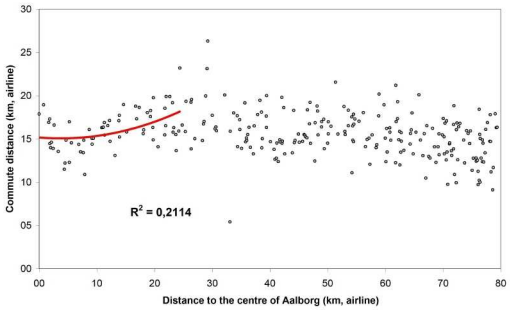
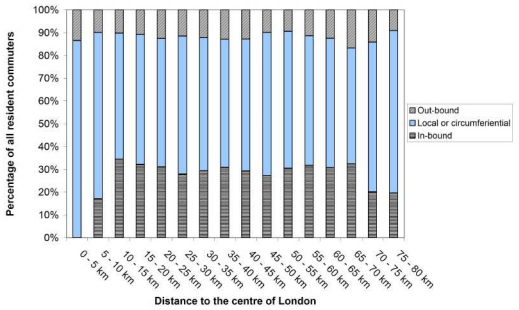


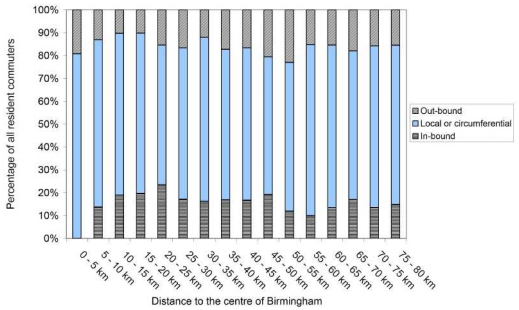
Figure 13- 18: Commuting directions in distance bands

Cities in England:

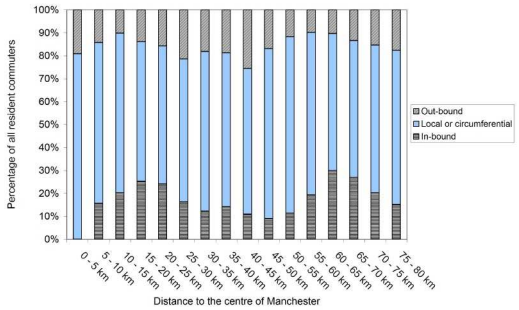
London



Birmingham

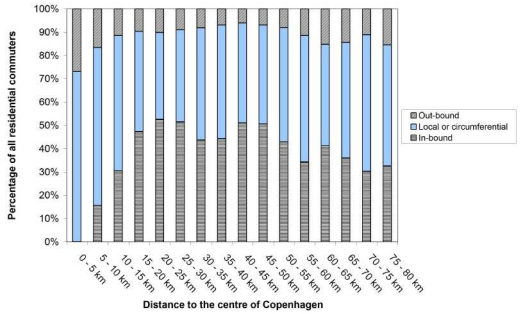


Manchester

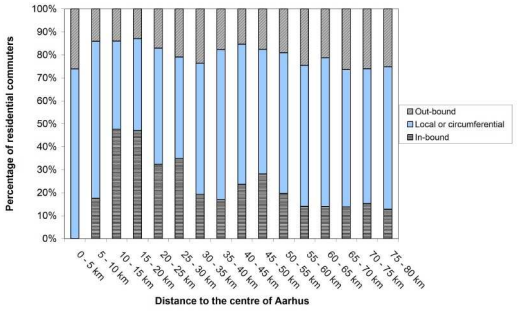


Cities in Denmark:

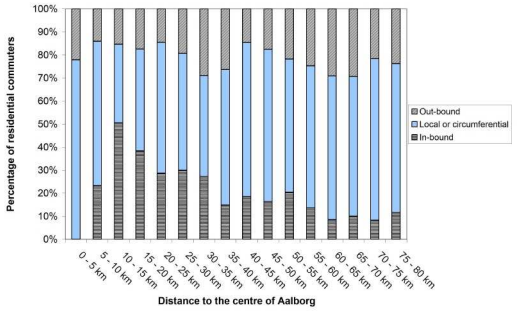
Copenhagen



Aarhus



Aalborg



For each city the proportion of the resident commuters in different distances from the city centre (5-km intervals) that commutes towards the city centre, away from the centre, or stays in the local area or in a circumferential band, has also been summarised. The direction of commuting is derived from whether the ward-centroid of the ward that contains the workplace is located more than 5 km closer to the city centre than the ward of residence (or more than 5 km further away). Thus the analysis adds to the knowledge of the impact of centrality on commute patterns and especially the dominance of the central areas as commuting destination (see figure 13-18). Sub-centring and sprawl is likely to reduce commuting towards the core – while a relatively monocentric structure should lead to more commuting towards the core.

Key results is summarised in the figures 19, 20 and 21. Capitals, Copenhagen and London seem to have a similar range – around 75 km – within which the explanation of commute distances from distance to the centre is optimal. The degree of explanation in the Copenhagen area is with its 87% of variation in commute distances explained by the distance to the centre in a bivaitate regression is by far the highest. The corresponding degree of explanation for the London area is 54%. The smaller cities have a shorter range of optimal explanation depending on the geographical context in which the city is located. The short range that comes out as the result for Greater Manchester can be seen as the consequences the more polycentric structure of the area (urban region) compared to the city of Birmingham. The lowest 0-25 km range tested in the analysis was probably not small enough to adequately reflect the differences between the Danish cities. An impact of a location in a polycentric context/Urban region can however bee seen on the level of explanation, where city of Aalborg reaches 21% in degree of explanation and the city of Aarhus – that is located in a more functionally integrated urban region settles with 18% within the first 25 km (figure 19).

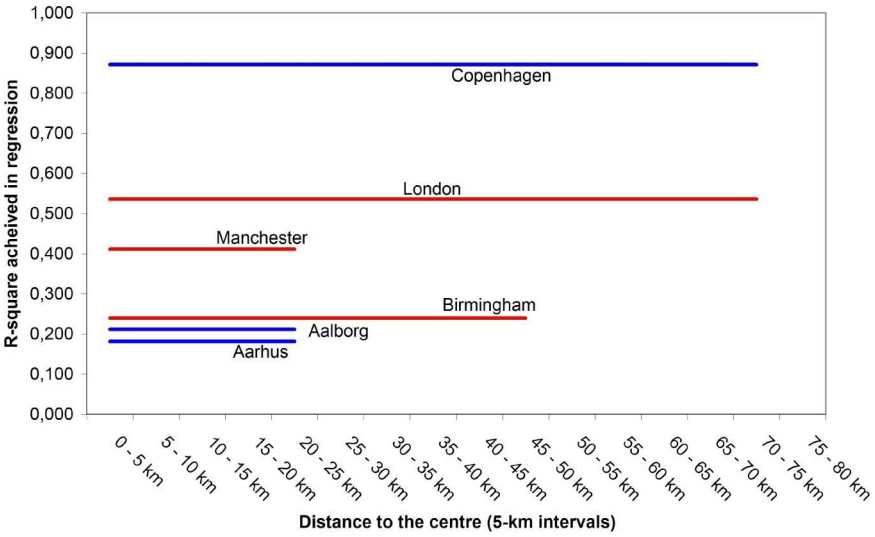


Figure 19: Degree of explanation in bivariate regressions between distance to the centre and commuting distances (Y-axis) – and the range within which the highest degree of explanation is achieved (X-axis).

The longest commuting distances by distance to the centre of the urban area (figure 20) generally reflects the difference in commute distances between Denmark and England/Wales. Besides this the Capitals in each country follows a comparable pattern by reaching the longest commute distances in the longest distance from the centre (Copenhagen 21 km on average, around 65 km from the centre – and – London 16 km on average, around 75 km from the centre). The smaller cities saturates at a shorter distance and with shorter commute distances. There is again a marked difference between Manchester and Birmingham – despite comparable sizes of the larger urban zone. This again reflects the more polycentric structure of the Manchester region and its surroundings – in

combination with the large mass of the city of Birmingham in itself (977.000 inhab. compared to the 419.000 in Manchester alone).

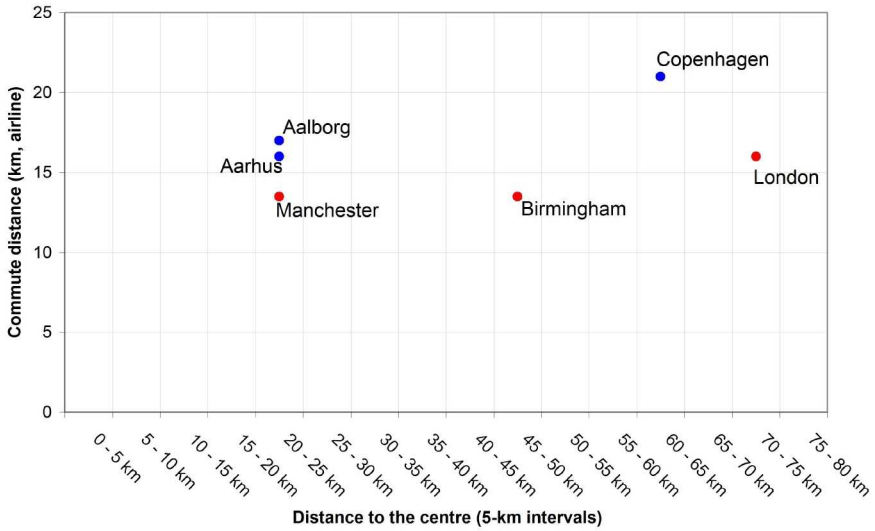


Figure 20: The longest commute distances among resident employees (Y-axis) and the distance to the centre where it is reached (X-axis).

Figure 21 plots the maximum share of resident commuters that commuted in the direction of the centre – and the distance from the centre where this occurred. The difference between England/Wales and Denmark is even more marked in this respect. All Danish cities in the sample have very high volumes of commuting towards the centre (around 50% at the highest) while the volumes in the English case are much lower. Again the centre orientation of commuting peaks the furthest away from the centre in Copenhagen among the Danish cities and in Birmingham among the English cities. This probably reflects the relative dominance of the core area and the existence of significant sub centres. Copenhagen has maintained a largely monocentric build up of jobs around the centre and has in the recent decade regained some strength – with high growth rates and a considerable building activity - after several decades with job loss to the periphery and locations further a field.

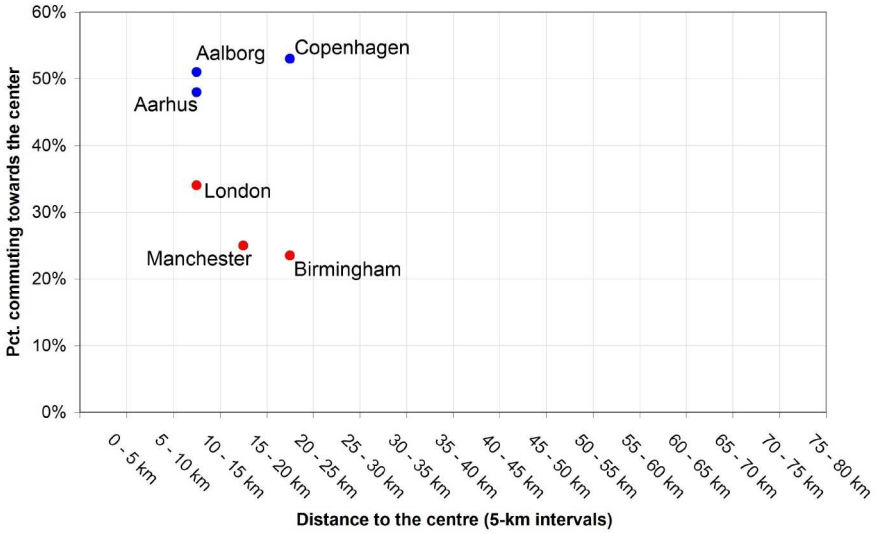


Figure 21: The percent of resident employees commuting in the direction of the centre (Y-axis) and the distance to the centre where it is reached (X-axis).

6. Summary and conclusion

This paper has presented mappings of commuter flows in England and Wales based on commute data from Census 1991 and 2001. This was followed by an analysis of the development in commute distances and the comparison of a number of "city profiles" that focuses on commute distances, commuting direction and centrality/location. Danish commute data was included in the analysis of commute distances and in the presentation of "city profiles" for three large Danish cities.

In absolute number the main part of commuting in England and Wales occurs within a corridor that connects London with Manchester and Leeds. This pattern was well established in 1991 and the development in the 1991-2001 decade can be described as a spreading of the commute pattern as the flows in the centre of the corridor decreases wile the corridor at the same time seems to be widening.

The development in commute distances adds to the explanation of this as there is high growth in the number of long commutes (> 50 km, airline) a development that for a large part can be attributed to the areas on the edge of the before mentioned corridor from where the resident populations commuted towards the largest urban nodes – especially London.

Comparison with the Danish data suggests that commute distances in Denmark are generally longer than in England and Wales. For a large part this is due to the strong development in Danish commute distances within the 1992-2002 decade. Compared to England and Wales the development in the Danish commute distances also seems to be a more general upwards shift (resulting in a decrease in the number of short commutes in favour of more longer commutes) while the pattern of development in England and Wales suggests a trend towards polarisation between a fixed number of short commutes while the long commute distances gets longer.

The city profiles allow a preliminary inquiry into the interplay between centrality and commute patterns in different cities and between Denmark and England and Wales. Overall the Capital cities seem to attract the longest commutes and induce the most radial movement towards the centre - within each country. Among the other cities differences seems to arise mostly based on the relative strength of the core and the poly centricity of the wider geographical context (whether the city is part of an integrated urban region with other centre close by).

In the comparison between Denmark and England and Wales – the Danish cities comes out with the longest commute distances and the highest proportion of commuters travelling towards the centre. Besides this there is no clear differences between the two countries. Overall Copenhagen is the "radical" case with the highest commute distances, the longest range of influence from centrality on commute distances, the highest degree of commute distances explained from centrality and the most commuters travelling in the direction of the centre. None of the cities included in the study can be said to hold the opposite position. Birmingham is however an example of a city with low commute distances, low dependence of commute distances upon centrality and low levels of commuting in the direction of the centre. To discover how these different attributes of the commute pattern is related is regrettably outside the scope of this paper.

Further analysis
It is the aim of the authors of this paper to proceed with cross-city and cross-country comparisons. The indicators should be developed further to include especially indicators of urban form and the development over time, together with maps of the relevant areas. The different countries and cities included in the material should also be expanded fore instance with data from France, Spain or

Germany where commute data is also available. The target would be a rigid cross case comparison that highlights if and how the development in commuting responds to changes in urban form under different conditions.

Acknowledgements
Analysis of commuting in England and Wales was based on the Origin-Destination statistics (Special Workplace Statistics) in combination with the output area boundaries and ward-history database, kindly made available by the Census Customer services.

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Analysis of commuting in Denmark was based on an Origin-Destination matrix based on 1390 geographical zones (derived from parishes). The matrix was created from the Danish register based workforce statistics (Registerbaseret arbejdsstyrkestatistik) by Statistics Denmark on request from Aalborg University.

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Appendix

Origins and destinations for long distance commuters, England and Wales, 2001:

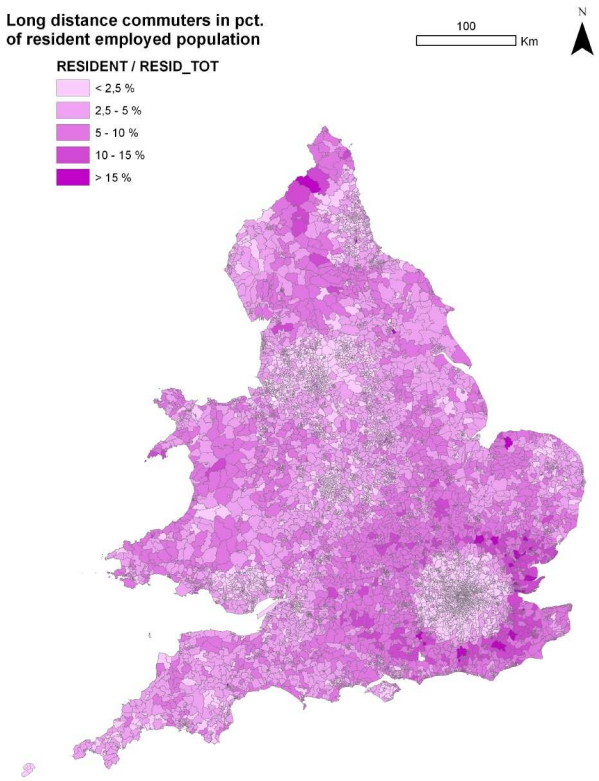

Figure: Pct. of resident employed population in wards - that travel more than 50 km (airline) between home and work, 2001.

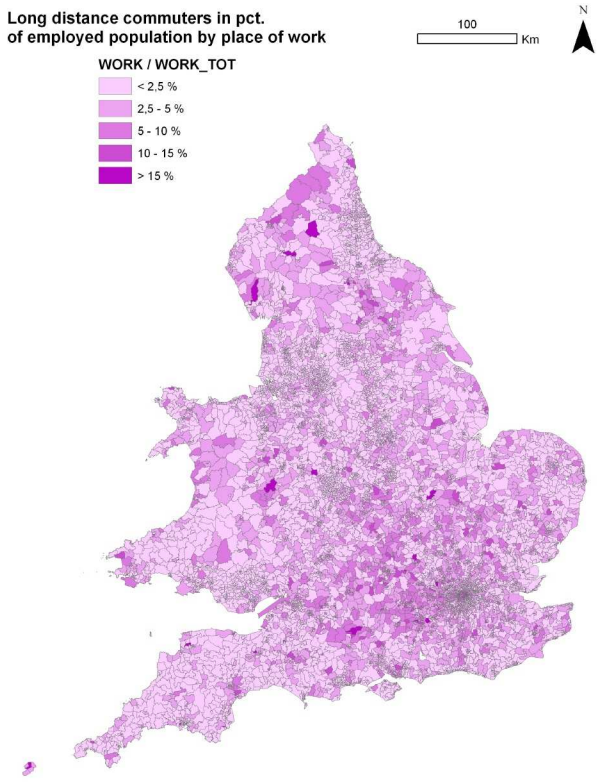

Figure: Pct. of employed population by place of work – that travel more than 50 km (airline) between home and work, 2001.

Occupations by commute distances, England and Wales, 2001:

	0-10 km	10-20 km	20-30 km	30-40 km	40-50 km	>50 km
Managers and senior officials	13%	17%	22%	26%	29%	30%
Professional occupations	9%	14%	17%	19%	18%	16%
Associate professional and technical occupations	12%	16%	18%	18%	18%	18%
Administrative and secretarial occupations	14%	15%	12%	10%	10%	8%
Skilled trades occupations	13%	10%	9%	8%	8%	8%
Personal service occupations	8%	5%	4%	3%	3%	3%
Sales and customer service occupations	9%	6%	4%	3%	3%	4%
Process, plant and machine operatives	9%	8%	8%	7%	6%	6%
Elementary occupations	14%	9%	6%	6%	5%	7%
Total	100%	100%	100%	100%	100%	100%