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Spatial and Individual Influence on Commuting Behaviour in Germany

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SPATIAL AND INDIVIDUAL INFLUENCE ON COMMUTING BEHAVIOUR IN GERMANY

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ABSTRACT

In regional planning literature it is often argued that regional deconcentration process and urban sprawl tend to increase the amount and distance of commuting (Vandersmissen et al. 2003). Supported by improved traffic infrastructure and falling transport costs, the spatial division of labour and housing locations extends the travel-to-work areas and compensates for locational disadvantages associated with local labour markets (Moss et al. 2004).
On the other hand, the contrary hypothesis is postulated, too. Since both working and living places are deconcentrated, shorter commuting distances may occur because centre-orientated connections are substituted with intra-peripheral commuting patterns (Gordon; Richardson 1991: 419).

The intention of this paper is to analyse the influence of spatial structure on commuting behaviour of employees. For example does commuting behaviour differ between types of regions and if so what are the reasons for these differences?
There are several ways in which the locational conditions of the living area may influence the commuting behaviour. Firstly, the more jobs that are available, the less is c.p. the necessity for long-distance commuting. Thus, the lower the regional density of jobs the more frequent and longer is the commuting that should be expected. In addition, the variety of local jobs should have an influence on the commuting behaviour. As in rural regions less varied jobs are available, there should be a pressure on the local residents to increase their job opportunities by extending their commuting distance.
However, apart from regional influences, individual characteristics may effect commuting behaviour, too. For example, highly qualified employees are likely to commute longer distances since they could be more interested in realising their investment in human capital. Conversely, long-distance commuting should be c.p. less attractive for part-time employees because of the less favourable relation between work and commuting time.

The empirical analysis consists of two parts: Firstly, regional differences in commuting behaviour are analysed. The investigation focuses on regions and the relationship between the regional characteristics of living places and the regional amount of commuting.

The second part includes individual influences. As they can only be observed at the level of individuals, the focus of investigation changes from regions to individuals: In addition to regional effects the commuting behaviour of individuals is explained by individual characteristics such as education or occupation.

The data base is given by the social security statistics. It covers all employees in the social security system and contains information about each individual. As data on both the living and the working places are available, the statistics provide a much greater regional differentiation than frequently used surveys do. The other information relates to some personal characteristics (like sex or education) as well as to occupation (such as full-/part-time or the sector of employment).

KEYWORDS: Commuting behaviour; spatial structure, individual characteristics, employment density, Germany

1. INTRODUCTION

Commuting and its determinants have been widely studied in several English-speaking countries (the USA, the United Kingdom and Ireland) (Preston; McLafferty 1997; Lloyd; Shuttleworth 2004). In the case of Germany most publications are kept at a descriptive level, often only commenting on commuting behaviour. Responsible for this are limitations associated with the use of aggregate data with low regional evidence. Usually survey results and random samples are used (Alecke; Untiedt 2001: 386).

The availability of a new data source - the German social security statistics – promises better results. Compared with survey results the advantage of these statistics is the possibility of regional disaggregation and representative results. Using these statistics the paper will examine the influence of spatial structure on commuting behaviour of employees in Germany.

As an introduction the historic development of commuting in rural and urban regions is shown. Subsequently explanatory approaches and models of commuting behaviour are given on spatial and individual levels. The database and the chosen approach are explained in the next section. In the remaining paper spatial differences in commuting behaviour are described by the commuting rate and the average commuting distance based on a rural-urban division of German regions. Furthermore the influence of individual characteristics on commuting behaviour is examined. The characteristics that are taken into account are age, education and working hours.

The separation of workplace and residential location as well as the interaction between these two places is generally seen as a result of transition from agrarian to industry and service based societies (Geipel 1954: 468 f.; Paesler 1992: 76; Boustedt 1970: 2283; Kaestner: 1940: 230; Otto 1979: 25). The final point of this development is an increasing temporal and spatial separation of working and private life.

Characteristically for preindustrial and early industrial societies there were close spatial relations between the functions of living and working. In many cases the workplace and residential location were situated in the same house. To a great extent work and profession determined spatial and functional location of private life. This applied particularly for the majority of inhabitants in the cities. In cases where the home and workshop were not situated in the same building, less than weekly commuting was recognised as economical (Boustedt 1970: 2284).

During the industrial age (in Germany between 1850 and 1873) these conditions mostly ceased. Even a certain connection between workplace and place of residence was kept up. The increased use of machines in factories, based on principles of division of labour organisation, led to concentration of the workforce in companies (Otto 1979: 25). At first employee demand starting with industrialisation was covered mainly by migration which in other words meant the opportunity to change the place of residence. In the wider course of the industrialisation process the number of commuters rose with increased concentration of working places in cities. Employees from the surrounding countryside had to be recruited to satisfy employee demand. As a result the urban region began to expand. Distances between residential and working places and the crowds which had to be transported increased. Effective transportation could only be managed with mass transportation systems (Otto 1979: 26). Since that time the absolute number of commuters as well as distances covered by them has increased further (Otto 1979: 28).

On the whole the main reason for the increase of commuting in the cities was the increasing

spatial separation of work place and residential location. It was caused by a specific local demand of the industry and service sector. Furthermore since the last world war the building of homes in the outskirts of towns and the availability of mass transportation systems have favoured the outlined process. A great part of the population now had the opportunity to settle in the outskirts and to keep their workplace in the city (Paesler 1992: 76). The necessity to commute was increased by housing shortages in the cities after the war as well as cheap land outside the city, rising demands on the residential sphere and the unbroken demand of industry for employees (Geipel 1954: 469). The explanations show that population and workplace concentration through industrialisation have influenced modern commuter traffic basically by growth of cities and improvements in transport technology (Boustedt 1970: 2284).

The origin of commuter traffic in rural areas is different compared to the cities and urban regions. By daily walks to work, the agrarian population in rural regions had to always overcome great distances to reach the scattered fields. Beginning in the middle of the 70s the Farmland Consolidation Act made efforts to reduce this type of "agricultural" dependent commuting.[1]

While in urban regions commuting was a result of urban sprawl, in the rural regions it was the only way to prevent migration. Where agrarian income possibilities were low, the search for supplementary income and a second occupation was particularly expanded into urban regions.[2] In this way new opportunities for earning money could be taken without having to give up the smallholding, the social contacts or the cheap life-style in the country (Otto 1979: 28). After the war - in contrast to the cities - vast living space was available in the rural regions. Gradually the development of these rural regions was improved with new transportation opportunities. As a result the move towards rural areas from urban regions increased. The necessity to commute became greater than before (Ott; Gerlinger 1992: 76).

The progress of decentralisation was not only limited to population but later also observed for workplaces (Bade; Niebuhr 1999: 6). Subsequently the interconnection between rural regions and cities intensified further. As a result the amount of outgoing commuting from rural regions to urban regions rose (Bade; Spiekermann 2000: 78).

1.1. Spatial and individual influence on commuting behaviour

In numerous studies it is assumed that commuting is a result of the developed spatial division of labor in industrialised societies. The process is based on spatial structure. This structure is characterised by local conditions, the spatial demand of population and employment as well as the technical and social infrastructure (Werner 1991: 47, Beckmann et al. 1998: 252).
In this context there are two main opinions: On one hand it is claimed that spatial deconcentration through sub-urbanisation and dispersion processes has increased the travel-to-work distances (Albers; Bahrenberg 1999: 3). On the other hand it is assumed that progressive decentralisation of employment and infrastructure has led to a reduction of commuting distances: Decentralisation of population results in the substitution of centre-orientated connections through intra-peripheral commuting (Gordon; Richardson 1991: 419).

[1] These are actions for reorganisation of rural land property according to improvement of production and working conditions. These actions were often connected with the joining of split or uneconomically formed field parts.

[2] This development was favoured by the rural tradition of the real division. It led to fragmentised and small agricultural fields. This made it very difficult for farmers to make their living. So it was necessary to search for wider possibilities beyond the rural regions to earn a living (Otto 1979: 27).

On the whole decentralisation and dispersion processes are not questioned. Also the opinion is shared that these processes have an effect on employees commuting behaviour. In contrast the degree of effectiveness as well as the proportions on commuting behaviour is evaluated contradictorily. There is another point which is open to criticism. Up to now the effect of decentralisation and dispersion processes on commuting behaviour was considered simply in the spatial context. Individual influence has not been taken into account.

The already described processes are not generally valid. They differ between urban and peripheral regions. Because of that, spatial structure seems to be an obvious reason for differences in commuting behaviour.

The intention of this paper is to analyse the influence of spatial structure on commuting behaviour of employees:

- Firstly it has to be examined if there are spatial differences in the commuting behaviour in Germany.
- Secondly individual influences on the commuting behaviour based on certain personal characteristics have to be analysed.

Spatial influence on commuting behaviour

As already indicated the settlement and economic development in Germany is characterised by decentralisation and dispersion processes. These developments led to a functional loss of urbanised areas regarding the functions of living and working. On the other hand they helped to extend the meaning of rural regions. Within these processes spatial structure plays an important role. Consequently it has a basic influence on the commuting behaviour.

The impact of spatial differences on commuting behaviour has rarely been investigated. For this reason employment density known from migration research is taken into consideration in this paper. It is intended to examine the effect of employment density on commuting behaviour. The assumption implies that differences in distribution of employment affect the supply of employment opportunities. This has direct influence on commuting behaviour (Motzkus 1997: 219). A great supply of employment allows inhabitants to use job opportunities provided in their region. This will have the effect of decreasing the amount of commuting (BBR 2003: 98). In contrast a low employment supply decreases the chance to find a job in a given radius. Large job markets have a strong attraction on employees from other regions. In comparison to small job markets they also offer a great variety of vacancies.

Individual influence on commuting behaviour

However, apart from regional influences, individual characteristics may affect commuting behaviour, too. Before outlining different individual characteristics and their influence on commuting behaviour, the logic behind individual decision making processes is examined (Kalter 1994: 465; Schneider et al. 2002: 30).

The starting point is the thesis that persons try to maximise their individual benefit and their benefit function. This happens by the fact that goods or other resources are used in a way that produces the biggest return (Hill 1995: 104).

The chosen residence and work location reflect two basic functions. These functions contain the ratio between the consumed goods and the returned benefit (Hill 1995: 105): On the one hand it is the benefit an individual can achieve by working in a region. On the other hand it is the benefit an individual can achieve by living in a different region. This combination is also

called “joint utility [...] of residence and employment” (Yapa; Polese; Wolpert 1971: 18). The value of a place of residence in combination with a working place results from the commuting and migration costs that are subtracted from this combined benefit (Kalter 1994: 465).[3] Finally the chosen combination takes possible commuting and migration costs into account. It also maximises individual benefit. In other words an individual decides on a certain combination if the subjectively expected benefit exceeds the other alternatives.

The described approach explains commuting behaviour as a result of a rational decision between commuting and migration costs as a function of income. A reason for criticism makes the assumption that workplaces are ideally situated in urban areas (Richardson 1986; Simpson 1992). Also it is supposed that all employees are identical. So basically their benefit function does not differ.

That is the reason why it seems to be necessary to look at individual characteristics that could influence commuting behaviour. The decision to commute is not only dependent on an employees benefit function but also on individual characteristics like age or level of education (Schneider et al. 2002: 43, Cervero; Wu 1997: 866). For an individual it can be worthwhile to accept certain commuting distances because of his or her personal situation or because there are no other alternatives available to him or her. The life approach known from the migration theory combines different individual characteristics with each other. The approach provides knowledge of the interaction between age, life and career as well as the residential biography. Life phases can be determined, mostly at the beginning of the professional life, where the willingness to move is quite high. Moreover it is supposed that especially young employees often change their workplace because they are not certain in assessing their skills (Job-Shopping). With increasing age, the probability rises for getting married and having a family or for the acquisition of residential property. At the same time workplace change becomes unlikely with an increasing period of employment (Christensen 1999: 5). Consequently attachment to a residential region rises which finally favours acceptance of long commuting distances. Also it is expected that with the quality of education, the acceptance of commuting increases. Vice versa workplaces further away should be less attractive for part-time workers because of the overvaluation of the travel time in relation to working hours (McQuaid; Greig 2001: 156).

[3] **Commuting costs** originate from the shuttle between place of residence and a working place. They can be of a monetary as well as a temporal nature. Non monetary costs are associated with psychological factors e.g. long driving times and stress. **Migration costs** result only in cases where it is necessary to change the present place of residence. Over time these costs can be neglected because they amortise very fast. Non monetary costs are for example the loss of social capital. It can result in a loss of local friendship relationships.

1.2. Used data/ approach

The database is provided by the social security statistics.[4] The used data record is a full capture of all employees who required social security insurance in Germany in the year of 2003. The statistics allow a much better regional differentiation than frequently used surveys. Individual as well as regional connections can be examined.

In this paper commuters are examined as employees working beyond their residential municipality (LAU[5] 2, formerly NUTS 5). In other words they have to cross a boundary. If no boundary is crossed they remain inside commuters. The distance between work and residential location can be measured when commuters are crossing boundaries 'as the crow flies'. In the case that commuters are not crossing boundaries no distance can be measured. Results of the German sample census show that the distances covered by inside commuters on average are shorter than the distances covered by commuters that cross municipality boundaries. 75% of all inside commuters commute less than 10 km. However only 20% of the boundary crossing commuters commute less than 10 km (BBR 2003: 129). As a result short distances are systematically underrepresented by capturing boundary crossing commuters. The probability that commuters leave their municipality in order to commute to work is quite high in regions with a small average area size. In regions with an extensive surface area this probability is much lower. This is the reason why boundary crossing commuters with a distance of under 10 km are taken out of the analysis (Saviranta 1970: 7).

On the other hand commuters differ in the frequency of travel and thus the work commuting distance covered. Where a commuting distance of 30 km appears to be covered daily, it is assumed that a distance of 150 km is covered weekly. To examine a homogeneous object of research, a distance value is placed. It separates daily from weekly commuting. Based on appropriate investigations (Kalter et al. 2001, BBR 2003) a value of 100 km is assumed to delimit daily from weekly commuting. Commuters are defined as boundary crossing employees who cover a distance of 10 to 100 km.

Commuting behaviour is measured by the commuting rate in percent and the average commuting distance in km. Further a distinction in spatial and individual influences associated with commuting behaviour is made similar to Coombes; Raybould in 2001. They distinguish "place factors" and "people factors" (Coombes; Raybould 2001). On the spatial level the focus of investigation lies with the region which is chosen as an observation unit. The first objective is to find out if there are spatial differences in commuting behaviour between urban and other types of regions. Therefore commuting rates and average commuting distances are examined based on a differentiation of Germany in agglomeration centers, urban fringes, low density and peripheral regions.[6] The influence of supply of employees on commuting behaviour is expressed by employment density. It is calculated from the accumulated employee's interests. The higher this Gini coefficient[7] is, the higher is the

[4] The German social security statistics contain all social security insurance requiring employment. Since 1993 employees are registered with their place of home and place of work. The statistics include employees, workers and trainees. Government officials and public servants, self-employed, insignificant employees and family workers do not require social security insurance and are not included in the statistics. It is estimated that the data covers about 75% to 80% of all employed persons in Germany.

[5] Local Administrative Units (LAU) are the basic components of NUTS regions (Nomenclature of Territorial Units for Statistics).

[6] The classification is based on four spatial categories according to their centrality. The starting point is the main agglomerations of Germany that are further divided into agglomeration centers and urban fringes. Areas with low accessibility and density are classified as low density and peripheral regions (Bade; Niebuhr 1999: 138, 152).

[7] The Gini coefficient is a measure of inequality of a distribution.

employment density. Besides this, the volume of employees illustrates the supply of job opportunities. It is expected that a high concentration of employees and a great supply of jobs cause low commuting rates. On the other hand commuting rates will be quite high if a low supply of job opportunities exists. In addition to commuting rates the average commuting distance will be taken into consideration.

To answer the question if commuting behaviour is influenced by individual characteristics age, education and working hours are analysed. The commuting rate and average commuting distance for these individual characteristics are examined dependent on age.

2. RESULTS

2.1. Regional level - spatial structure

In this section spatial differences of commuting behaviour are examined. The consideration of the commuting rate by municipalities and spatial categories shows strong regional differences (Fig. 1). In the middle part of Germany there are regions with low commuting rates. They are situated especially along an imaginary line between the cities Koblenz - Siegen – Kassel - Erfurt and Gera. Such regions with low commuting rates can also be located in the southeast of Germany on the Czech Republic and Austrian borders. Nevertheless regions with commuting rates of more than 50% can only be found irregularly. An above-average accumulation of these regions appears in the north and in the southeast of Germany.

Taking the different spatial categories in Germany into consideration it becomes obvious that regions situated in close proximity with respect to agglomeration centers appear to have especially high commuting rates. The mentioned regions are for example situated around Hamburg, Frankfurt, Berlin or Munich. They are classified as urban fringe regions. The commuting rates in these regions are much higher than in the agglomeration centers and especially higher than in the peripheral regions situated far away from the agglomeration centers. Altogether the agglomeration centers show, with a commuting rate of 23.47%, the lowest values. In contrast to the agglomeration centers the urban fringes have with 47.68% the highest values. The values of the low density (38.75%) and peripheral regions (40.17%) are in between. On average 38.33% of the employees in Germany are commuting (Tab. 1).

The calculation of the average commuting distances of commuters crossing boundaries shows a big east west discrepancy (Fig. 2). The former East German states show average commuting distances between the residential municipality and working municipality of 30 km. In contrast the former West German states only show average commuting distances between 15 and 25 km. The agglomeration centers Hamburg, Berlin, Frankfurt and Munich need to be viewed more closely. Immediately around them there are rings with relatively low average commuting distances. The majority of these regions can be classified as urban fringe regions. With rising distance to the agglomeration centers the average commuting distance rises too. In summary: the average commuting distances in the agglomeration centers (64.65 km) are significantly higher than in the low density (43.38 km) and peripheral (45.93 km) regions. The shortest distances are covered by employees from the urban fringes (38.4 km) (Tab. 1).

Besides the already mentioned commuting rates and average commuting distances in the regions, Tab. 1 shows the commuters' flows. It separates them into a region of origin and a destination region based on the spatial categories in Germany. Over half (51.68%) of all commuters from the agglomeration centers commute into urban fringes and only about 40% stay in the same spatial category. Only a small part is allotted to the low density (6.72%) and peripheral regions (1.4%). Vice versa the flows from the urban fringes to the agglomeration centers look similar. Every second commuter (54.67%) has his or her destination in agglomeration centers and 38.04% remain in urban fringes. The commuting rates of commuters with destinations in low density (5.98%) and peripheral regions (1.3%) are small. Commuters from agglomeration centers are strictly oriented towards urban fringe regions.

Most commuters from low density regions (74.01%) stay in the same spatial category. In any case 12.12% commute in agglomeration centers and 11.8% in urban fringes. However with 2.08% the flows into peripheral regions are very low. Commuters with a place of residence in peripheral regions remain with 75.93% in their spatial category. Into the agglomeration center commute 9.38%, whilst inside urban fringes 6.94%. 7.76% are allotted to low density regions. Commuters from low density and peripheral regions are determined to regions of the same

spatial category. The commuting flows into agglomeration centers and into urban fringes are very low.

The illustrations (Fig. 3, Fig. 4) should point out that there is a connection between employee density and commuting behaviour. To answer this question the employee concentration is put in relation with the commuting rate and the average commuting distance of the 440 German districts (NUTS 3) distinguished in relation to spatial category. Fig. 3 shows a clear connection between employee density and commuting rate. With decreasing employee density commuting rate rises. The differences between the spatial categories are clearly visible. The agglomeration centers show with a high employee density the lowest commuting rates. They concentrate in the left upper area of the illustration. In contrast the employment density in the urban fringes is lower although it is still at a high level. The commuting rates vary between 30% and 60%. The majority of low density and peripheral regions concentrate in the bottom part of the illustration. Even though their employment density is low, their commuting rates are lower than in the agglomeration centers.

In contrast the connection between employment density and average commuting distance is weak. With decreasing employee density the average commuting distance rises slightly (Fig. 4). Indeed, the above described connections between spatial categories can be discovered, however, in total spatial categories are more strongly scattered.

The explanations have shown that there are spatial differences in commuting behaviour. Commuting rates as well as average commuting distances are varying spatially. Frequently they fall together with special spatial categories. Also the consideration of commuting flows shows spatial differences in commuting behaviour. It was shown that the supply of jobs, as a possible spatial explanation variable, has a strong effect on the explanation of the commuting rate. The higher the employee density in a region the lower the commuting rate. This applies in particular to agglomeration centers and low density regions. However this connection is weak for urban fringes and peripheral regions. Thus even urban fringes with high employee density show quite high commuting rates. The reason for this is the immediate spatial neighbouring to agglomeration centers. It was shown that the majority of employees from urban fringes are oriented towards agglomeration centers.

The element of employee density as a means of explaining the average commuting distance is weak. The average commuting distance increases with decreasing employee density in most spatial categories. For agglomeration centers and peripheral regions this connection is not valid. In these regions the average commuting distance increases with employee density. Different commuting distances seem not to be determined by spatial structure. Another explanation is that employees that did not find a suitable job in the agglomeration centers are forced to search beyond the boundaries of their region. This can be put down to the fact that most employment opportunities still can be found in the agglomeration centers. In comparison low density and peripheral regions are offering much lower employment opportunities. Because of that employees have to extend their search to other agglomeration centers. Rather it seems that there must be more reasons to be taken into consideration, for example special regional circumstances like polycentric or monocentric spatial characteristics. Moreover reunification processes could explain differences in commuting distance between West and East Germany to a certain degree. But in this paper they should not be an object of investigation.

2.2. Individual level – personal characteristics

The aim of this section is to shed some light on the contribution of selected individual characteristics to the explanation of commuting behaviour. The illustrations (Fig. 5 and Fig. 6) show whether commuting behaviour differs due to personal characteristics and life phases. Fig. 5 shows the commuting rates dependent on age, Fig. 6 the average commuting distance of employees with different education grades (intermediate school leaving certificate [ISCED[8] 2], university entrance qualification [ISCED 3] and university degree [ISCED 5]) and working hours (full-time, part-time) for the year 2003.

On the whole commuting rates differ strongly between educational grades (Fig. 5). Employees with university degrees show above all age groups with 45.15% the highest commuting rates. While at the beginning of working life the employees show low commuting rates (about 41%), at the end of working life the values rise up to about 48% at the age of 41 years and fall afterwards to about 32%. Employees with university entrance qualifications leave their residential municipality much more seldom (40.67%). In comparison to employees with university degrees their working life begins much earlier. Shortly after work life begins they show a relatively high commuting rate (about 43%). At the age of 36 years it rises up again to about 43% after a decline and falls later successively to about 30%. Employees with intermediate school leaving certificates have the lowest commuting rates (around 33.51%). As noticed earlier at the beginning of work life the commuting rate is also still low. Later at the age of 29 years it rises up gradually to 37%. Then the commuting rate continuously drops down to 25%. Also the displacement of maximal commuting rates between different educational grades has to be examined. While employees with intermediate school leaving certificates reach their maximum at the age of 27 years, employees with university entrance qualifications reach it at the age of 36 years and employees with university degrees at the age of 41 years.

The differences of commuting rates are even stronger if a differentiation between full-time employees and part-time employees is made. In the year 2003 over all age groups 36.49% of the full-time employees were leaving their residence municipality. For part-time employees there were only 26.4%. The curve reaches its maximum between the 33rd and 36th year. Full-time employees have their maximum at about 39%, part-time employees at about 30%. In higher ages the commuting rates fall continuously. Only part-time employees show an increase from 20% to about 25% in the 56th year.

In the case of average commuting distances differences are small (Fig. 6). They commute between 23 km and 28 km. As mentioned for the commuting rates the widest average distances over all age groups are covered by employees with university degrees (28.9 km). Already at the beginning of working life the maximum of 32.3 km is reached (here at 26 years). At the end of work life the average commuting distance decreases continuously up to 28.2 km. With an average commuting distance of 26.37 km between place of residence and work, employees with university entrance qualifications follow. In contrast to employees with university degrees the distances covered by them over all age groups are relatively steady. The maximum of 27.3 km is reached at the beginning of working life. At higher ages the covered distance is levelled out at 25.5 km to 26.5 km. Employees with intermediate school leaving certificates cover an average distance of 23.07 km. Except employees with university degrees the average commuting distance covered by employees rises with increased age.

Full-time employees cover an average commuting distance of 24.49 km which lies above part-time employees with 23.34 km. The average commuting distance of part-time employees

[8] International Standard Classification of Education (ISCED 97)

is 27.3 km at the beginning and 26.5 km at the end of work life above that of full-time employees (24.54 km/ 26.15 km).

The explanations have shown that commuting behaviour of an individual is dependent on educational grade, as well as on an employee's life phase. The higher the educational degree the higher is the commuting rate and the distance covered. On the one hand an educational degree is connected with individual opportunity costs and investments. These have to be compensated later by an adequate employment payment. On the other hand the probability of finding a suitable nearby job decreases with increasing qualification levels. Consequently the employee's searching radius is expanded with increased qualification.

In this part the influence of life phases on commuting behaviour of employees is discussed. At the beginning of working life all educational grades have very low commuting rates. The first job usually is accompanied with a change of place of residence. The change of place of residence is orientated by place of work. Also it is possible that a workplace is searched for near the place of residence - the working place is orientated by the place of residence. Family reasons or employment uncertainty are reasons for such a decision. In both cases commuting rate as well as average commuting distance will be very low.

The following life phase shows rising commuting rates. Typically this life phase is influenced by career opportunities. Professional chances of success are improved through job changes. Because a spatial commitment already exists, with the acceptance of new employment the place of residence is not changed - particularly as it is unclear if the new job is not only a stopover on the career ladder. So the only way to compensate for a change of working place is through commuting.

Consolidation and establishment of the professional life characterise the following life phase. The employee themselves has no need to change his or her job. For the employer it becomes difficult to replace the employee as the period of employment increases. At least in the medium term the working life seems to be predetermined. Up to now the motives of the employee were determining mostly by professional decisions. Now the private life and social connections become more important. Also with increasing age commuting starts to become a health burden. Because of consolidated working situations commuting seems to become unnecessary. The consequence is that the place of residence is influenced by the working place. With increasing age - particularly at the end of the working life - the place of residence is maintained. The main reasons are an increased desire to maintain home ownership and the start of a family life. Also employment doubts are not questioned anymore. If at the end of working life a workplace change becomes unavoidable, long commuting distances are accepted. Fig. 6 shows for all educational grades increasing average commuting distances at the end of working life.

Commuting rates and average commuting distances increase from the 56th year for part-time employees. Responsible for this development are early retirement laws that transform full-time employment into part-time employment. The formerly full-time employees do not break their habits, so they increase the commuting rate and average commuting distances of part-time commuters.

On the whole all educational grades are characterised by the described life phases. However the time of their appearance is different because of the differences in the duration of education. While employees with intermediate school leaving certificates need 10 years for graduation, employees with university entrance qualifications need an additional three years and employees with university degrees need an additional 5 years. The assumption that an

impact of individual characteristics is related to different life phases is basically confirmed in the illustrations by the relations between the education curves.

3. SUMMARY

The results presented in this paper show that there are spatial as well as individual differences in commuting behaviour. In the spatial context the employment density as a chosen indicator was only partly suitable to measure the impact of spatial structure on commuting behaviour. While it was possible to show the influence of spatial structure on commuting rate - the higher the density of employees in a region the lower was the commuting rate - the impact on average commuting distance was weak. While average commuting distance increases with decreasing employee density in urban fringe and low density regions this connection is not valid for agglomeration centers and peripheral regions. In these regions the average commuting distance increases with density of employees. It is assumed that different commuting distances seem not to be strongly determined by spatial structure as understood in this paper. Rather it seems that beyond spatial structure there must be other reasons responsible for the differences in commuting distance. For further investigations the examination of special regional circumstances like polycentric or monocentric spatial characteristics could be a promising approach.

In contrast to spatial level the impact of individual characteristics like age, education and working hours on commuting rate and average commuting distance is much stronger. The higher the educational degree the higher is the commuting rate and the covered distance. Further it was shown that the life phases of employees influence the commuting rate as well as the average commuting distances. After the beginning of working life the commuting rates and average commuting distances are low. Average commuting distances reach at the middle age a temporal maximum and then decrease for a short period and increase again at the end of working life. With increased age commuting rates decrease rapidly after the maximum at middle age. Further investigations have to test the impact of individual characteristics in relation to different spatial categories. How does the probability of a specific individual to commute change in regard to spatial category of place of residence? Moreover it is necessary to prove if spatial structure or individual characteristics are the deciding factors in commuting behaviour.

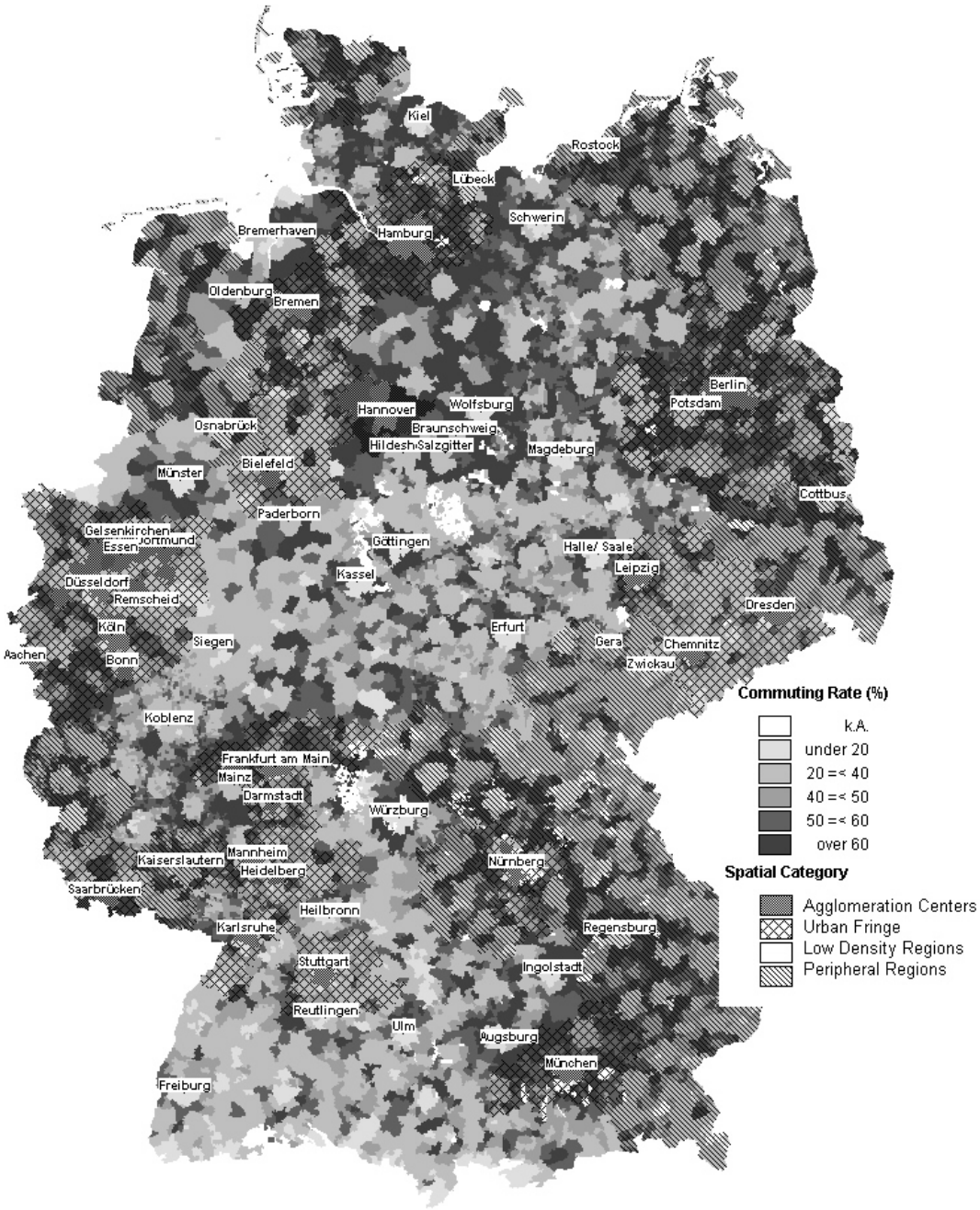
APPENDICES

Tab. 1: Commuting flows by spatial categories

		Place of residence ...				Total	
		Agglomeration Centers	Urban Fringe	Low Density Regions	Peripheral Regions	Commuting rate	Average distance
Place of work ...	Agglomerations						
	- Agglomeration Centers	40,65%	51,68%	6,27%	1,40%	23,47%	64,65 km
	- Urban Fringe	54,67%	38,04%	5,98%	1,30%	47,68%%	38,40 km
	Non Agglomeration Areas						
	- Low Density Regions	12,12%	11,80%	74,01%	2,08%	38,75%	43,38 km
	- Peripheral Regions	9,38%	6,94%	7,76%	75,93%	40,17%	45,93 km
	West Germany					38,33%	44,69 km

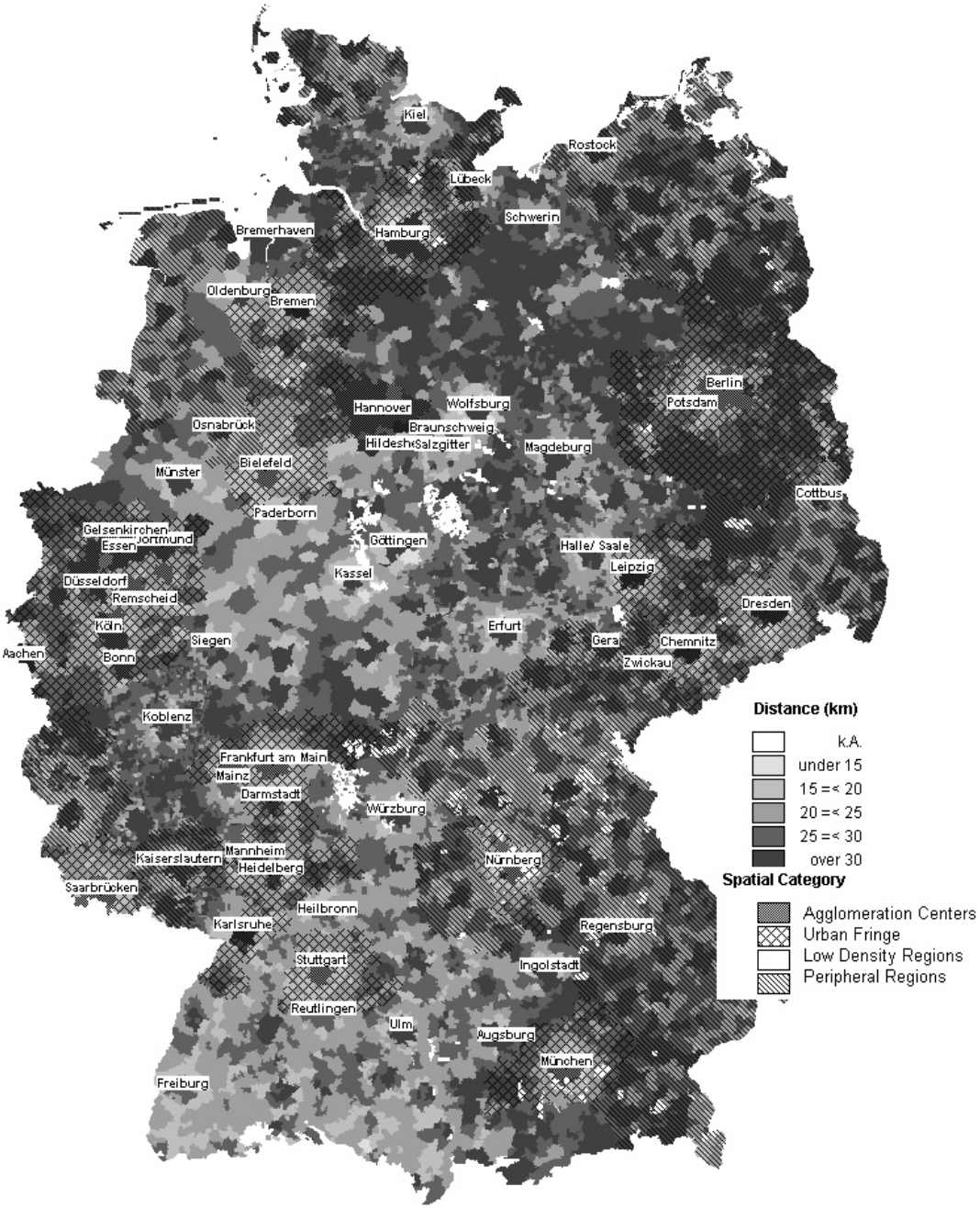
Source: Employment statistic 2003, own calculations.

Fig. 1: Commuting rates by spatial categories (LAU 2)



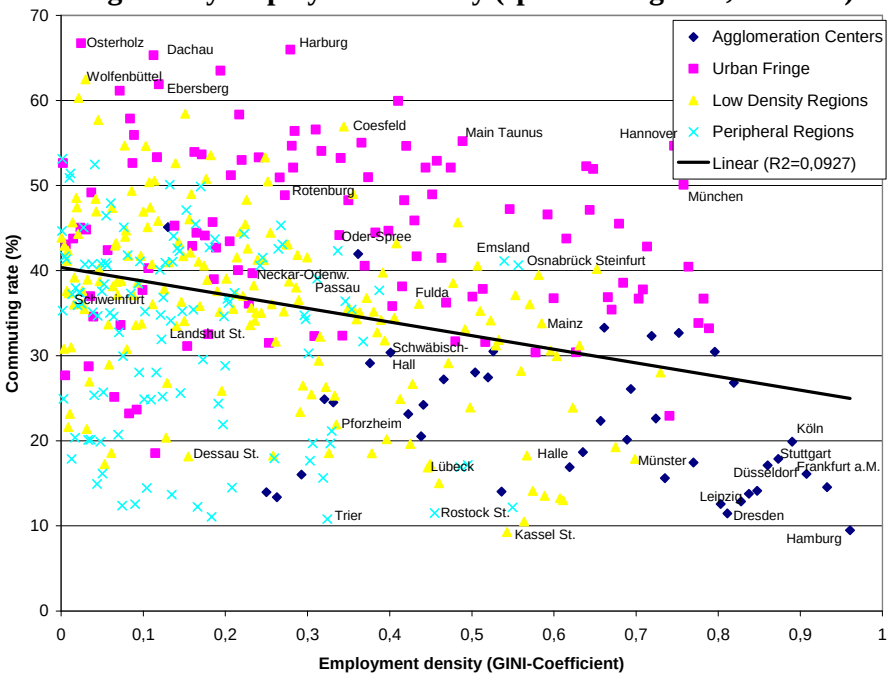
Source: Employment statistic 2003.

Fig. 2: Average commuting distances by spatial categories (LAU 2)



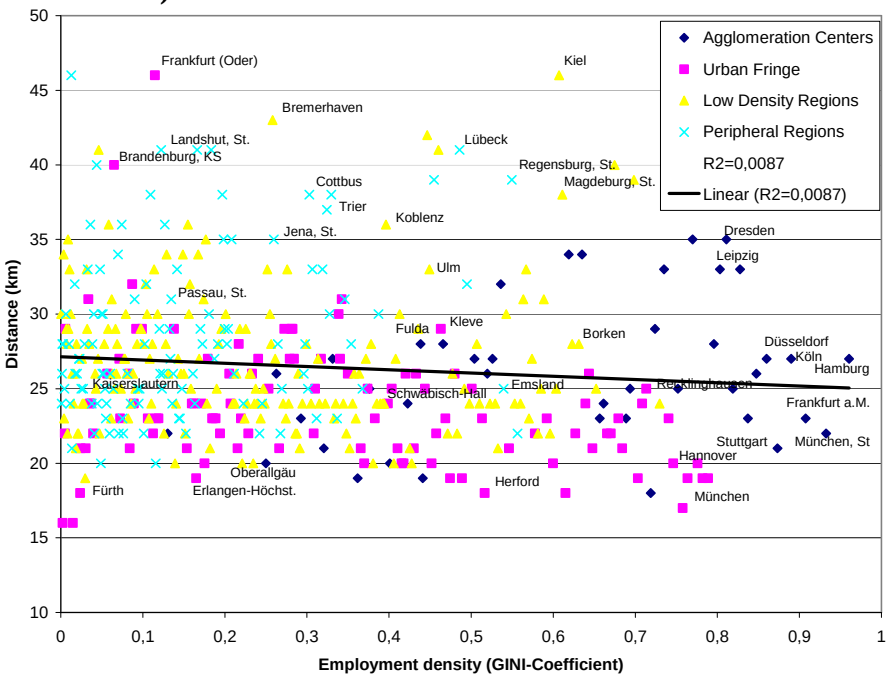
Source: Employment statistic 2003.

Fig. 3: Commuting rate by employment density (spatial categories, NUTS 3)



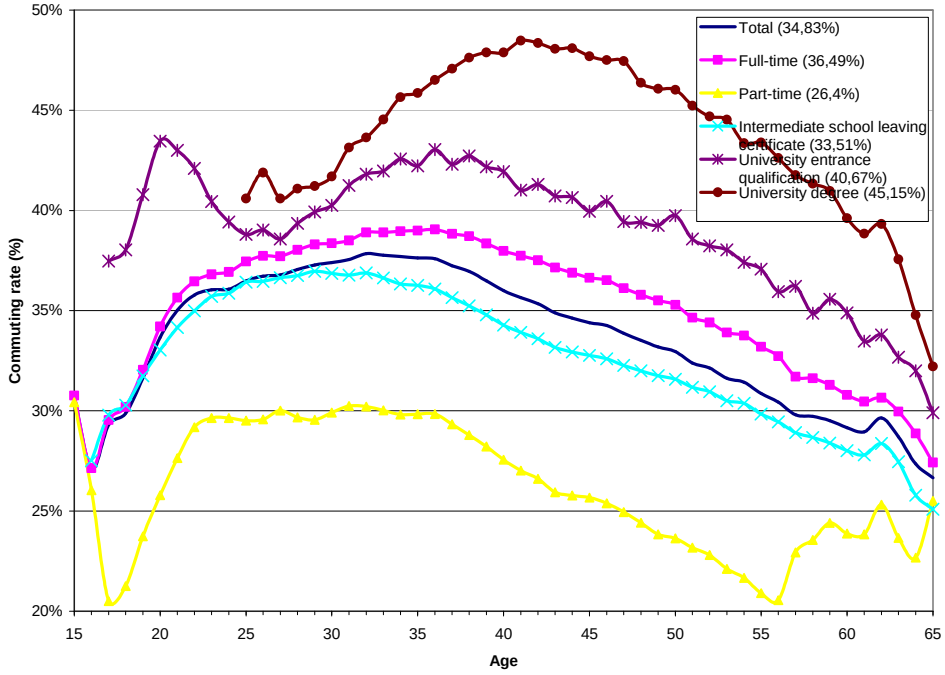
Source: Employment statistic 2003.

Fig. 4: Average commuting distance by employment density (spatial categories, NUTS 3)



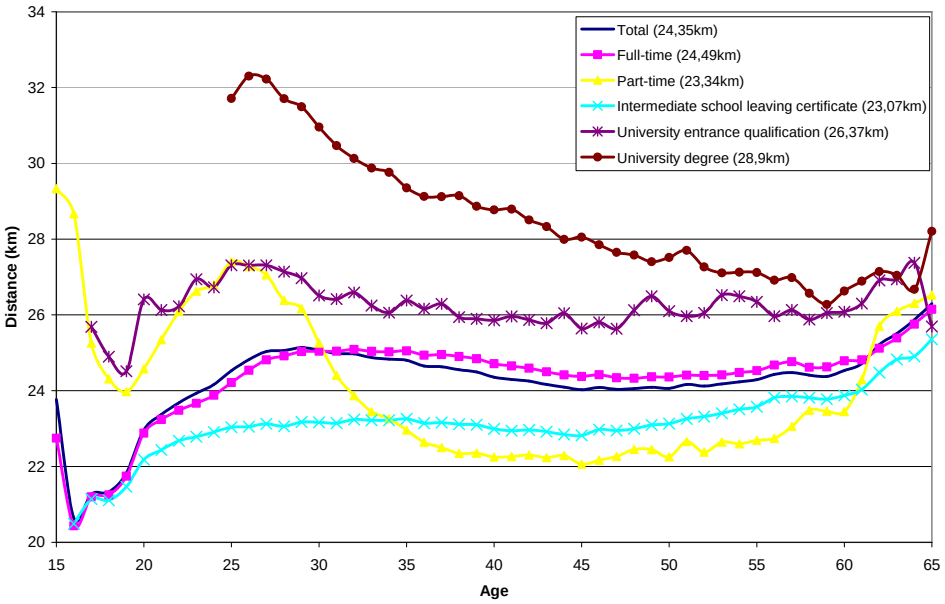
Source: Employment statistic 2003.

Fig. 5: Commuting rate by educational attainment and employment status



Source: Employment statistic 2003.

Fig. 6: Average commuting distance by educational attainment and employment status



Source: Employment statistic 2003.

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