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Urban Fields in the making

new evidence from a Danish context

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Urban fields in the making: new evidence from a Danish context

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Abstract

A recent study of transportation and urban structure in a larger Danish city concludes that the location vis-à-vis attractions far beyond the city borders, has a detectable bearing on the inhabitants transport patterns inside the city. This indicates a high degree of functional integration between cities and accentuates the concept of the “urban field” suggested by John Friedmann (1978). The concept of “urban field” suggests that mobility has been democratized and increased to a level where several cities can be part of the same functionally integrated urban field. As a consequence the significance of the single urban centre and the city as an entity will change markedly.

This paper aims to analyse the development towards urban travel- and commuter fields in Denmark. The questions asked is to what degree urban fields are emerging? - And what is the speed of this development?

Key data sources are the Danish commuter statistics and the national travel surveys. They are both used as means to map the increasing functional integration, indicated by the exchange of commuters and other travellers, between cities in the Danish urban system. The Danish commuter statistics provides a rare opportunity to analyse the speed and patterns of change over the last 20 years. Places of work as well as residences have been registered systematically for all members of the workforces since 1981. The analysis relies on an origin-destination dataset based on the 2200 Danish parishes. The national travel survey has been conducted systematically since 1992. It covers the entire country on the basis of a representative sample of approx. 15.000 respondents each year. Based on origin-destination data from the representative travel survey it will be possible to add the functional integration of leisure and shopping purposes to the analysis.

The data is used as a means to map and discuss the development of urban fields in Denmark and to analyse the development of commuter fields in relation to the largest urban centres (commuting to the city, directionality of commuting, commuting distances).

Keywords

Urban field, urban structure, commuting, time series, flow, spatial interaction, functional integration

Introduction

The analysis results presented in this paper are an offshoot from the project: Town, Road and Landscape, carried out by Aalborg University in corporation with the Danish Road Directorate and the Royal Danish Veterinary and Agricultural University and jointly (50%) sponsored by the private foundation RealDania. The general purpose of the “mother project” is to analyse the development that has occurred around the Danish motorway system in the past 20 years. Commutes and travel patterns are the subjects of the analysis and conclusions relevant for the general development in interaction patterns in Denmark is presented here.

There is no doubt that the scale of spatial interaction – as it can be registered on the basis of fore- instance distances travelled for different purposes are increasing. Evidence also suggests that the volume of long distance trips that bridge what was formerly separate urban entities has reached a level where the relevant scale from which to judge the relations between location and travel in many cases will move up from the city to the regional level. This expansion of scale has of course been on its way for a long time but the new development may be that

the functional regions do not contain a continuous urban structure but a number of urban entities clearly distinguishable in space but interlinked by spatial interaction.

The imprint of such a development seems visible in a recent PhD dissertation (Nielsen, 2002). Travel patterns for the residents of Aalborg – Denmark’s third largest city – were affected by the city’s location in a regional context. Specifically, a southward pull towards the densely populated areas of east Jutland was detectable (statistically significant). The volumes of outward travel from the city are of a magnitude and sufficiently biased to the south so as to leave a mark on the relationship between the location of dwellings and the inhabitants transport inside the city. City internal location variables (the distance to the CBD and external centres) still dominate but the finding is taken as an indication of the expansion of scale that may change the scale of functionally integrated areas in the future. In the urban-structure and transportation literature others have concluded as to how the inclusion of small cities in larger functional regions change the premises for everyday transportation (Higgit and Headicar, 2000; Curtis, 1995). Even though adaptation may have to occur through the settlement of new groups that have the larger functional region as their frame of reference (see for instance Higgit and Headicar, 2000).

John Friedmann launched the “Urban field” (Friedmann and Miller, 1965; Friedmann, 1978) concept in the mid sixties pointing out among other things the increasing scale of spatial interaction and the disappearance of clearly delimited urban areas.

What is properly urban and properly rural can no longer be distinguished...The corresponding view of the city is no longer of physical entity, but a pattern of point locations and connecting flows of people, information, money, and commodities...The idea of the urban field is similarly based on the criterion of interdependency. (Friedmann and Miller, 1965)

Friedmann and Miller suggested that the urban field would stretch for a two hour drive outwards from a core (SMSA) area. This would be the approximate geographical limit for commuting to a job and the limit for intensive recreational use. The concept of the urban field seems to be a highly relevant point of departure for analysis of the present state of affairs in the Danish context. The relevance of the two-hour drive is of course debatable. Most people commute far less than two hours and two hours would only leave room for two urban fields in Denmark – and would therefore not appropriately explain the variations in interdependencies inside the country. Marco Bontje (2000) researched the scale of spatial interaction in the Netherlands and did not find any justification for the claim of the increasing scale of interaction in correspondence with the urban field concept.

For the purpose of this paper the urban field is taken as a description of a tendency or a hypothesis of the changes occurring in the interdependencies between cities. The paper aims to analyse the development towards urban travel and commuter fields in Denmark, and to highlight the structure of change in spatial interaction between cities and regions.

Methodology

This paper seeks to investigate the expanding scale of functional integration between areas and cities through the mapping of integration based on commuter and travel relationships and through a closer investigation of the relationships between Denmark’s two largest cities, Copenhagen and Århus and their respective catchment areas and hinterlands. The analysis will be based on a number of indicators of their expanding “influence”.

Data

The analysis draws on two data sets, both containing information on spatial interaction at a relatively disaggregated level. One data set is Statistics Denmark’s commuter statistics (workforce statistics) where home and place of work is registered for almost everyone who has a job. In 2002, the home and workplaces for 2,6 million commuters were registered in the database – effectively a full count of all commuters. The database relies on employer’s reports on where their employees work and it is maintained by Statistics Denmark to reflect actual home-workplace relationships. Implausibly long commutes induce an inquiry as to the correctness of the information. The database has been kept since 1981 and therefore allows analysis of some 20 years for change in commute patterns. For the purpose of analysis an origin-destination matrix with number of commuters in 1982 and 2002 has been generated based on the 2200 Danish parishes. The parishes are judged to be of a suitable geographical level for analysis at the national level. This avoids the disaggregation that can lead to data handling

problems arising, but is yet a lot more disaggregated than for example the municipal level, which would be the “normal” geographical unit in the presentation of Danish statistics. In the origin-destination matrix the 2,6 million commuters are distributed in 286.000 different commuter relationships (pairs of parishes linked by a number of commuter relations).

The other data set is the national travel survey conducted by Statistics Denmark in corporation with among others the National Transportation Research centre. This survey has been run with a representative sample of the population every year since 1992. Before this a survey was held every 5 to 10 years but with differing methodologies. Since 1992 the references to geographical locations has also undergone some changes and it is only for the period from May 1997 through 2001 that a reliable record exists for the geographical locations of origins and destinations (it should be possible to add 2002 and 2003 to the dataset later). From this part of the survey 200.000 trips have known origins and destinations. When an O-D matrix is constructed on the basis of the 4000 travel analysis zones in Denmark used in the survey, the result is 58.000 different travel relationships (pairs of zones connected by a number of trips). A geographical representation of travel and spatial interactions of the character desirable in this analysis was never intended with the national travel surveys. Thus to avoid arbitrary results of the mapping exercise conducted here all trips and travel relationships is used together. Analysis of changes over time on this data set will therefore not be possible.

Mapping functional integration in Denmark

As an important contribution to this paper’s analysis of functional integration and spatial interaction, maps of flow areas have been drawn. In this case flow is understood as a characteristic of a given area and is derived from the numbers of spatial relationships passing through, originating or ending in the given area unit. The spatial relationship comes from the commuter statistics and the national travel surveys. Therefore flows are measured in the number of commuters or the number of trips (by purpose).

The flow maps were created in ArcGis/ArcView. The first step was the creation of a GIS shape where the origin-destination matrix is used to create a desireline-diagram where information on the number of commuters or trips is attached to the individual desirelines. The second step was the intersection of the desirelines with a superimposed grid. The third step was the summarisation and mapping of flows based on the grid-cells (see figure 1).

The result is a series of maps that use colour codes to show areas of continuous spatial interaction at a given level. 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 more quantitative delimitation of commuter regions (see for example Andersen, 2002). If the flow maps were to be used to delimit commuter regions, then an important difference would be that the regions could only be identified through decreasing flows over a surface of land in absolute numbers – and not on the basis of an area’s relative self-sufficiency. In practice these two approaches are likely to produce the same results – given the relatively large scale generally used in the delimitation of commuter regions.

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. This is of course only one among many other interpretations of centrality. Many central city functions do however have a large flow of people as their basic requisite. Characteristic for core areas is generally also that infrastructure as well as spatial interaction focuses on the centre – it is therefore tempting to point to the flow of persons as a very important component of “centrality”. Through this, the flows of persons would be linked to the landmarket and developer interests.

The commuter statistics are used to map the commuter flows in 1982 and 2002 – and growth in flows in the same period. The national travel survey supplements the commuter flows with flows derived from other travel purposes, but only in one recent period (1997-2001). While change over time can be judged from the commuter flows, the travel surveys allow for an evaluation of how different travel purposes allows for functional integration across distances.

For comparison purposes the same grid (2x2 km) is used for commuter flows as well as for trip-based flow maps. The suitability of the grid-cell size for the mapping of commuter flows can be judged from the continuity

of the flow "surfaces" on the maps. The trip-data is considerably "thinner" and the resulting maps therefore somewhat less continuous in their characterisation of the surface and its flow volumes.

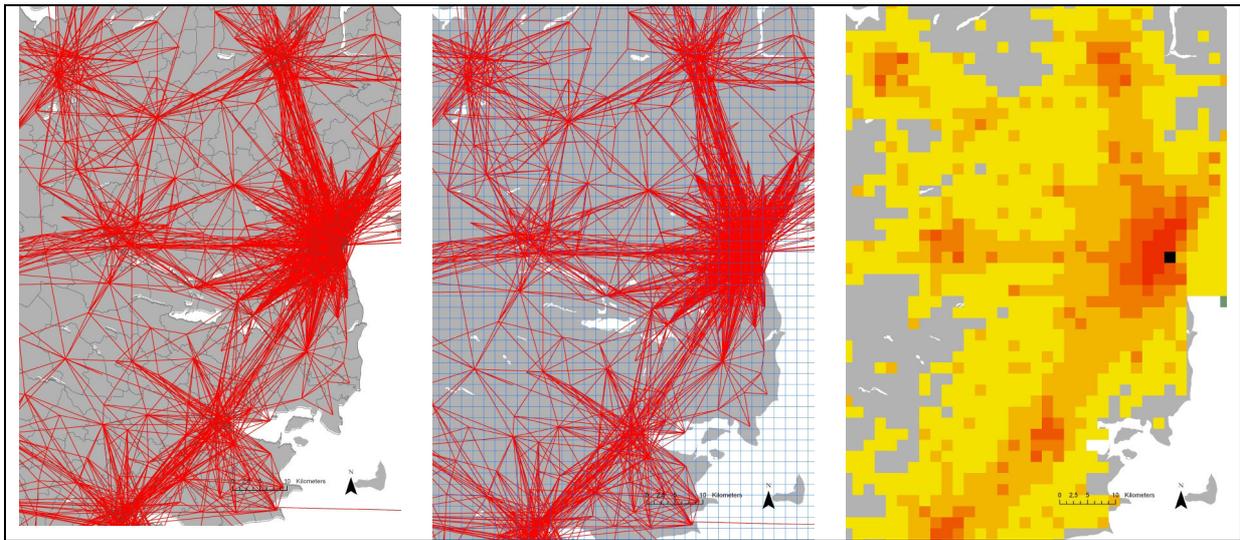


Figure 1: The approach to flow mapping step by step. 1 (left) Desirelines between home and work is created based on parish centroids. 2 (middle) A 2x2 km grid is superimposed and intersected with the desirelines to summarise the number of commuters "passing" each cell. 3 (right) The resulting flow map.

Indicators of the development around Copenhagen and Aarhus

For further analysis of the changes occurring in the last 20 years an inquiry into the commute patterns around the country's two largest cities: Copenhagen / The capital area and Aarhus is made (see figure 2). Three indicators are used to analyse the changes: commuters into the central part of the agglomeration, commute directionality and commute distances. In all instances data comes from the commute statistics – with parishes as the geostatistical unit.

Calculations of the proportion of resident population commuting into the urban area make it possible to draw up isolines to show where the commute percentage drops below a given level. This type of inquiry was used by Fisher and Mitchelson (1981; 1987) to investigate the development of extended commuting around metropolitan centres in the United States over time.

In this paper commute-percentage isolines are mapped around Copenhagen and Aarhus using 1982 and 2002 commute data and the municipality of Aarhus and the county of Copenhagen together with the municipalities of Copenhagen and Frederiksberg as destination areas. This means that the target area for the commuters is broadly defined as a very large part of the urban area.

The commute-directionality is another indicator used to analyse the development around the two cities. The measure of commute-directionality vis-à-vis the CBD was for instance used by Christopher et.al. (1995) as a way to measure the state of development towards cross and reverse commuting. Measures of commute-directionality will certainly reflect this 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. 1997) 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. In this paper commute directionality is plotted as a function of distance to the CBD. Commute directionality is measured as the proportion of the resident population commuting more than 5 km closer to the CBD from their parish of residence. Distances are measured from parish centroids (which necessitates that 5 km or longer be the criteria chosen).

The last indicator is the commute distance and its correlation with the distance to the CBD. 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 CBD and then level off and possibly fall (see for instance Næss and Johannsen, 2003). 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.

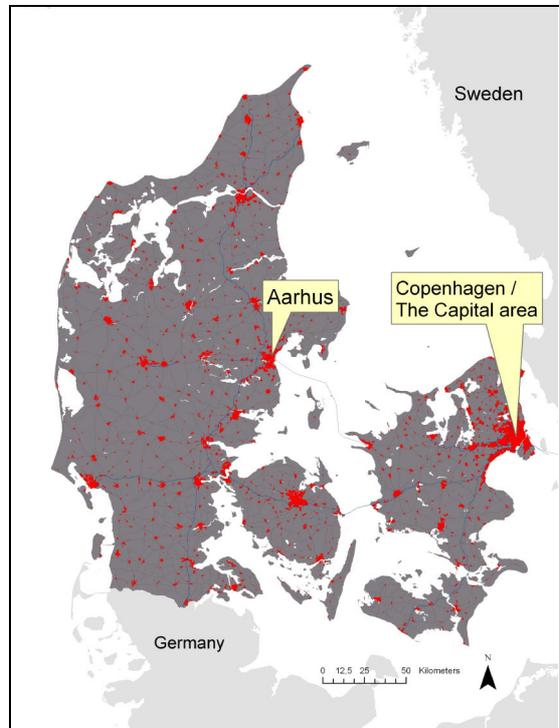


Figure 2: The location of the two largest Danish cities. Copenhagen /The capital area on the island of Sealand in the east - and Aarhus on the eastern part of the peninsula of Jutland. The neighbouring countries Germany and Sweden are marked with light grey. Urban areas within the Danish borders are marked with red - and the motorway network with a thin blue line.

Commuterflows: the last 20 years

The maps of commuter flows (see figure 3) show a remarkable development where commuter volumes have grown all over the country from 1982 to 2002. As a consequence, still larger geographical areas are increasingly being interwoven as measured by the exchange of commuters. Generally, there has been an expansion of scale so that the “build up” of commuting around the urban centres in 2002 starts at a much longer distance from the city than it did in 1982. It is also increasingly difficult to identify the build up of flows as something that belongs to the single city. The concentric pattern is increasingly “blurred” by merging commuter fields and development along infrastructure axes.

The changing commuter flows are particularly evident in the eastern part of the peninsula of Jutland (around the city of Aarhus) where the expansion of the area and integration of existing cities through commuting can be said to have undergone a qualitative change. Commuting has also expanded on the island of Sealand in east Denmark (around Copenhagen) but has proceeded on a course that was already recognisable in 1982.

Taking the commuter flow as an indicator of the relative integration of areas, very large areas can be seen to have been integrated through commuter flows in the range of 1000-2000 commuters “passing by”. At this level the development over the last 20 year period has merged what was previously a geographically separated build up of commuter flows around cities. If one were to use the commuter flows to delimit an area around the city of Aarhus that did not merge together with the larger urban entities around the city, an area delimitation based on 2000 commuters passing by would do in 1982. In 2002 one would have to raise this level more than 100% to 5000 commuters to delimit an area almost equal with the one delimited by 2000 commuters in 1982. If the level

of 2000 commuters passing by was reused in 2002 – the area delimited would not encircle Aarhus but would extend along infrastructure axis's to include all the larger adjacent cities – and Denmark's 3. largest cities (Odense) more than a one hour drive to the south.

Using a higher level of area integration as a basis for evaluation - for instance zones where 5000 or more commuters are “passing by” - the merging of previously separated areas from 1982 to 2002 is more limited and occurs either as an expansion of commuter fields around large urban areas (this is evident around the cities of Copenhagen and Aarhus), or as an integration of very proximate urban areas (fore instance the cities of Herning and Ikast in mid-Jutland). The volumes of the commuter flows are of course very dependent on population densities. The high volume flows are generally more fixed in space develops slower.

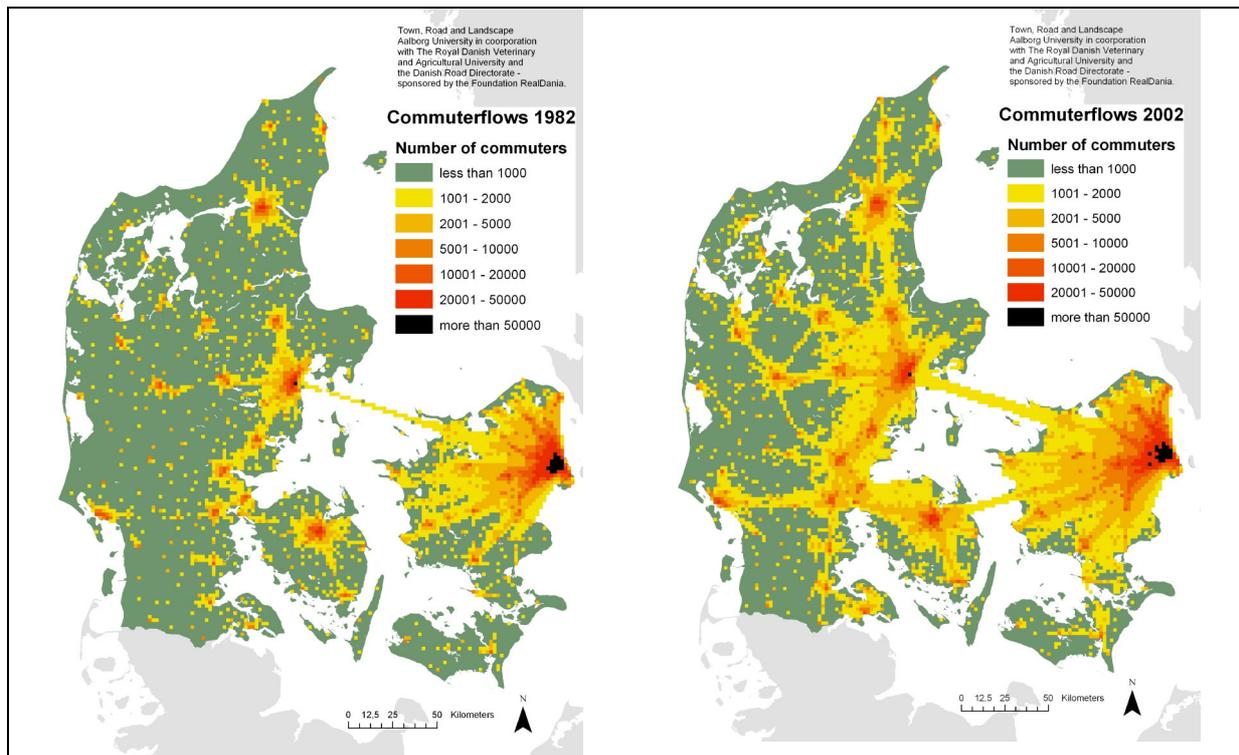


Figure 3: Commuter flows in Denmark 1982 (left) and 2002 (right). The flow is derived from the total number of commuters passing, originating or having a destination within a given grid cell – judged from airline distances between home and work parish.

Accordingly the established urban centres are still where the largest commuter flows are. There is a build up of flows in concentric circles around every city of a certain size (the cut off level of 1000 commuters is of course important in deciding which cities in the remote areas that will get on the map in the first place). City “peaks” are clearly visible but the development that has occurred over the 20 year period has made it increasingly difficult to see where the build up around a city begins. Consequently a larger proportion of the commutes to and from a given place are embedded in and dependent on a much larger geographical context than before.

The tendencies towards a new commute pattern and a new pattern of functional integration can be evaluated on the basis of the growth in commuter flows in absolute numbers. The growth in commuter flows can be seen on figure 4. The close up on Copenhagen / The Capital area shows what is general to all the larger cities. There is no growth in commuter flows in the historical core and thus a relative erosion of the still existing build up of flows towards the central city. The focus of growth has moved to the suburbs – but is still centrally located within the context of the larger urban area. As an indicator of tendencies towards functional integration between cities and the erosion of the self containment of the individual cities – the development in commuter flows between cities compared to the development of flows within cities is interesting. Generally the growth of flows between cities is at a level where they will gain in relative importance compared to the build up around the individual cities. In a few cases the growth in flows between cities is also at a level where it may end up “dissolving” the imprint of the former individual cities into a larger surface or corridor of functional integration.

This may for instance be the result (if the development continues) for some of the cities in north-south corridor in Jutland – that has experienced very strong growth in commuter flows from 1982 to 2002.

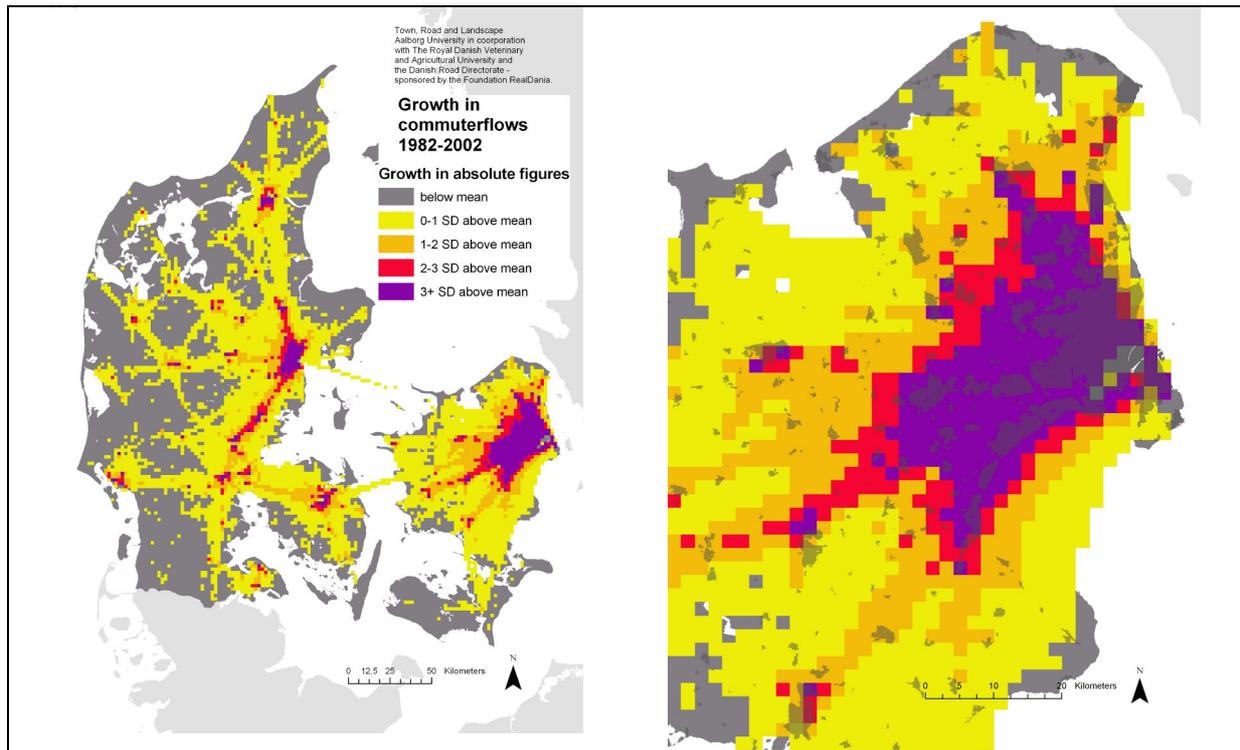


Figure 4: Growth in commuterflows in absolute figures in the whole country (left) and in the capital area in close up (right). Note that the delimitation of the urban area(s) can be seen as dark zones on the map to the right. Colour codes for growth in commuter flows are the same on both maps.

Tendencies towards the development of urban fields in the Danish context would be the development around the capital on the island of Sealand. Here the development is towards an expanding scale of dependency and spatial interaction focussed on the capital area. The development in Jutland is, besides the expanding scale of spatial interaction, also in the direction of something that might resemble a polycentric urban region in a corridor like shape. There is a high degree of interaction all the way from the city of Randers (some 30 km north of Aarhus) through Aarhus and all the way through to Odense (on the island of Fyn). This corridor is also well served by railways and motorways, probably supporting this interaction axis.

Travel flows: spatial interaction by purpose

The inclusion of national travel survey data allows a comparison of commuter flows with flows derived from other travel purposes. The flows and spatial interaction that follows from travel purposes other than the commute can be judged on the basis of the sum of 1997-2001 data – but not from a time series of data. The travel purposes that can be mapped should also not be too specific to avoid the thinning out of the data coverage. After all, the use of the national travel surveys to map interaction in two geographical dimensions is to stretch the data to its limits in terms of representation. For the purpose of a comparison with commuter flows, person flows, shopping flows, social flows and leisure flows have been mapped. The measure of flows derived from the travel surveys is the number of trips passing by a given 2x2 km grid cell. Person flows mean that all trips irrespective of travel purpose are counted; shopping flows mean that actual shopping trips together with errands to dentists etc. are counted; social flows mean that trips to visit family and friends are counted and leisure flows means the other leisure trips than social trips are counted (escort, business and commute trips to work or education is not represented on any of the maps). To allow comparison between the maps, colour codes are used and defined on the basis of mean value and the number of standard deviations above the mean. This way an inter-map comparison of shape and coverage becomes reasonable (see figure 5).

Overall the “person flows” are very close to the “commuter flows” lending some support to the use of commuter flows as an indicator of the development of spatial interaction beyond commuting. In some areas however, the person flows seem to cover and integrate larger areas than the commuter flows, meaning that some travel purposes are more spatially integrated over distance than what seems to be the case for the commutes.

Looking at the three travel purposes (flows) depicted, shopping flows seem to be spatially more concentrated than commuter flows. Among the travel purposes investigated shopping seems to be the one least responsible for the increasing scale of functional integration. Unfortunately, shopping for everyday necessities and shopping for non essential consumer goods are registered together and can not be separated. Shopping for goods is likely to be much less distance dependent and thus display a higher degree of functional integration over longer distances.

The social flows display the highest degree of functional integration between cities and regions. Thus, travel for visits to friends and relatives is relatively distance independent and links what in other circumstances (travel purposes) would be relatively functionally independent cities and regions. This is especially evident in the central and eastern part of the peninsula of Jutland.

When it comes to the leisure flows (leisure purposes other than visits to friends and relatives) the degree of functional integration displayed by the travel purpose can be said to resemble the commuter flows. However, the leisure flows seem somewhat less focussed on city to city and suburb to suburb relationships than commuter flows and shopping flows. Functional relationships between large cities and the costal zones between cities and recreational/second home areas in the urban hinterland appears on the map of leisure flows – in addition to relations between cities and between cities and suburbs. This can be seen around the city of Aalborg (north Jutland) and its leisure flows to the west and east coasts of Jutland. Around the cities of Aarhus and Copenhagen, both urban areas display stronger relationships to the costal zones within the “leisure” category.

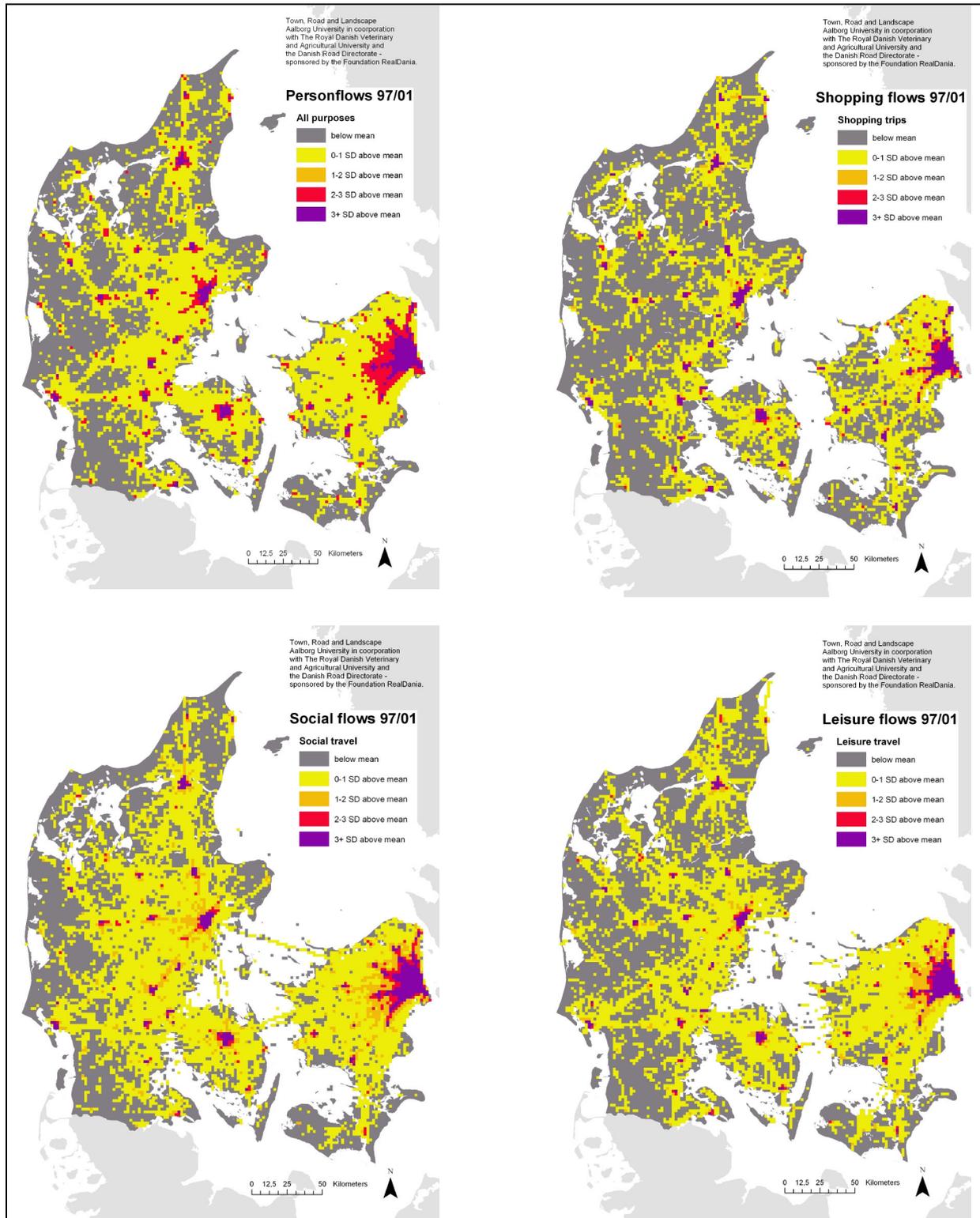


Figure 5: Mapping of flows based on the National Travel Survey data (from may 1997 through 2001) and its registered travel purposes. Flows are derived from the total number of registered trips irrespective of purpose (top, left), the total number of shopping trips (top, right), the total number of trips to visit friends and relatives (bottom, left), and the total number of trips for leisure purposes – other than visits to friends and relatives (bottom, right).

What is happening around the cities of Copenhagen and Aarhus?

To get a closer look at the structure of change in commuting patterns, three indicators are applied to the development around Denmark's two largest cities: Copenhagen/The capital area and Aarhus.

The capital – as delimited by Statistics Denmark has 1,08 million inhabitants within its boundary (1.1 2004). The functionally integrated urban system in which the capital is the centre is however much larger. The 2,2 million inhabitants of the island of Sealand are probably a fairer estimate of the population base of the capital and its labour market.

The city of Aarhus is the country's second largest city. As delimited by Statistics Denmark it has 229.000 inhabitants. The functionally integrated area around Aarhus is of course much larger. The cities of Randers (56.000 inhabitants) to the north, Viborg (33.000 inhabitants) to the north-west, Silkeborg (38.000 inhabitants) to the west and Horsens (50.000 inhabitants) to the south are within a range where they could easily play the part of suburbs to Aarhus (see figure 6 – right). The mass of these near neighbours also tells us that even though Aarhus is the country's second largest city it is much less dominant in its area. Especially if one looks to the south, then the dominance of Aarhus can be matched by a concentration of cities in the so called "triangular area" (the cities of Horsens, Kolding, Vejle, Frederica etc.) within a one hour drive from the centre of Aarhus. This asymmetrical distortion to the build up around and focus on Aarhus as the dominant centre in the area will probably add to that area being regarded as a polycentric urban region – more than parts of a urban field with a dominant core. Whether this is actually the case depends on the degree of spatial interaction between the aforementioned entities.

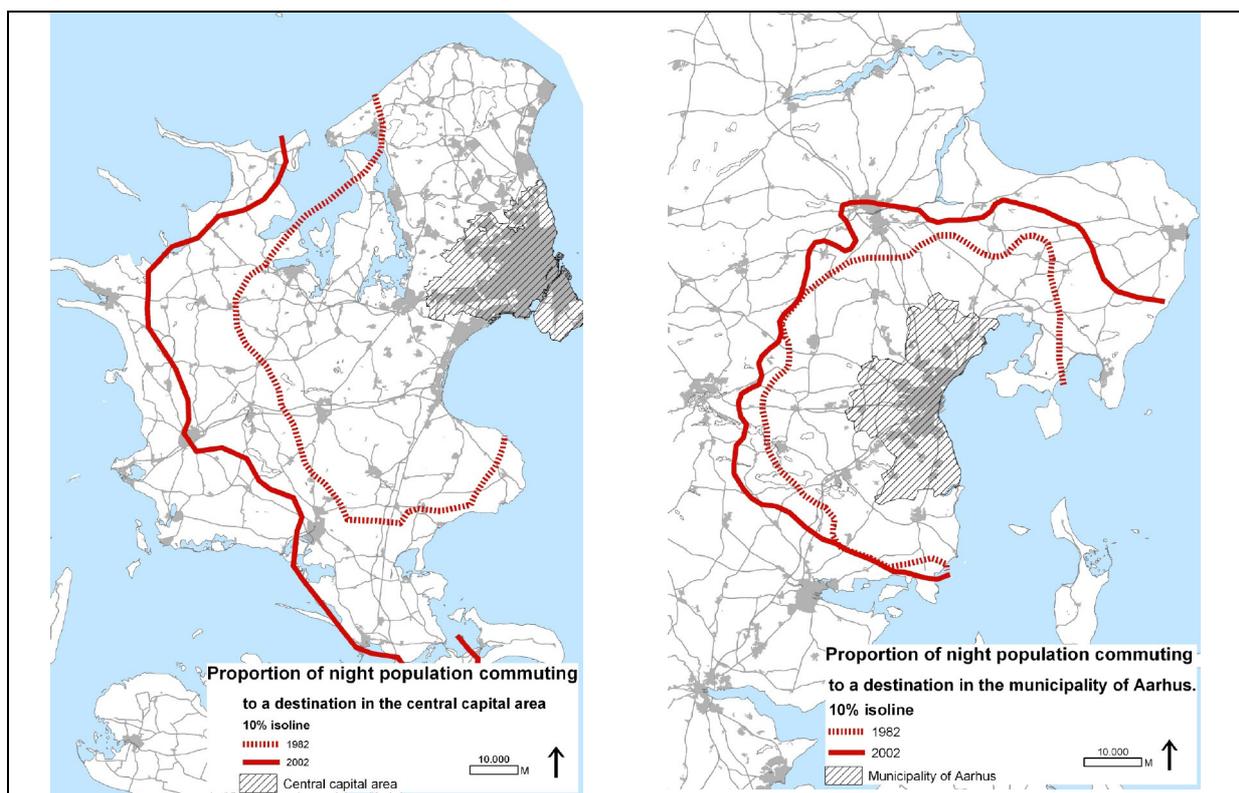


Figure 6: 10%-isolines for the proportion of the residential population commuting into the central capital area (the county of København, and municipalities of København and Frederiksberg) (left) and into the municipality of Aarhus (right). The delimitation of destination areas can be seen as hatched areas on the maps.

Commute percentage isolines

The maps in figure 6 show the 10% isoline for the percentage of the resident population commuting into the central capital area and the municipality of Aarhus respectively (destination areas are hatched out on both maps) in 1982 and 2002.

Around both cities an outward expansion of the isoline can be seen. The strongest expanding tendency is around the capital area where the 10% isoline has moved as far as 30 km outwards to the south. The longest outward expansion is seen along established infrastructure axes, with the least expansion along the corridor not served by motorways and the longest expansion along the corridor served by the least congested motorways. The role of the motorway in itself can not be inferred from this, but the role of the established corridor is evident.

The expansion of the 10% isoline around Aarhus is more limited and has a different character.

Aarhus has included the city of Randers to the north (56.000 inhabitants) within its 10% isoline but still leaving the cities of Silkeborg to the west (38.000 inhabitants) and Horsens to the south (50.000 inhabitants) outside the 10% isoline. The many relatively large urban centres in the area and the high quality of the transport infrastructure makes it possible for commuters to work in many different locations and is likely to lessen the dominance of the city of Aarhus. The longest expansion of the 10% isoline (20 km) is also not along infrastructure axis's but into the more remote peninsula of "Djursland" to the east of the city. This probably has two explanations. The area is at the "back end" of the city and has to pass Aarhus to gain access to the many competing centres in the area. And the area is much favoured by families settling in the rural-urban hinterland around Aarhus.

Commuting directionality

The graphs in figures 7 and 8 show the proportion of the resident population in parishes commuting in the direction of the Copenhagen and Aarhus CBD respectively – as a function of distance to the CBD. Both display the observed proportion of the resident population commuting in the direction of the CBD in 1982 and 2002 – and the corresponding regression line. The 4th degree polynomial function was found to reflect the structure of the data best.

Generally, a steep rise in the share of commuters commuting towards the CBD was found and then a levelling off as distance increases. The steep rise in the beginning occurs as cross and reverse commuting has the best conditions for people living near the CBD. At a certain distance a very large proportion of the commutes are directed towards the CBD as a result of the location of the "attractions" and the distance friction associated with the position vis-à-vis these attractions. The increasing distance friction then, gradually "forces" the percentage of commuters in the direction of the CBD to level off as the dependence of the workplaces in the central part of the urban area (the majority of workplaces in the area) is reduced. Fluctuation of the directionality after peaking and levelling off would indicate that the distance to the larger city is such that relatively self contained urban systems with their own commuting patterns can exist.

Around Copenhagen the peak of CBD-directionality in commuting in 1982 is found at 29 km from the CBD and 50% commuting in that direction. In 2002 this peak had moved to 36 km from the CBD and 55% commuting in that direction (regression results). Most of the change however, seems to have occurred in "the long tail". The directionality curve levels off slower and ends at a higher level within the first 90 km used to delimit the figure. In this part of the figure the 40% CBD directionality has for instance pushed from 50 km from the CBD in 1982 to 70 km from the CBD in 2002. This is a scale of change that is closer to resembling the development of the 10% isolines. Generally, the capital area can be seen to have reinforced its position as the dominant centre and seems to have a much stronger imprint on the commute patterns in 2002 than it did in 1982. Another indicator of this is the degree of explanation by the polynomial regression measured by R-square. It has increased considerably from the 1982 to the 2002 regression.

Around Aarhus the scale is smaller with the peak occurring between 15 and 16 km and 52% in 1982. In 2002 this had moved to 18 km but dropped a bit in percentage to between 50 and 51%. Corresponding with the isoline development, there has been some expansion of influence, but not in the same "single minded" fashion as it had occurred around the capital. The proximity of competing centres probably has an imprint. If the explanation yielded by the polynomial regression is taken as an indicator, then again the R-square drops from 1982 to 2002.

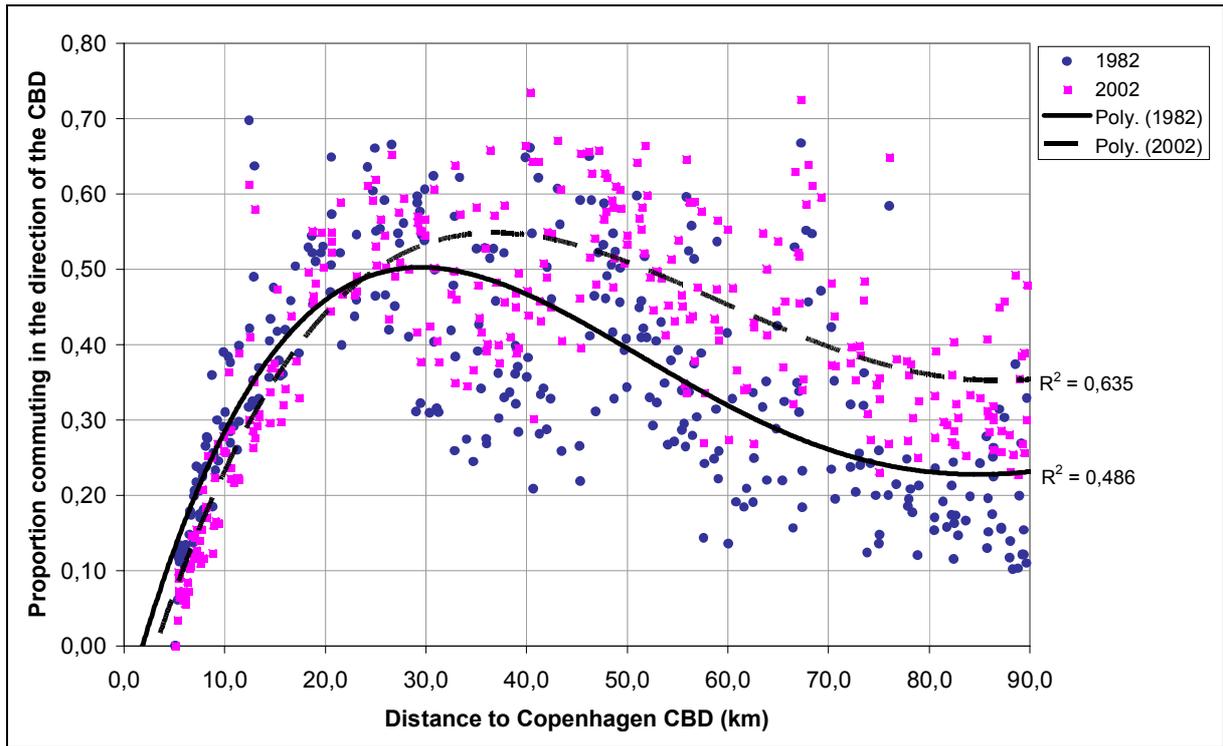


Figure 7: Proportion of resident population (parishes) commuting in the direction of Copenhagen CBD in 1982 and in 2002 - as a function of distance to Copenhagen. Polynomial (4. degree) regression lines are displayed together with the observations.

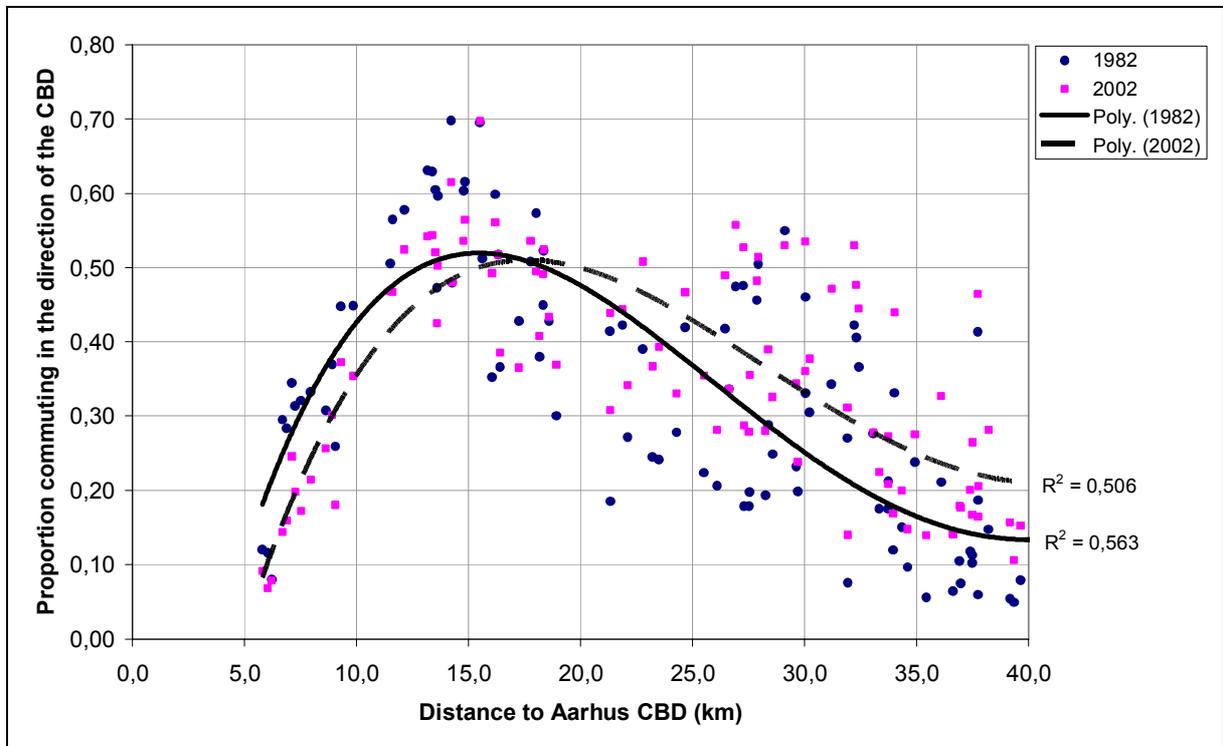


Figure 8: Proportion of resident population (parishes) commuting in the direction of Aarhus CBD in 1982 and in 2002 - as a function of distance to Aarhus. Polynomial regression lines are displayed together with the observations.

Commuting distances

Figures 9 and 10 show the average commuting distances for the resident populations in 1982 and 2002 as a function of distance to the CBD. Distances are calculated on the basis of the parish to parish matrix and the respective road distances between parish centroids. Again, the observed and calculated values are shown with their corresponding regression lines (4th degree polynomial).

A rise in commute distances is expected as a function of the increasing distance to the “attractions”. The rise should be followed by a peak and a levelling off as a consequence of the constellation of travel distance and travel friction as distance to the CBD increases. It should be kept in mind that the analysis results presented here are only bivariate and do not include for instance socio-geographic relationships that could influence the commute pattern. This probably explains the deviance from the “expected” in the central areas in Copenhagen and Aarhus.

Commuting distances among the city population (within 8 km of the CBD) have raised relatively more than in other parts of the “survey area”. In Aarhus this has led to the bivariate relationship actually displaying a negative slope for the relationship between commute distance and distance to the CBD for the first 8-9 km. A part of the explanation for this is that the populations of the urban centres have changed during the period. An aging “blue collar” population has been exchanged for a younger population with better education and managerial occupations. Over the last 10 years especially, a trend towards city living and continued densification of the city with modern dwellings has been displayed. Consequently, a more mobile and specialised workforce take up more dwelling space in the central city areas and probably leave its mark on the commute distances. On top of this the migration of industrial work places from the central city areas have continued forcing any “blue collar” population left behind in the central city to commute outwards.

Generally though the development in commute distances around Copenhagen/The capital area reflects what was found with the isolines and commute directionality. The location vis-à-vis the CBD has a stronger imprint on commute distances than before. The peak has moved from 50 km to 70 km. Furthermore the R-square for the regression line has increased considerably.

Around Aarhus the situation is somewhat different and probably reflects the closeness of competing centres and the high quality infrastructure. The degree of explanation of the variation in commute distances yielded by the distance to the CBD is much smaller than around the capital area. The shape of the regression line has also undergone the mentioned change from 1982 to 2002. For 1982 the expected rise from the shortest commute distances in the central area can be presented. In 2002 this structure was destroyed partially with the central area residents having the same commute lengths as that part of the population around Aarhus that commutes the longest. The expected relationship is in effect however for a part of the area and the peak can be seen to have moved from 24 km to around 32 km to the CBD. The relative marked increase in commute lengths among the city population probably reflects that there are many other destinations (cities) close by. As the commute distances are significantly lower than those found around the capital area a large potential for growth in commute distances and spatial interaction probably exists as a larger share of the population may adopt the pattern of the central city population and travel longer for jobs.

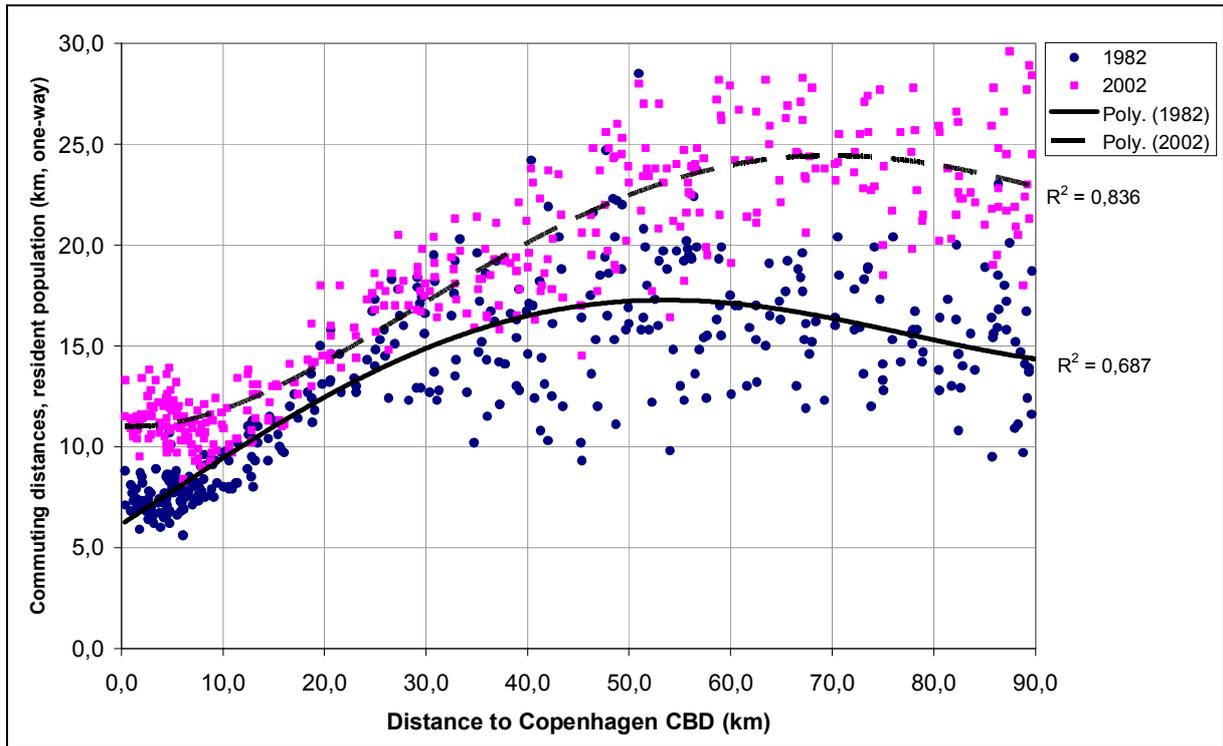


Figure 9: Average commute-distances for resident population by parish in 1982 and 2002 – as a function of distance to Copenhagen CBD. The commute distances are displayed together with polynomial regressionlines.

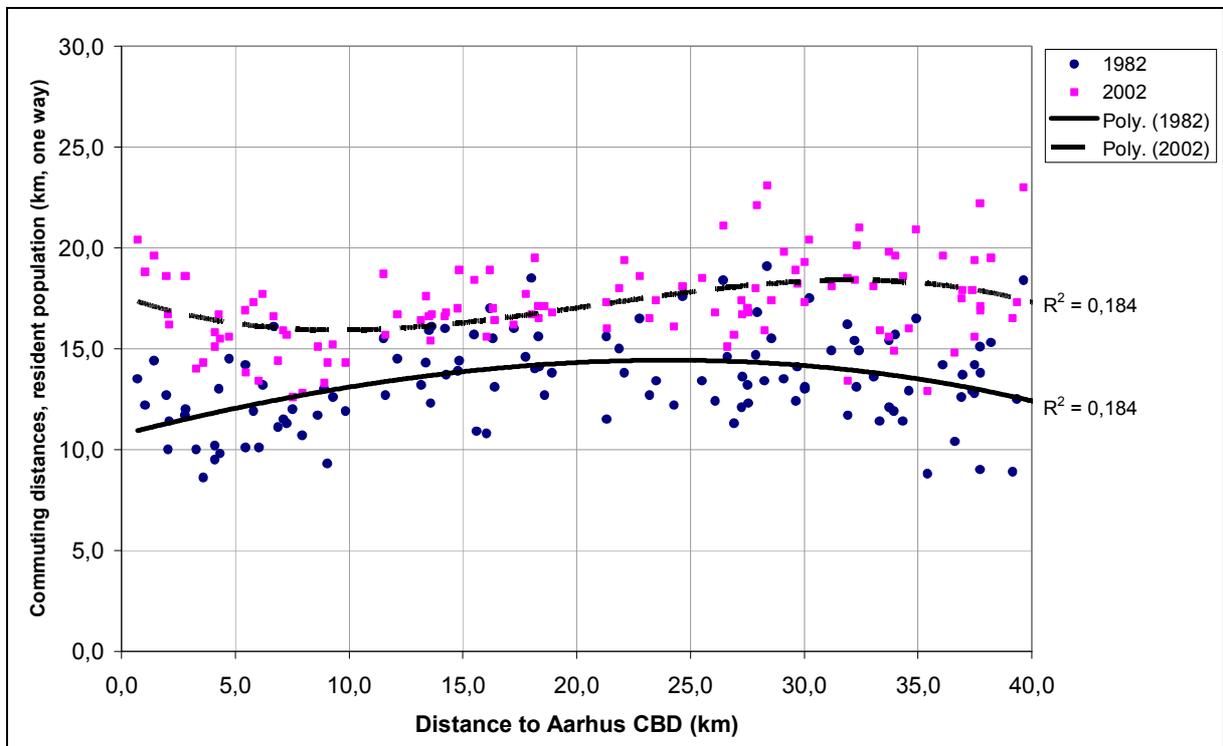


Figure 10: Average commute-distances for resident population by parish in 1982 and 2002 – as a function of distance to Aarhus CBD. The commute distances are displayed together with polynomial regressionlines.

Concluding remarks

This paper has taken the urban field concept as a point of departure for an inquiry into the state of development in this direction in the Danish context. The scale of functional integration suggested by Friedmann and Miller (1965) does not seem to be in effect in the Danish context. However judged from the indicators included in the inquiry the development has gone far in the direction of large functionally integrated fields. Moreover the direction of development is towards erosion of the degree of self containment and self sufficiency for the individual cities and integration into larger functional regions.

Commuting has grown all over the country in the study period (1982-2002). Still larger geographical areas are increasingly being interwoven as measured by the exchange of commuters. Generally, there has been an expansion of scale so that the “build up” of commuting around the urban centres in 2002 starts at a much longer distance from the city than it did in 1982. It is also increasingly difficult to identify the build up of flows as something that belongs to the single city. The concentric pattern is increasingly “blurred” by merging commuter fields and development along infrastructure axes.

The spatial distribution of growth in commuter volumes can be used as an indicator of the direction of change in the patterns of spatial interaction. Decentralising and sprawling tendencies are clearly evident – eroding and flattening the “traditional” build up of commuters towards the urban centres. In addition to this there is evidence of a strong growth in the number of commuters between cities which will contribute to an erosion of the self containment of many cities and make them part of a larger functionally integrated region. This development can especially be recognised in the eastern part of the peninsula of Jutland where fairly large cities are located close to each other and where interaction have been supported by high quality infrastructure (motorway and main rail line).

The inclusion of data from the national travel surveys made it possible to judge the contribution from different travel purposes to the geographically expanding functional integration – from a cross sectional perspective. Social travel followed by leisure travel seems to be the ones most responsible for the scale of functional integration between areas and cities in Denmark. Shopping – at the other end – is the one least responsible – and contributes much less the scale of functional integration than commuting. Regrettably no conclusions can be drawn as to the contribution from these travel purposes respectively to the current development trends.

The inquiry into the developments around Copenhagen and Aarhus shows two very different types of development. Copenhagen and the Capital area are dominated by a strong core area holding a large proportion of workplaces as well as the population base. The Capital area has significantly strengthened its influence – whether measure as commute percentage isolines, commuting directionality or commute distances. The commute-pattern from any location in east Denmark depends much more on its location vis-à-vis Copenhagen than it did 20 years ago.

Around Denmark’s second largest city Aarhus the evidence is much more mixed. Developments towards expanding the influence of the city are much weaker than around Copenhagen. The statistical results show that the location vis-à-vis the city of Aarhus is less important in explaining the commute patterns than it was 20 years ago. The likely explanation is that Aarhus is much less dominant in its regional context and to a large degree plays the part of a node in an increasingly integrated polynucleated urban region focussed on the north-south infrastructure axis in east Jutland.

Both types of development rely on the increasing scale and volume of spatial interaction and this is likely to develop further in the future. Improvements in transportation infrastructure are likely to be an important driver behind the development. In Denmark speed limits on 50% of the motorway network has been increased from 110 km/h to 130 km/h after 2002 - and the construction of additional roads continues. However the transportation infrastructure will not be alone in affecting the scale of spatial interaction. Aspirations towards living, leisure (consumption) and attitudes towards travel are probably just as important. The differences in commuting patterns between academics and other educational groups - found today - can be interpreted as an indicator of this.

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