Regional Patterns of Urban Development and Travel Behaviour – It's a matter of proximity in addition to choice.[i]

Petter Næss, Aalborg University, Fibigerstræde 11, DK-9220 Aalborg Øst, Denmark
Hans Henrik W. Johannsen, Aalborg University, Fibigerstræde 11, DK-9220 Aalborg Øst, Denmark
E-mail: petter@plan.aau.dk or hhwj@plan.aau.dk

Abstract

A study of residential location and transport in three provincial counties in Denmark shows that residential location affects the travel behavior of households, and that this affect is still apparent when various socioeconomic characteristics of the households are taken into consideration. The study also shows, that the spatial distribution or geographical spread as well as the size of the different urban centers in the three counties play a significant role in explaining the travel and transport behavior of individual households. Theoretical and empirical evidence from a recent study into the relationship between the residential location and distance to urban centers the Copenhagen metropolitan area shows that individuals emphasize choice rather than proximity to the urban centers for most travel purposes. Thus, as a result, the travel behaviour of households and individuals is primarily influenced by the location of the residence in relation to downtown Copenhagen, whereas the location of the residence in relation to lower-order centers with lower concentrations of facilities only to lesser degree has a bearing on the travel behaviour of households and individuals. The same influence of the distance to urban centers with the highest concentration of facilities seems to apply to households in three provincial counties of Denmark, but in contrast to the metropolitan area of Copenhagen, no single urban center in each of the three counties asserts enough of an influence on the travel behaviour to stand alone. Although cities like Holstebro in the county of Ringkoebing, and Aalborg in the county of North Jutland have a significant effect on travel behaviour, it seems that the location of the residence in relation to a conglomeration of 1st order urban centers in each of the provincial counties is needed to describe the relationship between residential location and regional patterns of urban development.

Introduction and background

Of the wide range of policies and planning tools that essentially stand at our disposal in our endeavor to promote a more sustainable transport sector, spatial planning has been suggested as a way of moving this process along, by concentrating urban development in and around the central parts of our urban centers, by avoiding urban sprawl, and by improving public transport in order to make it a viable alternative to private motorized transport (Ministry of Environment and Energy, 2000; COWI, 2000).

Theoretical and empirical research both abroad and in Denmark (among others Newman and Kenworthy, 1989; Næss, 1993a and 1993b, 2000, 2002; Banister, 1992; Owens, 1986; Larsen, 1982) universally show that there is a strong relationship between land-use patterns and transport, both at a city level and at a regional level. However, while most of this research agrees on the fact that such a relationship exists, there is considerable disagreement as to the exact nature of this relationship. This is especially apparent when it comes to describing the relationship between urban settlement patterns and transport at a regional level.

Studies conducted by Larsen et al. (1982) in Denmark and Næss (1993) on Swedish regions suggest that a decentralised regional pattern of urban development, consisting of several smaller, more dense and more self-contained urban centres scattered throughout the region, is more transport-efficient (and thus more energy-efficient) than a centralised regional pattern of urban development, where most of the region's population is concentrated in one or two large urban centres. Other studies (among others Banister, 1992), however, seem to contradict this conclusion. These studies seem to favour a more concentrated (monocentric) regional pattern of urban development as an energy-efficient "tool". So while there seems to be a growing consensus among researchers as to which land-use measures and policies are the most energy-efficient within the city-limits, a great deal of uncertainty exists as to which measures and policies should be used outside the city-limits.

In an attempt to further our knowledge-base on the relationship between residential location and transport - both at an urban and at a regional level - the research programme *Transportation and Urban Planning* was set up in 1999 as a joint venture between the now defunct Danish Research Council and Aalborg University (Næss, 1999). To this date several large-scale empirical investigations into the travel behavior of residents in different urban and regional settings in Denmark have been conducted. Some of the studies within the research programme have concentrated on the relationship between residential location and transport on an urban level, notably the study of residential location and transport in the provincial town of Frederikshavn (Næss and Jensen, 2000; Næss, 2003), and the study of residential location and transportation in the city of Aalborg (Nielsen, 2002).

Other studies within the research programme have concentrated their efforts on establishing whether or not a similar relationship between residential location and transport exists on regional or sub-regional levels (Johannsen, forthcoming; Næss and Jensen, forthcoming). The latter two studies concentrate their attention on three provincial counties scattered throughout the peninsula of Jutland and the greater metropolitan area of Copenhagen, respectively.

The underlying assumption of this paper is that the regional patterns of urban development in a region (i.e. the geographical spread or location of the individual villages, towns and cities) have a discernible bearing or influence on the amount of transport of individuals, and thus ultimately on the energy use for transport. It is important to continue to reiterate this, partly because there seems to exist the already mentioned uncertainty within the international research community as to the exact nature of this relationship between urban patterns of development and transport, partly because any subsequently adopted land-use policies or strategies that are set in place to alleviate the unsustainable by-products of our travel- and transport behaviour, requires that we in the research community are able to describe, quantify and qualify the effects, which our urban structures have on transport, both on a local and on a regional level.

Drawing from the results of our studies of the relationship between residential location in relation to urban centers, first in three provincial counties of Jutland, and subsequently in the greater Copenhagen metropolitan area, this paper will attempt to answer the following questions:

1. Which urban form variables or factors contained within a regional pattern of development can be said to have an impact on a household's amount of transport with private motorized vehicles?
2. Is a polycentric regional pattern of urban development more transport-efficient than a hierarchical regional pattern of development?
3. What rationales do individuals apply in choosing destinations?

The answers to the first two questions are drawn from the investigation of the relationship between residential location and transport in three provincial counties of North Jutland, Vejle and Ringkoebing, where a large scale quantitative questionnaire survey was conducted. The answer to the last question is derived from the investigation of the relationship between residential location and transport in the greater Copenhagen metropolitan area, relying mainly on data from qualitative interviews of 17 households, living at different distances from the center of the city of Copenhagen.

Each of the four selected regions or counties in our investigations displays a unique regional pattern of urban development. The metropolitan area of greater Copenhagen and the provincial county of North Jutland could be termed as regions with a distinct hierarchical regional pattern of urban development, in that both regions contain a large and dominant city, which exerts a considerable influence on its surrounding hinterland. These are the cities of Copenhagen and Aalborg respectively.

The provincial county of Ringkoebing has a more duo-centric regional pattern of urban development centered around the two cities of Holstebro and Herning. The county of Vejle has a distinct polycentric regional pattern of urban development defined by the four main cities Vejle, Kolding, Horsens and Fredericia.

Urban structures as contributory causes to travel behavior

According to theories of transport geography and transport economics, the travel between different destinations is influenced on the one hand by the reasons people may have for going to a place, and on the other hand by the discomfort involved when traveling to this location (Beinborn, 1979; Jones, 1978). Or, in other words, by the attractiveness of the locations and the friction of distance. By creating proximity as well as distance between activities, and by facilitating various modes of traveling, the urban structure makes up a set of incentives facilitating some kinds of travel behavior and discouraging other types of travel behavior. Still, it is *people* who travel, not buildings or geographical distributions of urban functions. The causes of travel behavior of course also include personal characteristics of the travelers, such as age, sex, income, professional status, as well as their values, norms, lifestyles and acquaintances. The emerging travel habits are a result of people's resources, needs, and wishes, modified by the constraints and opportunities given by the structural conditions of society.

Any study of the effects of urban structure on travel behavior assumes - at least implicitly - that structural conditions have a potential to influence human actions. Even though structures are created by the actions of agents, they make up conditions for future actions, often for a long time beyond the life of those who once created the structures. For our concrete actions in daily life, the urban structures make up constraints and possibilities. The built environment creates accessibility and barriers, proximity and distance, and it facilitates some activities at the expense of others.

Ontologically and epistemologically, our study leans on the position of Critical Realism (Sayer, 1992 and 2000, Danermark et al., 2001). Critical Realism acknowledges structures (social and natural) as capable initiators of mechanisms that might (or might not) result in empirical events that we as researchers try to comprehend. Critical Realism's conception of events as the results of the combined mechanisms at work in the actual situation, and the activation of mechanisms as resulting from the context-dependent combination of causal powers and liabilities, matches the multiple-cause situation a researcher is facing when trying to explain travel behavior. This model also helps us understand why we can never expect to find the same kind of strong empirical regularities between causes and events in society as in some natural sciences. (For a more thorough account of the ontological and epistemological basis of our research into the relationship between land use and travel, see Næss and Jensen, 2002.)

Facilities, activities and destinations

The so-called activity based approach (Jones, 1990; Fox, 1995; Vilhelmson, 1999) offers a useful conceptual framework for our study. According to this approach, nearly all travel activity is considered to be derived from the need or wish to carry out other, stationary activities. Travel is thus a derived demand. Everyday life is considered as a sequence of activities conducted by individuals at different places during the 24 hours of day and night. Activities are carried out in order to fulfill physiological needs (eating, sleeping), institutional needs (work, education), personal obligations (childcare, shopping) and personal preferences (leisure activities). (Vilhelmson, 1999:178.) In recent years, this view has been challenged by theorists who consider travel in contemporary, late modern society to be increasingly a purpose in itself, rather than an instrument to move from one place to another (see, e.g., Urry, 2000; Steg et al., 2001). This may be the true to some extent about holiday and leisure trips, but the activity-based approach is, in our opinion, still fruitful in order to understand and analyze daily-life travel behavior.

Based on Vilhelmson (ibid.:181) trips can be classified into four categories, depending on how fixed or flexible they are in time and space. "Bounded trips" are trips in order to reach activities where both the time and geographical location are fixed and cannot freely be deviated from. Typical examples are journeys to work or school, and trips in order to bring or pick up children at kindergarten or school. "Non-bounded" trips are trips where the time of the activity is flexible and the location may vary. Many leisure activities belong to this category, e.g. visiting friends, jogging and outings. An intermediary group includes trips where the time of the activity is fixed but the location may vary, and

trips where the location is fixed but the time may vary. An example of the former is the journeys to work of people working at different places (e.g. service mechanics), while visits to one's parents may be an example of the latter. The "semi-bounded" trips also include a number of purposes where the destination may vary and the trip frequency is not fixed in any rigid way, but where the trips with the purpose in question must still be made relatively regularly. A typical example is grocery shopping.

It is also important to be aware that the importance to the amount of travel of living close to or far away from different facilities may differ, depending of the facility type. For some functions, we almost always choose the closest facility, because the various facilities are more or less equal. But for other facilities, quality differences within each facility category may make people travel beyond the closest facility to a more attractive one. For example, having a cinema in the local neighborhood doesn't help much if you are interested in Lars von Trier films and the local movie theater has only spaghetti westerns on the repertoire. For cinemas and a number of other recreational facilities, many types of shops, and not least workplaces, a number of other features than proximity are also important when choosing among facilities.

A person's radius of action during a given period depends on, among others, the speeds by which the person can travel through space. A person who has a car at his/her disposal may reach a higher number of destinations during the day than a person who is left to use non-motorized modes of transport. Yet, the spatial reach of a person is not determined by travel speeds alone, but also by the time available for traveling. (Economic costs and inconvenience caused by traveling comes in addition.) Torsten Hägerstrand (1970) has developed the so-called time-geographical approach as a method to understand human activity patterns. Hägerstrand distinguishes between three types of restrictions: capacity restrictions, coupling restrictions and control restrictions. *Capacity restrictions* include limitations due to the individuals' biological properties or the ability of the tools they have at heir disposal. In our context the speeds of the various means of transport (ibid.:18-19) are of particular interest, cf. above. *Coupling restrictions* are regulations necessitating individuals, instruments, materials and signs, on grounds of production, consumption and social contact, to be coupled together into cooperating groups. The necessity of being present at a workplace is a typical example of a coupling restriction (ibid.: 21-22). The concept of *control restrictions* includes spatial restrictions as to who is entitled to move through or stay in different places, as well as temporal restrictions, e.g. the length of the working hours and their location in time. The control restrictions also include, among others, the layout and time schedule of public transport (ibid.:25-27).

Together the different types of restrictions imply a considerable limitation on people's use of time and the spatial distribution of their activities. In particular, this is the case for workforce participants and pupils on workdays and schooldays. The scope for "free" activities on weekdays far away from home is thus limited, in particular for those who do not have a private motor vehicle at their disposal. The location of the dwelling relative to the destinations of the "bounded" trips could thus be expected to exert a considerable influence on the actual amount of daily-life transport. On the other hand, the time possibly saved when living close to these destinations could be utilized by making more "non-bounded" trips, thus outweighing some of the travel-reducing effects of proximity.

Center hierarchies and travel

The size of the population base necessary for retail and services to run profitably varies between different types of services and commodities. A generalist doctor does need as large a population base as a brain surgeon, since the proportion of the population treated by an ordinary physician during a year is far higher than the fraction who have their brains operated on. Functions like retail, health services, education, cultural activities, entertainment etc. may therefore be graded according to the size of the geographical area usually covered by each facility. The different sizes of catchment areas form the basis for the development of a hierarchy of centers. The largest centers include both highly specialized functions and functions requiring a smaller population base, whereas the lower-level centers include only those types of functions that can survive with a small population base. (Christaller, 1933/1966:49-70; Johnsen, 1970:125; Brown, 1995).

For many types of businesses, a location in the largest city of the region may offer so-called agglomeration benefits (Vatne, 1993). The advantages of being located close to other businesses in the same branch include the cost reductions of utilizing each other's competencies, as well as more qualitative relations in the form of informal contact between the companies. For an office business, for example, where the employees go to frequent meetings with public authorities or private consultancies, proximity to these agencies and services will be advantageous. Large cities are also often nodes in national and international public transport networks (railway lines, flights, express buses). The central parts of large cities are also usually well served by local/regional public transport. Businesses in the region center thus have better opportunities for contact to local as well as non-local partners.

The above-mentioned conditions imply that the largest city of a region, and in particular its central parts, usually includes the largest supply of work opportunities, the broadest range of commodities in the shops, as well as the highest diversity of service facilities. The closer people live to a center belonging to a high level in the hierarchy of centers, the wider range of facilities will be thus available within a short distance from the residence. In particular, people living close to the downtown area of the biggest city of the region usually can reach a high number of workplaces and service facilities within a few kilometers from the dwelling. Due to their wide radius of action and their specialized work qualifications, the most mobile and educated parts of the population are likely to emphasize choice rather than proximity. The amount of travel will then be influenced to a higher extent by the location of the residence in relation to concentrations of facilities, rather than the distance to the closest single facility within a category. Thus, among people who emphasize the opportunity of choosing among several work opportunities, shops and recreational facilities, people living close to (the central parts of) the region center city could be expected to travel less than those who live in more remote parts of the region. In particular, this could be expected to be the case among two-income households, since it is more difficult for couples than for single breadwinners to combine peripheral residences with suitable local jobs for both spouses. Because people living close to concentrations of possibilities are more likely to have their daily destinations within walking or biking distance, a central residential location could also be expected to lead to a higher proportion of non-motorized trips. Large cities have also usually a higher standard of their public transport system (Næss, Larsen and Røe, 1994).

Among persons less tied to the concentration of facilities found in the largest centers, notably non-participants of the workforce, the location of the residence relative to local centers may still be more important.

However, the choices made by human beings tend to be a bit more complex and less predictable than indicated by the above influences. For example, high accessibility may create increased demands. A high accessibility may be utilized by opting between a wider range of jobs, shops and leisure activities, rather than reducing the amount of transport. Furthermore, traveling distances and choices of mode of transport are considerably influenced by factors like income level, household composition, and lifestyle. Thus, the relationship between land use and transport is embedded in contexts where causes are multiple and where it is necessary to take into account a broad range of possible factors of influence in order to disentangle the specific effect of residential location on travel behavior. Moreover, if the distance from the residence to the largest concentrations of facilities is very long, many people will find it too time-consuming, cumbersome and expensive to visit these locations regularly. Therefore, there will be a "distance decay" in the attractiveness of a large center. The range of attraction will vary with the type of facility, cf. above. Beyond that range, most people will orient themselves to smaller, more local centers, even if the job opportunities and selection of service facilities are narrower than in the big city. This might form a basis for the development of more local lifestyles and activity patterns among people living in the peripheral parts of a region.

Earlier empirical studies

The above-mentioned tendencies to shorter travel distances and less car driving among residents living close to the main regional center have been found in several city regions, including Greater Oslo

(Næss, Røe and Larsen, 1995), Aalborg (Nielsen, 2002) and Greater Copenhagen (Næss and Jensen, forthcoming). At the level of individual cities or metropolitan areas the evidence is quite strong that a residential location close to downtown contributes to reduce the amount of travel and energy use for transportation. As we mentioned in earlier in this paper, it is however more doubtful whether the advantages from centralization are also present when we turn from looking at single towns to larger regions (for instance a county). Some professionals maintain that this will still be the case, from a line of argument that there will be a lot of crisscrossing transport between the different local communities in regions with a decentralized population pattern. However, a study of commuting distances in Finnish municipalities has shown that people living in rural and peripheral municipalities usually have shorter commuting distances than those who live in the suburbs of the largest cities (Martamo, 1995). Similarly, an investigation of transport energy use in Swedish regions found that the energy use tended to increase the more the regional population was concentrated around the largest town of the region. Contrary to expectations, a high degree of urbanization, meaning that the proportion of the regional population living in rural areas and small settlements is small, tended to *increase* the use of energy for transport. On the other hand, a high population density within the cities contributed to reduced energy use. (Næss, 1993b). A Danish study of travel behavior in several center types concluded in a similar way (Larsen et al., 1982). A slight tendency of reduced travel distances when people live very far from the region center could also be observed in the above-mentioned study of the Greater Copenhagen area (Næss and Jensen, forthcoming).

Some other studies, however, point in the opposite direction; among others analyses of data from the nationwide Traffic Surveys (TU) of Statistics Denmark. Here, the longest driving distances were found among the inhabitants of rural areas and small villages (Christensen 1996). Corresponding results were found in an English comparison of town size and energy use (Banister 1992). This study showed that people in scattered areas, and urban areas with a population of less than 3000, had a higher average energy use for transportation compared to the inhabitants of any other category of size among British towns and urban areas. The results neither fit well with findings from Oregon in the USA, where those living in scattered areas around the city of Portland had a very high energy use compared to the inhabitants in the city itself (Davis, Nelson and Dueker 1994). These discrepancies may perhaps be due to variations in lifestyles between different countries, but they may also be a hint about methodological weaknesses, e.g. lack of control for socioeconomic variables in some of the studies.

Travel surveys in three Jutlandic counties

How do people's rationales for location of activities and the actual geographical distribution of workplaces, service facilities and leisure opportunities at a regional scale combine into resulting travel distances? In the following, we shall take a look at some of the results from travel surveys conducted in the three provincial Danish counties of North Jutland, Ringkoebing and Vejle.

In the study into the relationship between regional patterns of urban development and transport in the three provincial counties, some 1300 questionnaires were distributed by mail to randomly selected households situated in each of three counties. In total 3900 questionnaires were distributed, and some 969 completed questionnaires were returned. The return rate from each of the participating counties varied a little between 27% from the households in North Jutland, over 25% in the county of Vejle, to 22% in the county of Ringkoebing. The overall response rate of this questionnaire survey thus hovers around 25%, which considering the quite large sample, as well as the requirement of the respondents to register their weekly travel behaviour, must be considered both acceptable, and within the rate of what could be expected. In comparison the overall response rate of our questionnaire survey in the Greater Copenhagen metropolitan area was 33% (Næss, 2002; Næss and Jensen, forthcoming), the overall response rate in our Frederikshavn study was 24% (Næss and Jensen, 2000), while the response rate in our Aalborg study was 32% (Nielsen, 2002).

The questionnaire, which was distributed to the randomly selected households in each of the three counties, consisted of 22 main questions of which 12 centered around the household's travel- and transport characteristics. Although some of the questions pertained to the travel behaviour of the

individuals of the household, most of the questions concerning the travel- and transport behaviour of the household were kept at a household level of aggregate, where the individual households were expected to register their amount of transport with different means of transport during the week of investigation.

Since it is highly unlikely that the travel behaviour of individuals and households alike can be solely attributed to the spatial structures, the questionnaire contained a number of questions related to the socioeconomic composition of the household and the individuals herein. Factors such as the gross income of the household as well as a variety of demographic characteristics of the individuals in the households were included in the questionnaire, thus allowing for a statistical control for the influence of these factors in the analysis of the relationships between residential location and travel behavior.

In the subsequent multivariate statistical analysis of the data from the survey in the three provincial counties, the socioeconomic and other control variables were included: the number of residents in the household, the average age of the adult household members, whether or not the household has pre-school children (below the age of six), whether or not the household has school children (between the ages of six and fourteen), the household gross income (indexed DKK), the number of cars per adult member of household (log), and the number of motorcycles per adult member of household (log). The two control variables of car- and motorcycle ownership were transformed logarithmically, reflecting that the households' accessibility to the first motorized vehicle has a stronger influence on the travel behaviour of the households than the accessibility to the second or third motorized vehicle.

It could be argued that car ownership in itself might be a product of the residential location in the spatial landscape, and any use of this variable as a control variable in the statistical analysis would be a kind of "over-control". In an attempt to address this question, regression analysis without these two vehicle ownership variables have been conducted in all three provincial counties.

The urban structural variables included in the analysis were the location of the residence relative to the main urban centers in the respective counties (six centers in North Jutland, four in Ringkoebing, and four in Vejle), the location of the residence relative to the largest or most centrally placed main urben center in each of the counties (Aalborg in the county of North Jutland, Vejle in the county of Vejle, and Holstebro in the county of Ringkoebing), the location of the residence relative to the 2nd and 3rd order towns of the size 1.000 to 9.999 inhabitants of the respective counties, and the location of residence relative to the 4-order towns and hamlets of the size 200 to 999 inhabitants in each of the counties. In the county of Vejle, an additional urban variable of the residential location in relation to the provincial capital of Jutland, the city of Aarhus, was included in the analysis.

Residential location and travel behavior in the county of North Jutland

As already mentioned, the county of North Jutland has a fairly monocentric regional pattern of urban development with regards to not only the size and distribution of the major cities and urban centers in the county, but also the geographical distribution of workplaces, service facilities and leisure opportunities. The county has approximately 500.000 inhabitants of which some 120.000 live in the city of Aalborg, making the city the largest by far in the county and the fourth largest city in Denmark.

The county is the northernmost county of Denmark and as such has a somewhat peripheral location with regards to not only the main transport arteries of the country, but also to the rest of Denmark as such. Historically the main industries of the county have been tourism, agriculture, fishing as well as blue-collar industries such as cement production and ship-building. Although agriculture, fishing and tourism still play a pivotal role in the development of the county, the 1990'ies saw the emergence of new propellant industries centered around the electronic- and mobile-telephone industries, and concentrated in and around the area of Aalborg.

Although much of the development in the county has been centered in and around the city of Aalborg, the sheer geographical spread and size of the county of North Jutland, which covers more than 6000

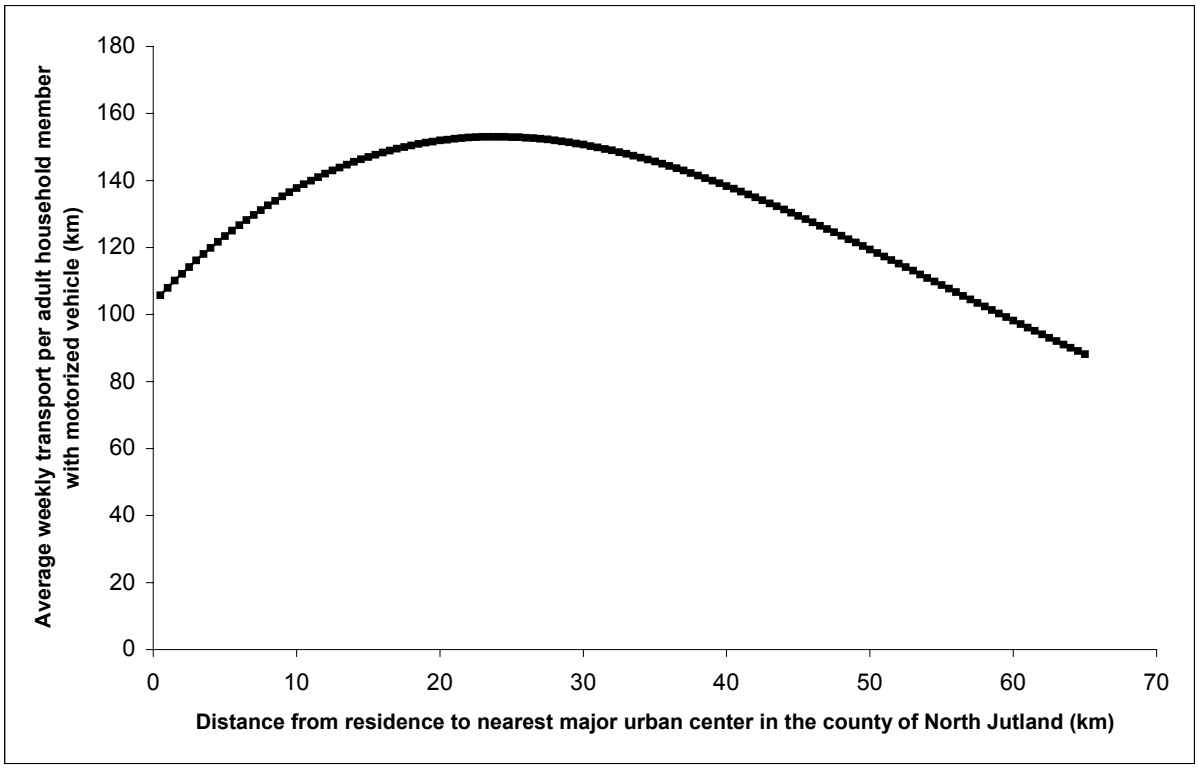
square kilometers makes it theoretically implausible to think of the city of Aalborg as being the only urban center in the county to have an influence the travel behavior of the inhabitants of the county. The distances between the different population centers and thus the distances to travel within the county are simply too great, and the resulting friction of distance would at some point begin to deter the amount of criss-cross transport between the different parts of the county.

It is also plausible, and in line with gravitational theory (Kellermann, 1964), that the gravitational pull of the different urban centers in the region, and thus the influence on transport that these centers exert, would decrease as the distances to the various city centers increases. This would also apply to the city of Aalborg, regardless of the dominant role this city holds in the county of North Jutland. Several other first- and second-, and even third- or fourth-order urban centers could therefore also be expected to have some effect on the travel behavior of the inhabitants of the county. The question is at which distance from the city center does the city of Aalborg's influence on travel behaviour begin to decline, and which competing urban centers can be identified in the county of North Jutland.

The relationship between the transport variable of weekly travel with motorized vehicle per adult household member and the distance measured along the road-network from the residential location to the nearest major urban center of either Aalborg, Hjoerring, Broenderslev, Hobro, Frederikshavn or Skagen (see figure 2) gives us the beginnings of an answer to the two questions posed above.

The shape of the curve implies that the amount of travel at first increases at a steady pace as the distance between residence and urban center increases to top at a distance of some 20 to 25 kilometers from the city center of the six largest urban centers in the county, before gradually decreasing as the distance to the city centers of these towns increases further. The relationship is not a linear one. Through an iterative process of "curve-fitting" the relationship between the transport variable and the aforementioned urban structural variable, a cubic function was found to provide the best fit.

Figure 2: Average weekly travel with motorized vehicles per adult household member among residences located at different distances from the center of the nearest major city of Aalborg, Hjoerring, Frederikshavn, Hobro, Broenderslev and Skagen in the county of North Jutland, controlled for a number of socioeconomic and urban structural variables. N = 283 households. Sig. = 0,012



An additional analysis with the urban variable of the distance from residence to the urban center of Aalborg shows a similar but not identical curvature as depicted in figure 2; a clear indication of the importance of the city of Aalborg in the region of North Jutland.

Table 1 shows the results of two multivariate analysis of the influence on the average weekly travel by motorized vehicles per adult household member from a range of urban and socioeconomic variables. There are two models. Model one in which all variables are included, and model 2 in which the two variables pertaining to vehicle ownership of the household have been omitted. Both models show that the location of the residence in relation to the cities and towns of Aalborg, Skagen, Hobro, Hjoerring, Broenderslev and Frederikshavn has a significant effect on the travel behaviour of the households. Although the strength of the relationship between the urban variable and transport varies from a Beta coefficient of 0,129 in model 1 to a Beta coefficient of 0,279 in model 2, the relationship in both models is a strong and steady one with levels of significance well within the acceptable.

Table 1: Multivariate regression models to describe the weekly travel (km) with motorized vehicles excluding official travel per adult (18 years and above) household member in the county of North Jutland during the week of investigation.

1. **Model 1** includes the following variables: the number of residents in the household, the average age of the adult household members, whether or not the household has pre-school children (below the age of six), whether or not the household has school children (between the ages of six and fourteen), the household gross income (indexed DKK), number of cars per adult member of household (log), number of motorcycles per adult member of household (log), location of residence relative to the six largest centers in the county (transformed non-linearly), location of residence relative to the largest city of Aalborg of the county (transformed non-linearly), location of residence relative to the 4-order towns and hamlets of the size 200 to 999 inhabitants in the county, and location of residence relative to the 2- and 3-order towns of the size 1.000 to 9.999 inhabitants of the county. N = 283 households located in the county of North Jutland. **The power of explanation (adjusted R^2) is 0,324**. Outliers (i.e. households with extreme travel distances of more than three inter-quartile ranges above the upper quartile) have been excluded. In this model, households with more than 541 km's of motorized travel per adult household member per week have been excluded.
2. **Model 2** includes the same range of variables as model 1 with the exception of the number of cars per adult member of household (log), and the number of motorcycles per adult member of household (log). N = 300 households located in the county of North Jutland. **The power of explanation (adjusted R^2) is 0,171**. Outliers of more than 541 km's of motorized travel per adult household member per week have been excluded.

Model	Independent variable	Non-standardized regression coefficient (B)	Standardized regression coefficient (Beta)	Level of significance
1	(Constant)	-25,502		0,169
	Household gross income (indexed DKK)	3,372	0,101	0,055
	Location of residence relative to the centers of the six largest cities in the county of North Jutland (non-linear transformation of the distance measured along road network from residence to the cities of Aalborg, Hjoerring, Frederikshavn, Broenderslev, Hobro and Skagen)	0,434	0,129	0,012
	Number of cars per adult member of household (log)	637,002	0,469	0,000
	The household has children between the ages of 6 and 14 (yes = 1, no = 0)	35,419	0,092	0,065
2	(Constant)	12,731		0,490
	Household gross income (indexed DKK)	8,366	0,255	0,000
	Location of residence relative to the centers of the six largest cities in the county of North Jutland (non-linear transformation of the distance measured along road network from residence to the cities of Aalborg, Hjoerring, Frederikshavn, Broenderslev, Hobro and Skagen)	0,938	0,279	0,000
	The household has children between the ages of 6 and 14 (yes = 1, no = 0)	42,880	0,107	0,045

It should be noted that several socioeconomic variables also show significant effects on the travel behaviour of the households in North Jutland. The weekly travel by motorized vehicles tends to be higher with an increase of the gross income of the household, if the household contains schoolchildren, and with an increase in car ownership (model 1).

None of these effects or the strengths of the individual effects (indicated by their standardized regression coefficients – Beta) are surprising. What is surprising however, is the apparent negligible or non-existent effect, that the urban structural variables of the distances between the residential location and the 2nd, 3rd and 4th order urban centers exert on the travel behaviour of the households – especially when one considers the size and geographical spread of the county of North Jutland in relation to the location of the aforementioned 6 main urban centers.

Both models display fairly high powers of explanation, topping at an adjusted R^2 of 0,324 in model one and 0,171 in model 2.

Additional analysis with a slight variation in the composition of the urban variables, where the location of residence is accessed in relation to on the one hand the distance to the center of the city of Aalborg, and on the other hand the distance to the remaining five 1st order urban centers in the county yields a regression model, which almost has the same power of explanation as the depicted model 1. This further strengthens the conclusion that the city of Aalborg, while important, cannot by itself explain the variations of the travel behaviour of the individual households in the county of North Jutland. The other five main urban centers of Hjoerring, Hobro, Skagen, Broenderslev and Frederikshavn are needed to complete the picture.

Residential location and travel behavior in the county of Ringkoebing

As was the case of the county of North Jutland, the county of Ringkoebing also has a somewhat peripheral location to the main transport arteries and population centers of Denmark. Although the county has a number of larger towns and cities, notably the cities of Holstebro (31000 inhabitants) and Herning (29000 inhabitants), most of the urban centers of this county have less than 3000 inhabitants.

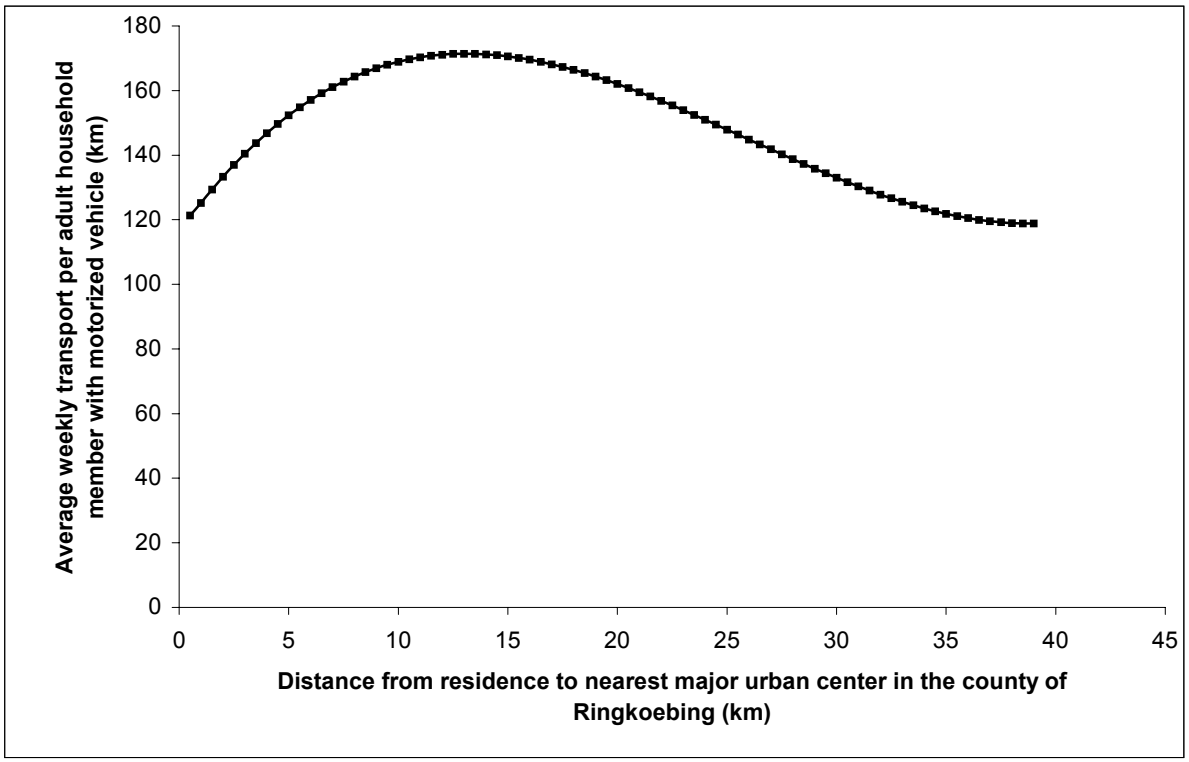
The demographic composition of the county is also lopsided in that the main population centers of the county are concentrated in a half-circle along the northern and eastern boundaries of the county leaving much of the western parts of the county with small and scattered population centers. The geographical size of the county is nearly five thousand square kilometers km compared to the more than six housand square kilometers of the county of North Jutland and the three thousand square kilometers of the county of Vejle.

In development terms the county has lain dormant until the middle of the 18th hundred, and the county could thus be seen as the Danish equivalent to the western territories of the United States of America. Early settlers of the county of Ringkoebing concentrated their efforts on small scale farming and the raising of sheep. This in turn propelled a budding textile industry – an industry that to this day has been the hallmark of this region in Denmark.

As was the case in the county of North Jutland, the relationship between the transport variable of weekly travel with motorized vehicle per adult household member and the measured distance along the road-network from the residential location to the nearest major urban center of either Holstebro, Herning, Ikast or Struer in the county of Ringkoebing is not a linear one. Once again it was necessary to transform the measured distance along the road-network with a non-linear function. A cubic function combined with a linear function was found to provide the best fit (see figure 3).

In contrast to the similar curve of the relationship in the county of North Jutland, the average amount of travel initially increases at a faster pace as the distance between residence and urban center increases in the case of the county of Ringkoebing than in the case of the county of North Jutland. This is due to a somewhat steeper inclination of the curve in the county of Ringkoebing.

Figure 3: Average weekly travel with motorized vehicles per adult household member among residences located at different distances from the center of the nearest major city of Holstebro, Herning, Ikast and Struer in the county of Ringkoebing, controlled for a number of socioeconomic and urban structural variables. N = 246 households. Sig. = 0,004



In the case of the county of North Jutland the curve topped at a distance of some 20 to 25 kilometers from the urban centers, before gradually decreasing, whereas the curve in the case of the county of Ringkoebing tops at a distance to the major urban centers of around 13 kilometers. This implies, that sphere of influence on travel behaviour of the main urban centers of the county of Ringkoebing has a shorter radius than the corresponding main urban centers of the county of North Jutland.

As we already mentioned in our presentation of the main results from the county of North Jutland, the radii of the spheres of influence of the main urban centers in the county of North Jutland are to a large extent influenced or determined by the city of Aalborg. As the county of Ringkoebing contains no comparable city class to the city of Aalborg, it is not only probable but highly in line with central-place theories, that the spheres of influence on travel behaviour should be smaller in regions with smaller cities, regardless of these cities current hierarchical status within the regions in question.

What is a bit more puzzling, is that the average weekly travel by motorized vehicle per adult household member in the county of Ringkoebing in general seems to be higher than in the county of North Jutland. The starting values of the average weekly travel by motorized vehicle in the county of Ringkoebing hover around 121 km per week per adult household member, compared to starting values of around 106 km per week per adult household member in the county of North Jutland. The corresponding top values of the average weekly travel by motorized vehicle in the two counties are 153 and 171 km respectively per adult household member. The implication of this is that the more polycentric regional pattern of urban development of the county of Ringkoebing is not necessarily a more transport- or energy-efficient pattern than the mono-centric pattern of North Jutland.

Although the slopes or curvatures of the two curves in figure 2 and 3 to some degree moderates the differences between the two counties in the average weekly travel behaviour, a difference can still be observed. A possible explanation to this difference could be, that a large number of the responding

households to our questionnaire in the county of North Jutland live in close proximity to the city of Aalborg where the choice of public- and private services within a small radius is the greatest (even in comparison with urban 1st order centers across the three counties), and where the level of public transport options is the highest, thus on the one hand minimizing the needs of the household members to use private means of motorized transport, and on the other hand maximizing the chances of the household members to use different modes of transport, notably walking, cycling and public transport.

An alternative explanation revolves around the composition of the urban structural variable of distance to nearest major urban center in the two counties. The curvature of the function of the average weekly transport and distance to nearest major urban center in the county of North Jutland is to a large extent determined by the presence of the city of Aalborg in the urban structural variable. This has the effect of "stretching" out the curvature depicted in figure 1, and thus in effect overexposing the influence of the city of Aalborg in the graphical depiction of the model.

Even with the above mentioned reservations in mind, the curves depicting the relationship between the locational variable of distance to nearestest main urban center and weekly travel in the two counties clearly show, that not only the size of the cities and towns in our two counties but also the spatial distribution on a regional scale has a significant effect on our travel behaviour.

Table 2: Multivariate regression models to describe the weekly travel (km) with motorized vehicles excluding official travel per adult (18 years and above) household member in the county of Ringkoebing during the week of investigation.

1. **Model 1** includes the following variables: the number of residents in the household, the average age of the adult household members, whether or not the household has pre-school children (below the age of six), whether or not the household has school children (between the ages of six and fourteen), the household gross income (indexed DKK), number of cars per adult member of household (log), number of motorcycles per adult member of household (log), location of residence relative to the four largest centers in the county (transformed non-linearly),, location of residence relative to the 4th order towns and hamlets of the size 200 to 999 inhabitants in the county, and location of residence relative to the 2nd and 3rd order towns of the size 1.000 to 9.999 inhabitants of the county. N = 246 households located in the county of Ringkoebing. **The power of explanation (adjusted R^2) is 0,235**. Outliers (i.e. households with extreme travel distances of more than three inter-quartile ranges above the upper quartile) have been excluded. In this model, households with more than 551 km of motorized travel per adult household member per week have been excluded.
2. **Model 2** includes the same range of variables as model 1 with the exception of the number of cars per adult member of household (log), and the number of motorcycles per adult member of household (log). N = 246 households located in the county of Ringkoebing. **The power of explanation (adjusted R^2) is 0,175**. Outliers of more than 551 km of motorized travel per adult household member per week have been excluded.

Model	Independent variable	Non-standardized regression coefficient (B)	Standardized regression coefficient (Beta)	Level of significance
1	(Constant)	95,306		0,007
	Average age of adult household members (years)	-1,493	-0,173	0,004
	Location of residence relative to the centers of the four largest cities in the county of Ringkoebing (non-linear transformation of the distance measured along road network from residence to the cities of Holstebro, Herning, Ikast and Struer)	0,635	0,163	0,004
	Number of cars per adult member of household (log)	298,833	0,327	0,000
	The household has children between the ages of 6 and 14 (yes = 1, no = 0)	37,581	0,115	0,058
2	(Constant)	107,327		0,008
	Average age of adult household members (years)	-1,325	-0,153	0,018
	Location of residence relative to the centers of the four largest cities in the county of Ringkoebing (non-linear transformation of the distance measured along road network from residence to the cities of Holstebro,	0,820	0,227	0,000

Herning, Ikast and Struer)			
Household gross income (indexed DKK)	7,205	0,215	0,001
The household has children between the ages of 6 and 14 (yes = 1, no = 0)	38,105	0,117	0,066

The multivariate regression models (seen in table 2) show that several socioeconomic and other control variables also exert significant effects on the travel behaviour of the households in the county of Ringkoebing. The weekly travel by motorized vehicles in this county too tends to be higher if the household contains schoolchildren and with an increase in car ownership, and the travel tends to be lower the older the adult household members seem to be.

Residential location and travel behavior in the county of Vejle

In stark contrast to the counties of North Jutland and Ringkoebing, the county of Vejle is not a county, which could be considered to have a peripheral location as to the main arteries of transport in Denmark. On the contrary, the county of Vejle is situated in and around what could essentially be termed the most important crossroad of the main transport arteries in the western part of Denmark. Main road and rail connections lead from the county of Vejle to the provincial capital of Jutland, Aarhus, in the north, to the commercially important German cities of Flensburg and Hamburg in the south, to the main oil-capital of Esbjerg in the west, as well as to the main islands of Fünen and Zealand in the east.

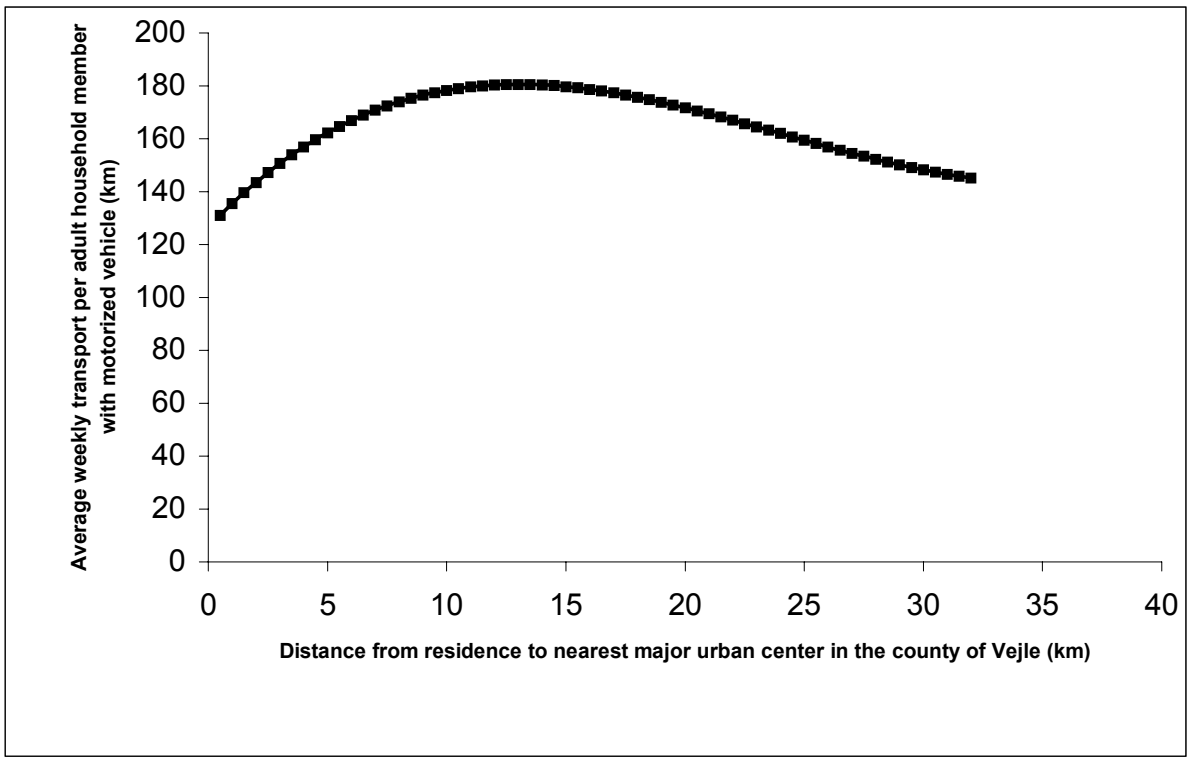
The regional pattern of urban development in the county is polycentric centered around the four main towns and cities of Vejle (48.000 inhabitants), Horsens (49.000 inhabitants), Fredericia (37.000 inhabitants) and Kolding (53.000 inhabitants) all of which are located comparatively close to each other, while at the same time being evenly dispersed throughout the rather small county of some 3000 square kilometers. Although the main industries of the county are predominately concentrated within the fields of transport and logistics – an emphasis of the regions high accessibility to the major transport networks of the country – the region as a whole sports a wide range of highly specialized public- and private services.

With a comparatively smaller geographical size than the two other counties, and with a closely knit spatial distribution of the main urban centers, all of which contain highly specialized functions, the catchment areas (or spheres of influence) of the four main cities in the county should theoretically form a interwoven mosaic with four spheres each radiating out from the center of the cities of Fredericia, Vejle, Kolding and Horsens. In theory this should have a limiting effect on the amount of travel, since the radius of each sphere of influence is limited by neighboring spheres of influence forming a pattern of spheres of influence emanating out from the center of four cities of roughly the same size and status in the hierarchy of urban centers.

In reality the four cities seem to form a large single green metropolitan area thus sharing not only the catchment area of each individual city, but also in effect negating or disintegrating the individual characteristics of each individual city. This is especially apparent when one studies the travel patterns of the inhabitants of the county of Vejle. Here the somewhat rigid boundaries of the catchment areas of the individual urban centers have dissolved to form a single catchment area covering a large proportion of the county. Within this area an extensive amount of cross-municipal and inter-urban travel can be observed – travel, which in the main part is defined by extensive patterns of commuting.

The curve depicted in figure 4 reflects this. With starting values of 131 kilometers per week per adult household member, rising to about 180 kilometers per week some 12 to 14 kilometers from the nearest main city center, this county displays the highest average volume of transport per adult household member of any of the three counties encompassed by the investigation.

Figure 4: Average weekly travel with motorized vehicles per adult household member among residences located at different distances from the center of the nearest major city of Vejle, Kolding, Fredericia and Horsens in the county of Vejle, controlled for a number of socioeconomic and urban structural variables. N = 278 households. Sig. = 0,037



The strength of the spheres of influence of the four main urban centers declines from around 13 kilometers from the city centers and outwards, a threshold that is in line with that in the county of Ringkoebing, but considerably lower than the threshold value of the county of North Jutland.

This closely corresponds with both gravitational theory and considerations about the size of catchment areas in central place theory, thus giving credence to the results of the multivariate regression models and their corresponding controlled relationship curves. Once again, a significant part of the average weekly travel per adult household member is explained by socioeconomic- and other control variables.

Table 3 shows, that an increase in the car- and motorcycle ownership of the household, or an increase in the gross income of the household tends to lead to an increase of travel, whereas an increase of the average age of the adult household members tends to decrease the weekly amount of travel per adult household member.

In addition to these socioeconomic- and vehicle related control variables, the analysis also shows that the distance between the residences and the nearest 2nd and 3rd order urban center also contributes to explain the travel behaviour of the individual households in the county of Vejle. An increase of this distance tends to produce more motorized transport.

Considering the relative small size of the county, coupled with the relatively even distribution throughout the county of the four main urban centers, the fact that these relatively small urban centers should have a bearing on the travel behaviour of our respondents seems somewhat puzzling. One could speculate that this perhaps is somehow related to the aforementioned high accessibility of the households to the main transport arteries of the country, providing the households with a greater incentive to "explore" the region than in the two other counties. An alternative explanation could be the households of the county of Vejle have a better selection of "best facilities" compared to the households of Ringkoebing or North Jutland.

Table 3: Multivariate regression models to describe the weekly travel (km) with motorized vehicles excluding official travel per adult (18 years and above) household member in the county of Vejle during the week of investigation.

1. **Model 1** includes the following variables: the number of residents in the household, the average age of the adult household members, whether or not the household has pre-school children (below the age of six), whether or not the household has school children (between the ages of six and fourteen), the household gross income (indexed DKK), number of cars per adult member of household (log), number of motorcycles per adult member of household (log), location of residence relative to the four largest urban centers in the county (transformed non-linearly), location of residence relative to the most centrally placed 1-order urban center of Vejle in the county (transformed non-linearly), location of residence relative to the 4th order towns and hamlets of the size 200 to 999 inhabitants in the county, location of residence relative to the 2nd and 3rd order towns of the size 1.000 to 9.999 inhabitants of the county, and location of residence relative to the provincial capital of Jutland Aarhus. N = 278 households located in the county of Vejle. **The power of explanation (adjusted R^2) is 0,351**. Outliers (i.e. households with extreme travel distances of more than three inter-quartile ranges above the upper quartile) have been excluded. In this model, households with more than 587 km's of motorized travel per adult household member per week have been excluded.
2. **Model 2** includes the same range of variables as model 1 with the exception of the number of cars per adult member of household (log), and the number of motorcycles per adult member of household (log). N = 279 households located in the county of Vejle. **The power of explanation (adjusted R^2) is 0,197**. Outliers of more than 587 km's of motorized travel per adult household member per week have been excluded.

Model	Independent variable	Non-standardized regression coefficient (B)	Standardized regression coefficient (Beta)	Level of significance
1	(Constant)	-6,897		0,864
	Average age of adult household members (years)	-1,102	-0,114	0,036
	Household gross income (indexed DKK)	6,285	0,178	0,003
	Location of residence relative to the centers of the four largest cities in the county of Vejle (non-linear transformation of the distance measured along road network from residence to the cities of Vejle, Fredericia, Kolding and Horsens)	0,470	0,116	0,037
	Number of motorcycles per adult member of household (log)	208,274	0,089	0,069
	Number of cars per adult member of household (log)	570,850	0,424	0,000
	Location of residence relative to 2nd and 3rd order urban centers in the range of 1.000 to 9.999 inhabitants	4,469	0,095	0,073
2	(Constant)	-32,701		0,261
	Household gross income (indexed DKK)	12,673	0,359	0,000
	Location of residence relative to the centers of the four largest cities in the county of Vejle (non-linear transformation of the distance measured along road network from residence to the cities of Vejle, Fredericia, Kolding and Horsens)	0,876	0,215	0,000
	Location of residence relative to 2- and 3-order urban centers in the range of 1.000 to 9.999 inhabitants	4,707	0,100	0,089

The provision of facilities is greater in the county of Vejle (even outside the main urban centers) and the accessibility to these facilities is higher than in the two other counties. Both explanations are however speculative, since we do not have sufficient information in our data set to fully explain why 2- and 3-order urban centers only play a role in determining the travel behaviour of our households in the county of Vejle, as distinct from the two other counties of Ringkoebing and North Jutland, where the longer distances between the various urban centers limits the choice of best facility, thus enhancing the role or importance of the nearest lower-order urban center.

Rationales for choosing destinations

Information about people's rationales for choosing destinations and travel modes is helpful in order to uncover the causal mechanisms by which developmental patterns influence travel behavior. Qualitative research methods can provide more detailed insight into such rationales and motivations than what is possible through ordinary travel surveys. The study of the three counties in Jutland did not comprise any qualitative interviews with residents living in various locations. However, such interviews were made in three of the other research studies included in our research program. Below, lessons learned from 17 qualitative interviews conducted as part of our investigation of residential location and travel in the Copenhagen Metropolitan Area (Næss and Jensen, forthcoming) will be used to shed light on people's rationales for choosing where to locate their activities and which travel modes to use. Although the geographical contexts of the three Jutlandic counties are different from the much more urbanized Copenhagen region, we believe the residents' main rationales for choosing the locations of their activities and their modes of transportation are common to a high extent. Since the quantitative results from the Jutlandic countries focused on in this paper concern the amount of travel and not the modal split between different means of transport, we shall concentrate on the rationales for location of activities.

The interviewees' choices of locations for their activities are made as a compromise between two competing wishes: A wish to limit travel distances, and a wish to be able to choose the best facility. The balance between these wishes differs somewhat, depending on the travel purpose. Our interviews suggest that each resident establishes an individual threshold value for the longest acceptable travel distance within each category of destination. Within these threshold values, the actual destinations are chosen more or less freely, based on other criteria than distance minimizing. In other words, the interviewees tend to practice a "distance satisficing" rather than "distance minimizing". *Within* the maximum distance limits we can sometimes find examples of people preferring medium rather than very short distances, e.g. because a wish for motion or "clearing the mind" on the way home from work can make some interviewees prefer the trip by bike not to be too short. These examples are still quite atypical. In general, the unsatisfactory/unacceptable distances are clearly the long ones, and within the thresholds for acceptable travel distances the closest facility fulfilling the relevant quality criteria is normally preferred.

Among the different travel purposes, trips to workplace or higher education, and visits to friends and relatives, are the trip purposes where the longest distances are accepted. Because the workplace or school/university is usually visited each weekday, whereas long visit trips are carried out far less frequently, this implies that journeys to work or education are clearly the travel purposes accounting for the largest proportion of the travel distance on weekdays. The acceptable travel distance to work or education appears to increase the more specialized work qualifications you have, the more mobility resources you have at your disposal, and the further away you live from the largest concentrations of work and education opportunities. If the distance exceeds the acceptable limit, you will either have to abstain from an otherwise attractive job or education opportunity, or move to a residence closer to the desired workplace or school. Our interviews show examples of residents moving in order to live closer to the workplace, as well as an interviewee who broke off her education because the distance between the residence and the university required too long and time-consuming journeys. Since primary schools, kindergartens and well-assorted grocery shops can usually be found closer to the residence than specialized jobs matching your specialized work qualifications, the threshold values for acceptable distances to, e.g., primary schools, kindergartens and grocery stores are usually shorter that for workplaces and higher educations.

Distance limitation is thus included as an important (but not the only) rationale for most interviewees' choices of locations for daily-life activities. The wish to limit travel distances may be grounded on different reasons, often in combination, such as

- saving time
- saving money
- bodily constraints with respect to walking and biking

- a wish to support the local community and maintain local social contacts

Thus, what counts for our interviewees is not only the two reasons associated with an "economic man" perspective (saving money or time), even though some interviewees mention these considerations explicitly and they probably are included as part of the distance limitation rationale among the remaining interviewees. In addition, several interviewees living in inner-city locations have chosen not to own a car, or choose to use the bike as their main mode of everyday transportation even if they have got a car. For these interviewees, the physical stamina of the body will enter as a reason to limit travel distances, along with a wish to save time. Thus, the choices of travel mode and the choices of activity location are to some extent interwoven. The rationale of distance limitation is in this way also indirectly influenced by, among others, environmental considerations and a wish for motion, which are the reasons - along with economic concerns and a wish to avoid car driving in queues - most often mentioned for choosing the bike as the means for everyday transportation. As mentioned above, the wish for motion may, on the other hand, make some people prefer somewhat further destinations to where the daily trip by bike fulfils the need for exercise, rather than the closest alternatives. Finally, the choice of local destination may be conditioned by a wish to support the local community and establish local social contacts. This may in part be based on a political wish to support local shops, clubs etc. in order to secure their future survival, and partly on the fact that the chance of getting acquainted with other customers or users is higher if you use the local facilities than if you spread your purchases and use of services over a large geographical area. Such prioritization of local shops in spite of prices possibly being lower and the assortment larger elsewhere, is probably more common in peripheral than in central areas. Inner-city residents are to a lesser extent able to obtain significantly lower prices or a better assortment by traveling beyond the local area, and their "local patriotism" and feeling of personal contact with the local storekeeper will perhaps also be lower. However, our interviews also show that the use of local shops in inner-city locations, originally chosen because of proximity, assortment and prices, is consolidated when the interviewees have become familiar with these shops and no longer need to search the shelves for the desired commodities.

Visits to friends and relatives are probably the travel purpose where distance minimizing plays the least important role. (Possible exceptions are the cases where interviewees have chosen their residence in order to live closer to friends and relatives.) Visits, in particular to relatives, are thus the most "specialized" activity of all, as those persons or households whom one might want to visit make up only a tiny fraction of the total number of inhabitants. Especially when visiting relatives, quite long travel distances are often accepted, in turn the frequency of such visits will usually be low. The circle of friends apart from relatives can to a higher extent be built up with the residence as a base, and trips to visit friends (non-relatives) will therefore usually be somewhat shorter. Several among our interviewees in the Copenhagen area make trips to visit relatives in other Danish regions (among others in Jutland) some times every year, but there are no similar examples of regular visits to non-related friends. Most of the latter trips go to destinations within the Copenhagen region, and particularly within the domestic sub-region. We also find a number of examples of interviewees having made friends with people from their own residential areas, to whom they make regular visits.

Along with distance limitation, a *wish to be able to choose the best facility* is the most important rationale for the interviewee's choices among destinations. In a way, this is the most fundamental rationale, as the trips would simply not occur if no sufficiently attractive facility existed that might be visited. Distance limitation and the wish for the best facility are two concerns pulling in opposite directions. In practical locational choices these regards must be weighed against each other. What is considered the "best facility" will vary with the purpose of the trip and with the individual characteristics of the person in question.

For workplaces, factors like job content, qualification requirements, wages and work environment will be relevant. For specialized jobs, the catchment area from which employees are recruited will be large and typically include considerable parts of the region. The job markets for non-specialized jobs are likely to be more locally delimited. Jobs as e.g. cashiers have largely the same job content and wages, independent of the workplace's specific location within the region, and the employees within this job

segment therefore have a higher possibility of finding a suitable job close to the dwelling than persons with more specialized qualifications.

For shopping locations the factors influencing the choices include, among others, assortment, prices and maybe parking possibilities. Among kindergartens, the reputation of the institution (pedagogy etc.) and perhaps also the ethnic composition of the children may be factors of influence. The distribution of children among public primary schools is to a high extent determined through the official school catchment areas, but because private schools make up a competing alternative the factors influencing the choices of kindergartens may to some extent also apply to primary schools.

The destinations of visiting trips are defined entirely by the traveler's family relations and circle of acquaintances, cf. above. When it comes to leisure trips, the choice among facility categories depends strongly on the interests and lifestyle of the person in question, but quality differences within each facility category matter as well. For example, a distant, but larger and more beautiful forest may be preferred for outings rather than a local forest.

In daily-life travel some trips are more fixed and basic than other trips, cf. the distinction between bounded, semi-bounded and non-bounded trips. Often, a bounded trips makes up the stock of a trip chain. Other travel purposes are then "hitched" on this stock trip. For example, buying groceries often takes place on the way home from work or after having picked up children in the kindergarten. By choosing a well-assorted store along the route followed anyway, the rationale of distance limitation can be combined with the rationale of choosing the best facility. This kind of adaptation - hitching some non-bounded or semi-bounded activities on the bounded trips, where the non-bounded activities are located to the most attractive of the facilities along the route of the bounded trip, is very common among our interviewees. In a time-geographical perspective this kind of adaptation implies that the shopping trip occupies a smaller part of the "space-time prism", thus enabling the individual to spend more time on other activities during the day and/or travel further to reach these activities.

The rationales for location of activities are also to some extent depending on the rationales for transport mode choice. For example, some interviewees abstained, for economic or environmental reasons, from owning a car. Given their car-less situation, the range within which destinations could be chosen would naturally diminish.

Consequences of the rationales to the relationships between residential location and the amount of travel

The above-mentioned rationales make up important links in the mechanisms by which urban structures influence travel behavior. In the following, we shall briefly summarize how the various rationales contribute to the influences on travel behavior from the location of residences relative to the main concentration of facilities and to local facilities, respectively. For this purpose, the rationale of distance limitation will be split into two aspects: Limiting geographical distances and limiting time consumption. The relationship between the amount of transport and the distance from the residence to the *main center of the urban region* is in particular strengthened by the rationale of being able to choose the best facility. The rationales of limiting geographical distances and time consumption also contribute to this relationship to some degree, both because the region's largest concentration of facilities will serve as local facilities for a large number of inner-city residents in the major city of the region, and because the center is the geographical point of gravity even for the more peripheral destinations that might - from a rationale of time-saving - be chosen by car drivers who want to avoid congested streets. The relationship between the amount of transport and the distance from the residence to *local facilities* is first and foremost based on the rationale of limiting geographical distances, but also on the rationale of saving time, as the local facilities will often be the ones that can be reached most quickly. In addition to the rationales for location of activities and modal choice we also identified some rationales for car drivers' and bicyclists route choices for daily-life transport: limiting time consumption, limiting geographical distance, traffic safety and views/esthetics. Among our interviewees, the two latter rationales were important only to bicyclists. The remaining two

rationales, which were emphasized by bicyclists as well as car drivers, imply that the interviewees are not apt to make long detours from the shortest or fastest route. The rationales for route choice thus support the general activity-based approach to transport analysis, cf. above (Jones, 1990; Fox, 1995).

Impacts of residential location to activity participation

Our interviews indicate that people's participation in activities is to some extent influenced by the distance from the residence to relevant facilities. There is a limit as to how far people are willing to travel in order to carry out an activity. Such a "distance decay" contributes to a certain weakening of the relationships between residential location and the amount of travel. Among our interviewees, this mechanism was still far from strong enough to offset the many mechanisms contributing to a higher amount of travel among residents of peripheral areas. The distance to facilities appears to influence mainly the *frequency* of participation. In some cases a type of activity can be completely abandoned, if the location where it can be performed is situated too far away. The freedom to abandon an activity is of course limited to the "non-bounded" types of activities, cf. above. The disadvantages of living far away from facilities thus consist partly of the need of spending more time, money and efforts on traveling to the facilities, and partly on having to renounce on some of the needs or wishes for activity participation. In other words, living far away from relevant facilities has some environmental and resource-related consequences, in the form of a high amount of transport, as well as some negative welfare consequences, in the form of unfulfilled wishes for activity participation.

Concluding remarks

The study of residential location and transport in the three provincial counties of North Jutland, Vejle and Ringkoebing in Denmark shows that location matters, even when socioeconomic differences among households and individuals are taken into consideration. The specific strengths of the effects on travel behaviour of the urban structures in the three counties may vary, and the locational variables in play may also differ slightly from county to county, but on average households located close to the main urban centers of our three counties travel less with private motor vehicles than households living further away from the main urban centers in question. Our study clearly indicates that among the locational characteristics of the dwelling, the amount of travel is primarily determined by the location of the residence in relation to the distance to the four to six main urban centers, and only to a lesser extent by the distance to lower-order urban centers in the counties in question. Our study also shows that although the distance to the main city of each county is important, this city can rarely stand alone and better explanations of the travel behaviour are achieved when these cities are paired with other high-order urban centers. Across the three counties the lower-order urban centers seem to have little or no effect on the travel behaviour of our households. This is in line with the qualitative results from the interviews conducted with households located in the greater Copenhagen metropolitan area, where the respondents tended to emphasize choice rather than proximity for most travel purposes; concentration of facilities is more important than the closeness of the nearest facility. On a regional level this translates to a dominating role of the higher-order urban centers, as these centers offer the widest range of both public- and private services. A dominant role that is clearly visible in the influence on the amount travel, which these centers exert on our participating households. This study does not support the notion that a polycentric regional pattern of urban development is more transport-efficient than a hierarchical regional pattern of development. On the contrary, it appears that a polycentric regional pattern of urban development is somewhat less transport-efficient than a more hierarchical regional pattern of development; especially if the former pattern of development is coupled with a high-end system of transport corridors between the principle urban centers of the region in question – as is the case in the county of Vejle.

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