Number of persons commuting to the home borough

150 - 200
200 - 250
250 - 300
300 - 350
350 - 400

Number of persons commuting to another borough

10
50
100

Reinickendorf
Pankow
Lichtenberg
Mitte
Marzahn-Hellersdorf
Spandau
Friedrichshain-Kreuzberg
Charlottenburg-Wilmersdorf
Tempelhof-Schöneberg
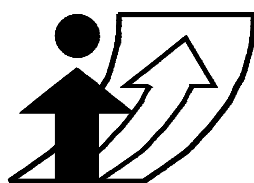Neukölln
Steglitz-Zehlendorf
Treptow-Köpenick

Analyses of commuting distances and times in the household context: The case of Berlin

Sigrun Beige
Institute of Transport Research, German Aerospace Centre, Berlin, Germany

Travel Behaviour Research: Current Foundations, Future Prospects

Analyses of commuting distances and times in the household context: The case of Berlin

Sigrun Beige
Institute of Transport Research
German Aerospace Centre, Berlin, Germany
Phone: 0049-30-67055-346
Fax: 0049-30-67055-283
E-mail: sigrun.beige@dlr.de

Abstract

Commuting is the consequence of a spatial discrepancy between the residential and occupational locations. Commuting distance and time are changed either by residential or occupational mobility. Residential locations are by their very nature chosen at the household level. These joint decisions determine commuting distances and times of each employed household member, leading to a sort of commuting collaboration between the spouses. Multiple-earner households have to adapt their residential location to several occupational locations instead of usually only one. In this context, the commuting distances and times of all concerned household members play a role. Some empirical evidence suggests that there is a trend towards longer average commuting distances and times. In order to better understand commuting behaviour, it is therefore necessary to consider not only the individual but the entire household, taking the situation of all employed household members into account.

The study at hand is based on data of the household mobility survey for cities, which was established in 1972 and aims to create a database of representative travel behaviour (SrV). The SrV survey, which is carried out by the Chair of Transport and Infrastructure Planning at the TU Dresden, collects behavioural data for weekday travel in various cities. Here, the data for Berlin, Germany, from the year 2008 is analysed in detail. The geo-graphical reference for Berlin is its 12 boroughs which are further divided into 195 statistical areas. The so-called Berlin hinterland is composed of 63 municipalities located in the federal state Brandenburg surrounding Berlin. The sample on commuting includes data of about 11'772 individuals in nearly 8'294 households. The workplaces of these individuals are with 93.5% mainly located in Berlin, whereas merely 4.9% commute to the Berlin hinterland and only 0.6% to other municipalities in Brandenburg. The shares of individuals living in households with one employee, two employees or more than two employees amount to 60%, 36% and 4%, respectively.

The empirical analyses start out from statistical explorations of the commuting behaviour in the City of Berlin. Furthermore, models for the commuting distances and times are estimated using regression techniques. The various indicators considered in the analyses include, on the one hand, socio-demographic and socio-economic characteristics of the individual and its household, such as gender, age, education, employment, the ownership of mobility tools (driving licenses, cars and public transport tickets) as well as the household composition and income. The household situation with respect to commuting is taken into account in terms of the sum of the commuting distances and times of all employed household members as well as the share of this sum relating to the respective individual. On the other hand, socio-demographic and socio-economic indicators characterising the place of residence as well as the place of employment are incorporated into the analyses at the level of the

statistical areas of Berlin and the municipalities of Brandenburg. These factors cover information about the population with respect to gender and age, the foreign population, the employment by economic sector, the number of enterprises and their turnover, unemployment rates as well as information on spatial features and land use. Based on this data, densities, various shares and ratios, such as, for instance, the employees-inhabitants-balance, are calculated.

The locations of the home and work place play an important role with respect to the commuting behaviour. On the one hand, a differentiation between East and West Berlin becomes visible. With respect to the distances and times covered on the work trip, a diametrically opposed commuting pattern emerges. Inhabitants of the Eastern part have longer commutes than persons living in West Berlin, whereas employees in East Berlin tend to travel shorter for work purposes than individuals employed in the Western part. Only in the case, that both, home and work place are located within either East or West Berlin, the trips to and from work are likely to be shorter. On the other hand, a place of residence in the inner ring of Berlin is related to shorter commuting trips, while persons living in the outer boroughs cover more distance and time. However, individuals working in the inner ring commute longer.

Comparing the commuting trip in single-, double- and multiple-earner households, certain differences are observable. Both, the average distances and times are considerably longer, as the number of employees within a household increases. The household context has a significant impact on the commute of an individual. Both, the summarised distances and times covered by other employees in the household show a positive effect, indicating that the commuting burden is more or less equally distributed among all household members.

The paper will provide a brief review of the literature on commuting, followed by a description of the data used for the empirical analyses. The main part will then concentrate on statistical explorations describing commuting behaviour in the City of Berlin, accompanied by the results of a number of regression models for the commuting distances and times. Finally, conclusions will be presented.

Keywords
Commuting behaviour, commuting distance, commuting time, linear regression analyses, household context, single- and multiple-earner households

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1. Introduction

Commuting is the consequence of a spatial discrepancy between the residential and occupational locations (Rouwendal and van der Vlist, 2005). Commuting distance and time are changed either by residential or occupational mobility. Altering the place of occupation over a long distance necessitates a residential move, whereas for shorter residential moves, i.e., within a housing and labour market area, it is generally possible to choose the residential location without reference to the occupational location, at least, when the commuting distance and time are not too long (Dieleman, 2001). The literature indicates that, besides the spatial structure and built environment in which people reside and work, the characteristics of individuals and their household context have a strong influence on commuting distances and times (for example, Gordon, Kumar and Richardson, 1989; Schwanen, Dieleman and Dijst, 2003; Schwanen and Dijst, 2002; Susilo and Maat, 2007). The household plays a central role, because it implies complex compromises of the individuals involved (Kaufmann, 2002). Residential locations are by their very nature chosen at the household level. These joint decisions determine commuting distances and times of each employed household member, leading to a sort of commuting collaboration between the spouses (Plaut, 2006). Multiple-earner households have to adapt their residential location to several occupational locations instead of usually only one. In this context, the commuting distances and times of all concerned household members play a role (Plaut, 2006; Van Ommeren, 2000). Some empirical evidence suggests that there is a trend towards longer average commuting distances and times (Rouwendal and Rietveld, 1994; Surprenant-Legault and El-Geneidy, 2010). However, this does not necessarily imply that all individuals living in multiple-earner households have commutes that are any longer than the overall average (Rouwendal and Rietveld, 1994). This is due to one of the strategies adopted by multiple-earner households to minimise the sum of distances between home and workplaces, by locating at least one of the workplaces close to home (Surprenant-Legault and El-Geneidy, 2010). In contrast, Plaut (2006) reports that commuting distances and times within a household appear to be strongly complementary with one another, meaning that commute trips are adjusted jointly, i.e., made longer or shorter together. Many of the factors explaining commuting patterns affect employed household members in similar ways (Plaut, 2006).

Dieleman (2001), Surprenant-Legault and El-Geneidy (2010), Van Ommeren (2000) as well as Van Ommeren, Rietveld and Nijkamp (1998) find that multiple-earner households move less frequently, facing more constraints, as they are more closely bound to their place of residence than single-earner households (Clark and Davies Withers, 1999). Findings by Rouwendal and Van Der Vlist (2005), however, show that multiple-worker household appear to be much more mobile, suggesting a more flexible behaviour with respect to locational choices.

In order to better understand commuting behaviour, it is therefore necessary to consider not only the individual but the entire household, taking the situation of all employed household members into account.

2. Data

The study at hand is based on data of the household mobility survey for cities, which was established in 1972 and aims to create a database of representative travel behaviour (SrV). The SrV survey, which is carried out by the Chair of Transport and Infrastructure Planning at the TU Dresden, collects behavioural data for weekday travel in various cities. Here, the data for Berlin, Germany, from the year 2008 is analysed in detail. The geographical reference for Berlin is its 12 boroughs which are further divided into 195 statistical areas. The so-called Berlin hinterland is composed of 63 municipalities located in the federal state Brandenburg surrounding Berlin. Figure 1 shows the City of Berlin and its 12 boroughs.
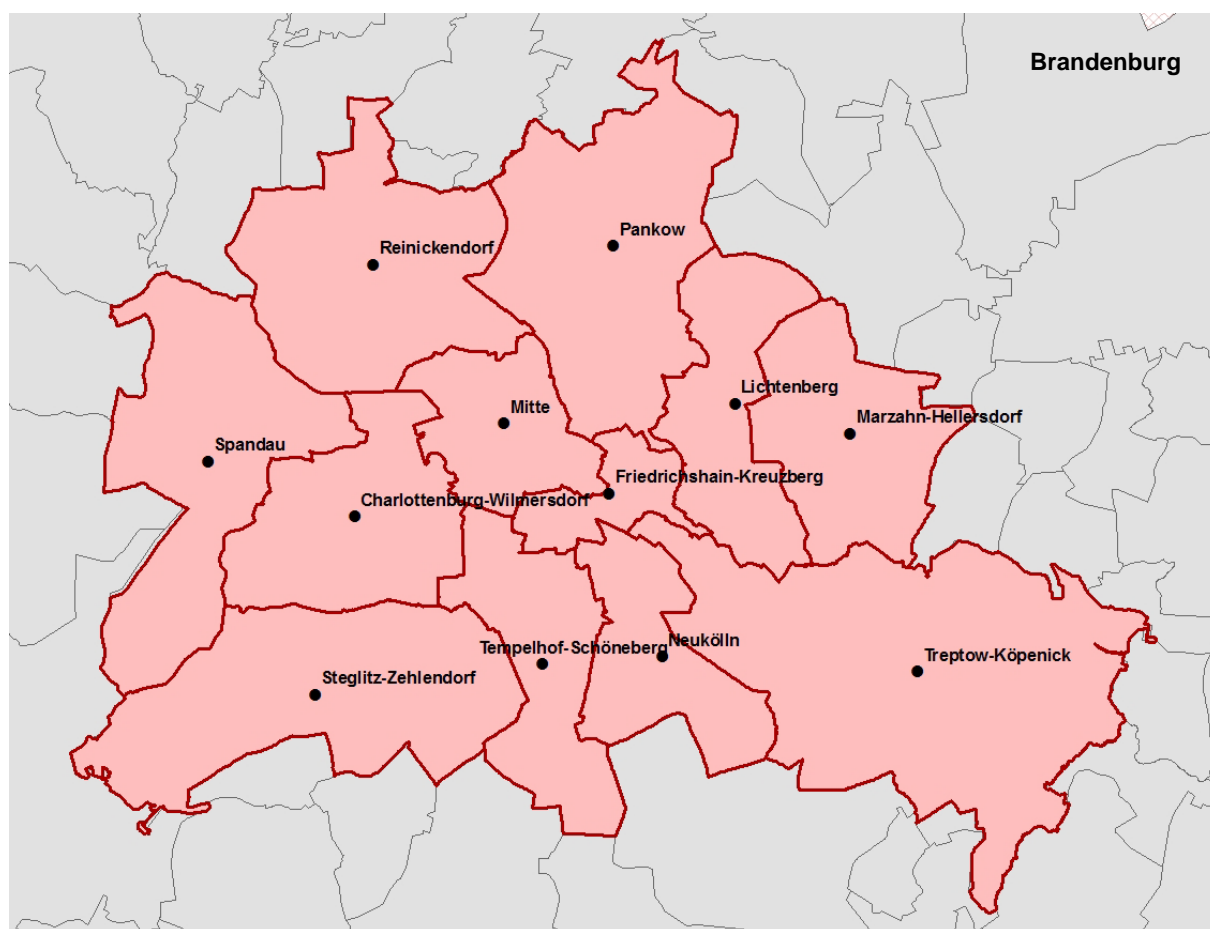

Figure 1   The City of Berlin and its 12 boroughs

Overall, the sample includes data of about 39'000 individuals in nearly 18'400 households. These individuals reported approximately 107'000 trips on their diary day. In order to examine the commuting behaviour with respect to the covered distances and times, only persons with directly observed trips from home to work or from work to home are included in the analyses. Then, the sample includes 11'772 individuals which live in 8'294 households. The workplaces of these individuals are with 93.5% mainly located in Berlin, whereas merely 4.9% commute to the so-called Berlin hinterland and only 0.6% to other municipalities in Brandenburg. The shares of individuals living in households with one employee, two employees or more than two employees amount to 60%, 36% and 4%, respectively.

3.   Results

3.1   Commuting in the City of Berlin

In a first step, the general commuting behaviour and relationships within the City of Berlin are described. In Figure 2, the relations between the locations of the home and work place of the respondents are presented on the level of the 12 boroughs of Berlin. Mitte and Charlottenburg-Wilmersdorf are the boroughs where most of the work places are located. These are also the two boroughs where the highest numbers of persons living and working in their home borough are found, followed by the borough Pankow. The strongest commuting connection exists between residents in Pankow and places of employment in Mitte.
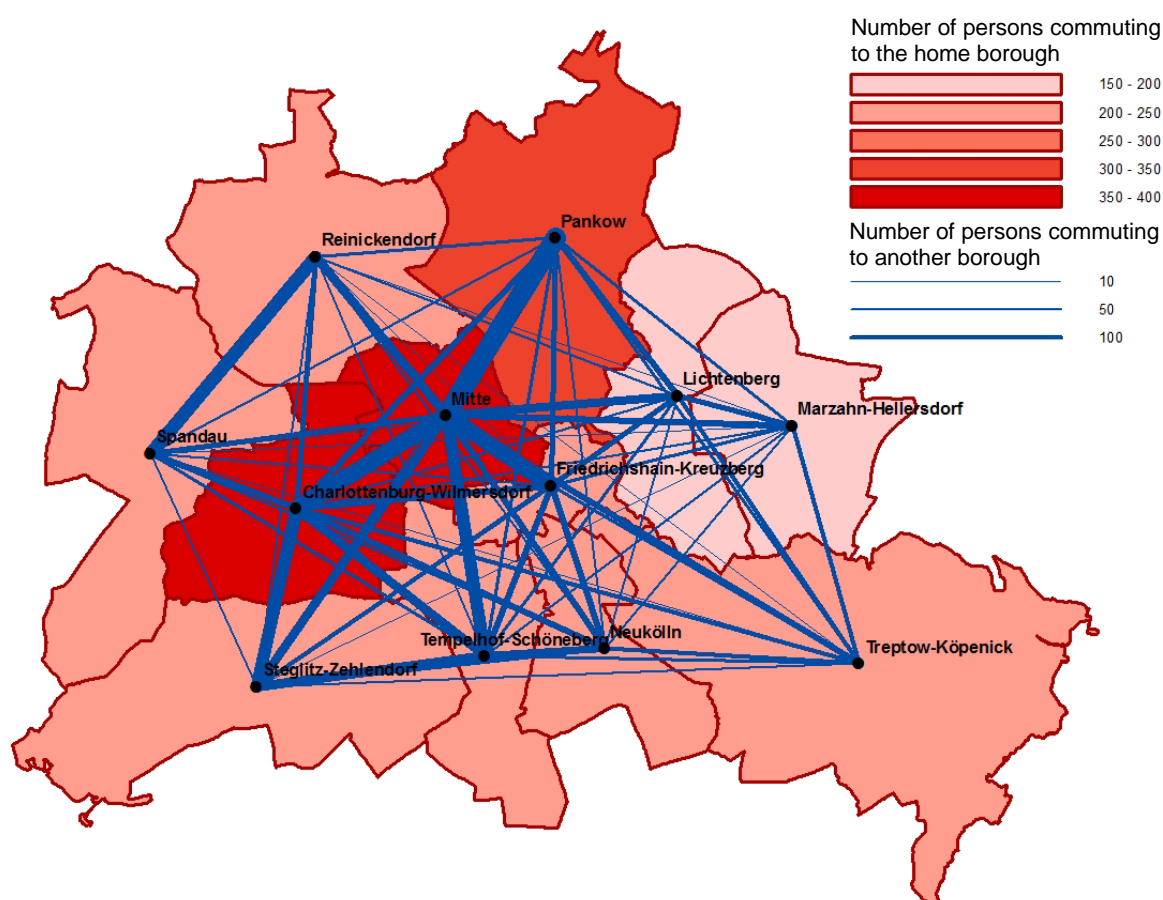

Figure 2   Commuting in the City of Berlin

Overall, 28.5% of the respondents live and work in the same borough. Mitte, Spandau and Charlottenburg-Wilmersdorf show with nearly 40% of their inhabitants the highest shares. The lowest shares, only amounting to around 20%, are found in Lichtenberg and Marzahn-Hellersdorf in East Berlin.

Table 1 shows the results of a binary logistic regression for the case that the home and work place are located in the same of the 12 boroughs.

Table 1   Binary logistic regression for home and work locations within the same borough

Explanatory variables	Regression coefficient	Significance
Person related variables		
Highest school graduation: Graduation from secondary general school	+ 0.237	0.019
Employment: Full-time	− 0.281	0.000
Part-time (less than 18 hours per week)	+ 0.403	0.005
Car driving licence ownership	− 0.169	0.030
Car availability: unrestricted	− 0.342	0.000
Public transport ticket ownership: high commitment	− 0.850	0.000
Household related variables		
Age in years of the oldest household member	+ 0.011	0.000
Monthly net income in 1'000 €	− 0.142	0.000
Monthly equivalent net income in 1'000 €squared	+ 0.037	0.005
Variables describing the home place *(on the level of the statistical areas or boroughs, respectively)*		
Density of inhabitants per hectare	− 0.006	0.000
Number of employees per inhabitant	− 0.139	0.001
Site occupancy index (without subsidiary building)	+ 2.038	0.006
Home place located in the borough Mitte as referential category		0.000
Home place located in the borough Friedrichshain-Kreuzberg	+ 0.031	0.743
Home place located in the borough Pankow	− 0.451	0.000
Home place located in the borough Charlottenburg-Wilmersdorf	+ 0.594	0.000
Home place located in the borough Spandau	+ 0.348	0.000
Home place located in the borough Steglitz-Zehlendorf	+ 0.033	0.695
Home place located in the borough Tempelhof-Schöneberg	− 0.018	0.829
Home place located in the borough Neukölln	− 0.194	0.022
Home place located in the borough Treptow-Köpenick	− 0.224	0.012
Home place located in the borough Marzahn-Hellersdorf	− 0.650	0.000
Home place located in the borough Lichtenberg	− 0.527	0.000
Home place located in the borough Reinickendorf	+ 0.188	0.040
Home place located in the inner ring of Berlin	+ 0.184	0.021
Variables describing the work place *(on the level of the statistical areas or boroughs, respectively)*		
Share of inhabitants aged 65 years and older	− 1.693	0.001
Unemployment: Rate of unemployment with respect to all civilly employed persons	+ 5.869	0.000
Share of unemployed persons aged from 15 to 65 years	+ 4.345	0.000
Mean monthly net income per capita	+ 0.002	0.000
Volume of migration in % of the number of inhabitants of the previous year	− 0.846	0.001

Table 1 is continued …

Table 1 continued ...

Explanatory variables	Regression coefficient	Significance
Density of inhabitants and employees per hectare	+ 0.004	0.000
Density of employees per hectare	– 0.003	0.001
Land use:		
Share of the area dedicated to settlement and transport	– 2.051	0.000
Share of the area dedicated to buildings and their surroundings	+ 1.623	0.000
Share of the area dedicated to supply and disposal facilities	– 4.567	0.000
Site occupancy index (without subsidiary building)	– 0.456	0.006
Work place located in East Berlin	+ 0.730	0.000
Work place located in the inner ring of Berlin	– 0.405	0.000
Further variables		
Constant	– 1.998	0.000
Number of observations		9716.668
L(0)		– 5625.590
L(max)		– 5123.885
Nagelkerke ρ^2		0.178

Individuals with a comparatively low school graduation are more likely to live and work in one borough. With a decreasing degree of employment, persons tend to work closer to home, concurrent with the expectation. The ownership of a driving licence as well as unrestricted access to a car is associated with a lower propensity to have a work place which is located within the home borough. This also applies to the ownership of public transport tickets with a high commitment, which include monthly, yearly and job tickets. The older a household or the oldest household member, respectively, the more likely individuals are to stay in their home borough for work purposes. The monthly net income of a household has a negative influence on the probability that people live and work in the same borough of Berlin, whereas the squared monthly equivalent net income, using the OECD-modified equivalence scale, has the opposite effect. Overall, the household income shows a positive association. This is due to the fact that Mitte and Charlottenburg-Wilmersdorf, where most of the work places, especially higher-level work places are located, are also the boroughs where living is more expensive.

Regarding the variables describing the home and work place, the job-housing-balance, i.e., the number of jobs per number of inhabitants (Susilo and Maat, 2007), in the residential statistical area has surprisingly a negative influence. This might be due to the fact that the number of jobs and the number of inhabitants are not necessarily balanced with respect to the qualification. Mainly the statistical areas lying in the inner ring of Berlin show a high value for the job-housing balance. These are also the statistical areas with a high density of inhabitants per hectare. This variable also has a negative effect on the likelihood to work in the home borough. With increasing intensity of land use, expressed by the site occupancy index, the propensity to live and work in the same borough rises. With respect to the location of the home place, a differentiation between East and West Berlin becomes visible. Persons residing in boroughs in East Berlin tend not to work there, whereas in West Berlin the opposite is observable, with the only significant exemption being the borough Neukölln,

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which is one of the social focuses of Berlin (Häussermann, Werwatz, Förste and Hausmann, 2010). Individuals living in the inner ring of Berlin are more likely to commute within the same borough. A high share of retirees living in the statistical area where the work place of an individual is located decreases the probability to live and work in the same borough, while high unemployment increases this probability. The mean monthly net income also has a positive influence. With a higher volume of migration, indicating boroughs that develop more dynamically, the propensity to have a work place in the home borough is reduced. The combined density of inhabitants and employees per hectare in the statistical area of the work place positively influences the likelihood to reside there too, whereas the density of employees shows the opposite relationship. The intensity of land use shows in general a negative effect. Persons working in East Berlin tend to live in the same borough, while employees in the inner ring of Berlin are more likely to live in another borough.

3.2   Commuting distances and times

As one expects, commuting distances and times are significantly shorter when individuals both, live and work in the same borough of Berlin, being consistent with results of Wang and Chai (2009). In this case, the mean distance amounts to 5.2 kilometres and the mean time to 18.9 minutes, whereas these values are 13.4 kilometres and 37.2 minutes, respectively, when persons commute to another borough. Overall, the average distance and time travelled to a work place located within Berlin are 11.1 kilometres and 32.1 minutes.

Significant differences are also observable between the various boroughs of Berlin. People residing in Friedrichshain-Kreuzberg, Tempelhof-Schöneberg, Mitte, Pankow, Charlotten-burg-Wilmersdorf and Neukölln show the shortest commuting trips with respect to the distance covered. The longest trips are found for the inhabitants of Treptow-Köpenick and Marzahn-Hellersdorf. Interestingly, regarding the commuting times, this sequence varies slightly. Charlottenburg-Wilmersdorf, Tempelhof-Schöneberg, Mitte, Friedrichshain-Kreuz-berg, Neukölln, Steglitz-Zehlendorf and Reinickendorf, mainly boroughs located in West Berlin, show commuting time values below the overall average of 34.5 minutes. The longest durations are observed for persons living in Treptow-Köpenick, Lichtenberg and Marzahn-Hellersdorf. These three boroughs are situated in the Eastern part of Berlin. Considering the locations of the work place, the picture is different again. Friedrichshain-Kreuzberg, Marzahn-Hellersdorf, Pankow, Lichtenberg and Mitte then show the shortest commuting distances, while persons working in Steglitz-Zehlendorf, Reinickendorf and Spandau travel the farthest. With respect to the commuting time, Marzahn-Hellersdorf, Lichtenberg, Pankow and Friedrichshain-Kreuzberg have the lowest values. Employees in Charlottenburg-Wilmersdorf, Mitte and Spandau spend the longest times travelling to work. Persons living in Berlin and commuting to places outside of Berlin exhibit overall the longest work trips.

In Figure 3, the distributions of the commuting distances and times for all Berlin respondents are shown. Overall, the mean commute is 14.3 kilometres long, with a standard deviation of 26.4 kilometres, and takes 34.5 minutes, with a standard deviation of 24.2 minutes. The distribution of the distances is very strongly left-skewed. 20% of all commutes are shorter than 5 kilometres, 45% shorter than 10 kilometres and 65% shorter than 15 kilometres. The commuting times are more normally distributed, though it becomes visible that individuals tend to report quarter hours, especially for longer commutes (30, 45, 60, 75, 90 and 120 minutes).

Over 40% of all work places are reached within 30 minutes. Only 7% of the employed respondents commute longer than one hour and only 0.5% even longer than two hours.

Number of observations:	11645
Mean:	14.288
Standard deviation:	26.372

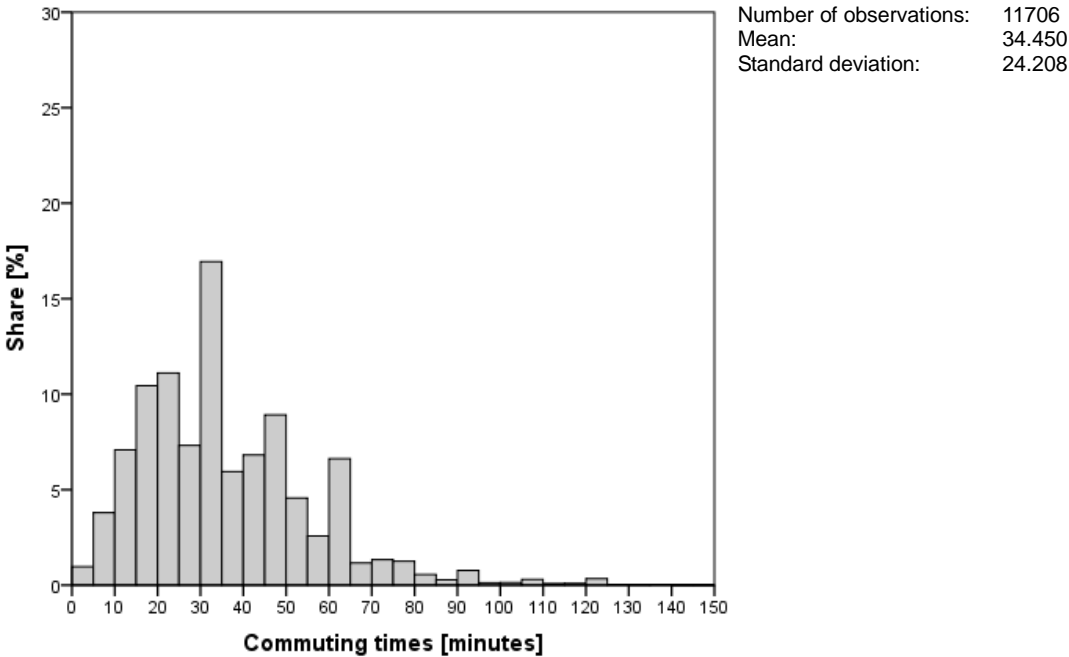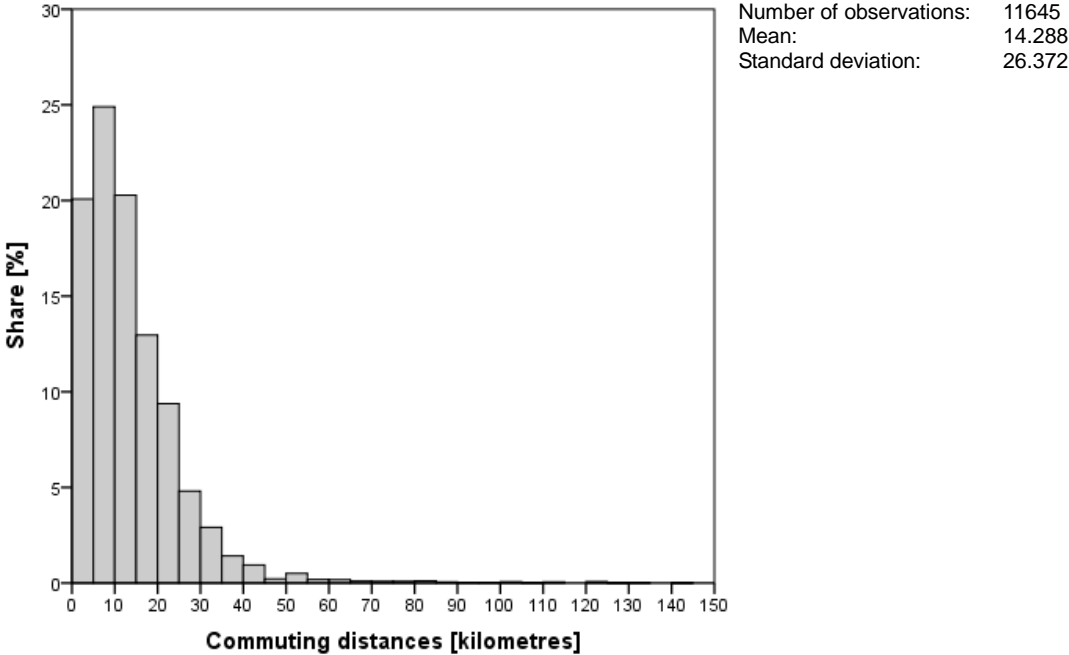|	
Number of observations:	11706
Mean:	34.450
Standard deviation:	24.208

Figure 3   Distribution of the commuting distances and times

Table 2 presents the results of a linear regression model for the commuting distances of the Berlin residents.

The higher the level of education, the longer are the distances travelled for commuting, which is found by Susilo and Maat (2007) as well. Individuals working full-time also tend to work farther away from their place of residence, whereas part-time employees with less than 18 hours per week show the opposite behaviour, concurrent with the expectations and the results

of Giuliano (1998) and Lee and McDonald (2003). A car with unrestricted access is related to longer commutes, supporting findings by Cervero and Duncan (2006). This also applies to the ownership of the public transport tickets indicating a high commitment, while public transport tickets with a low or short-term commitment have a negative effect. With increasing age of the oldest household member, the commuting distances decrease. The number of male adults in the household shows the same influence. An increase in the squared monthly net income of a household increases the length of the work trip, while the squared monthly equivalent net income has the opposite effect. Overall, the relationship is negative. A higher number of cars available in a household is associated with longer commuting distances, concurrent with results of Cervero and Duncan (2006), whereas an increasing number of operable bicycles leads to shorter work trips. The sum of the commuting distances of other employed household members has a positive effect, indicating that the commuting burden is more or less equally distributed among all household members, confirming results by Plaut (2006).

Comparing the various explanatory variables describing the home place and the work place with one another, mainly contrarian influences are observable, with the exception of the income level and the land use variables. This means that the statistical areas in which the home place and the work place are located tend to have different characteristics. With an increasing share of inhabitants aged less than 6 years in the residential statistical area, the length of the commuting trip decreases, while the shares of persons aged less than 18 years and from 18 to 29 years have a positive effect on this distance. This means that households with small children tend to commute to places closer to their homes. The share of male inhabitants increases the distances. An increase in the share of people with migration background leads to shorter commuting trips, but not when these people are younger than 18 years. The mean monthly net income per capita at the home place increases the probability to commute farther. Again, the job-housing-balance has, contrary to the expectation, a positive effect on the distance travelled to work. In the literature, findings by Cervero and Duncan (2006), Susilo and Maat (2007) as well as by Zhao, Lü and De Roo (2011) confirm that an increase in job accessibility shortens the commuting trip, whereas Giuliano and Small (1993), Miller and Ibrahim (1998) as well as Peng (1997) found that the job-housing-balance has only little influence on commuting. However, in all these studies, the job-housing-balance is measured differently. The approaches most similar to the one applied in this study are used in the latter group which found no noticeable effect. The size of the enterprises shows a negative influence, as does the number of enterprises per inhabitant, whereas a higher enterprise density per hectare, probably pointing to more commercially used premises, increases the length of the commuting trip. With a higher turnover per employee, the commuting distances tend to be shorter. The site occupancy index as well as the share of the area dedicated to settlement and transport has a negative influence, while the share of the area dedicated to supply and disposal facilities shows the opposite effect. With respect to the borough Mitte as referential category, only persons living in Friedrichshain-Kreuzberg, another borough almost completely located in the inner ring of Berlin, have shorter commuting distances. The other boroughs with a significant influence are situated in the outer areas of Berlin and exhibit, in comparison to Mitte, longer lengths for the commuting trip. This also applies to people living in the Eastern part of Berlin. The share of young adults, aged from 18 to 29 years, living in the statistical area where the work place is located leads to shorter commuting trips, as does the share of male inhabitants. With an increasing share of foreign nationals, the distance travelled for work purposes rises, whereas the share of inhabitants with migration background shows the opposite effect. Higher unemployment in the statistical area of the work place is related to shorter work trips, or the other way around, people tend to commute to closer work

destinations when this destination is located in an area with higher unemployment. Concurrent with this context, the mean monthly net income per capita has a positive influence. The size of the statistical area of the work place, expressed by the number of inhabitants and the number of employees, leads to longer commuting trips. A higher share of employees working in the tertiary or service sector reduces the distance travelled to work. With an increasing number of enterprises situated in the statistical area where the work place is located, the commuting trip tends to be shorter, while the turnover generated by these enterprises in total as well as with respect to the number of inhabitants has the opposite effect. Regarding the land use, the share of the area dedicated to buildings and their surroundings has a negative influence, whereas the share of the area dedicated to supply and disposal facilities increases the commuting distances, as these facilities tend to be rather land consuming. In the case that both, home and work place are located within either East or West Berlin, the trip lengths are likely to be shorter.

Table 2   Linear regression for the commuting distances

Explanatory variables	Non-standardised regression coefficient	Standardised regression coefficient	Significance
Person related variables			
Highest school graduation: Graduation from secondary intermediate school	+ 0.767	+ 0.045	0.000
Highest professional education: Apprenticeship, vocational school, business school	– 0.372	– 0.022	0.053
Technical college, college of cooperative education	– 0.691	– 0.027	0.005
Employment: Full-time	+ 0.598	+ 0.033	0.000
Part-time (less than 18 hours per week)	– 1.538	– 0.030	0.001
Car availability: unrestricted	+ 0.653	+ 0.041	0.001
Public transport ticket ownership: low commitment	– 1.053	– 0.066	0.000
Public transport ticket ownership: high commitment	+ 2.125	+ 0.133	0.000
Household related variables			
Age in years of the oldest household member	– 0.023	– 0.032	0.000
Number of male adults	– 0.372	– 0.027	0.007
Monthly net income in 1'000 €squared	+ 0.066	+ 0.048	0.003
Monthly equivalent net income in 1'000 €squared	– 0.180	– 0.058	0.000
Number of cars	+ 0.934	+ 0.087	0.000
Number of operable bicycles	– 0.187	– 0.035	0.001
Household context related variables			
Sum of commuting distances of other household members	+ 0.011	+ 0.025	0.006

Table 2 is continued …

Table 2 continued ...

Explanatory variables	Non-standardised regression coefficient	Standardised regression coefficient	Significance
Variables describing the home place *(on the level of the statistical areas or boroughs, respectively)*			
Share of inhabitants aged under 6 years	– 96.219	– 0.144	0.000
Share of inhabitants aged under 18 years	+ 61.865	+ 0.199	0.000
Share of inhabitants aged from 18 to 29 years	+ 9.117	+ 0.057	0.001
Share of male inhabitants	+ 19.962	+ 0.045	0.005
Share of inhabitants with migration background	– 7.105	– 0.126	0.000
Share of inhabitants with migration background aged under 18 years	+ 1.051	+ 0.028	0.021
Mean monthly net income per capita	+ 0.002	+ 0.027	0.080
Number of employees per inhabitant	+ 0.979	+ 0.113	0.000
Number of employees per enterprise	– 0.106	– 0.091	0.000
Density of enterprises per hectare	+ 0.171	+ 0.096	0.001
Number of enterprises per inhabitant	– 16.711	– 0.076	0.000
Turnover of enterprises in 1'000'000 €per employee	– 2.336	– 0.030	0.004
Land use: Share of the area dedicated to settlement and transport	– 1.210	– 0.023	0.107
Share of the area dedicated to supply and disposal facilities	+ 10.866	+ 0.023	0.016
Site occupancy index (without subsidiary building)	– 10.748	– 0.110	0.000
Home place located in the borough Mitte as referential category			
Home place located in the borough Friedrichshain-Kreuzberg	– 0.493	– 0.017	0.181
Home place located in the borough Spandau	+ 1.478	+ 0.042	0.000
Home place located in the borough Neukölln	+ 1.489	+ 0.052	0.000
Home place located in the borough Treptow-Köpenick	+ 3.825	+ 0.124	0.000
Home place located in the borough Marzahn-Hellersdorf	+ 2.494	+ 0.082	0.000
Home place located in the borough Reinickendorf	+ 0.852	+ 0.026	0.010
Home place located in East Berlin	+ 2.742	+ 0.170	0.000
Home place located in the inner ring of Berlin	– 1.091	– 0.067	0.000
Variables describing the work place *(on the level of the statistical areas or boroughs, respectively)*			
Share of inhabitants aged from 18 to 29 years	– 4.459	– 0.028	0.058
Share of male inhabitants	– 26.084	– 0.060	0.000
Share of foreign nationals	+ 14.932	+ 0.196	0.000
Share of inhabitants with migration background	– 7.673	– 0.145	0.000
Unemployment: Share of unemployed persons aged from 15 to 65 years	– 4.889	– 0.030	0.005
Mean monthly net income per capita	+ 0.004	+ 0.064	0.000

Table 2 continued ...

Explanatory variables	Non-standardised regression coefficient	Standardised regression coefficient	Significance
Number of inhabitants in 1'000	+ 0.020	+ 0.071	0.000
Number of employees in 1'000	+ 0.065	+ 0.109	0.000
Share of employees working in the tertiary sector	− 2.007	− 0.042	0.000
Number of enterprises in 1'000	− 0.571	− 0.111	0.000
Turnover of enterprises in 1'000'000 €	− 0.000	− 0.084	0.002
Turnover of enterprises in 1'000'000 €per inhabitant	+ 1.673	+ 0.036	0.080
Land use: Share of the area dedicated to buildings and their surroundings Share of the area dedicated to supply and disposal facilities	− 2.495 + 7.441	− 0.041 + 0.032	0.000 0.001
Variables describing the home and work place			
Home and work place located in East Berlin	− 7.090	− 0.380	0.000
Home and work place located in West Berlin	− 3.319	− 0.208	0.000
Further variables			
Constant	+ 11.967		0.026
Number of observations			9647.000
Adjusted ρ^2			0.310

In Table 3, the corresponding outcome of a linear regression for the commuting times is shown.

In comparison to the model for the commuting distances, the results are, as expected, very similar, since distance and time travelled are strongly related to one another. Nevertheless, some differences become apparent. For instance, gender (being male) has a negative effect on the commuting times, whereas there is no significant connection to the travelled distance observed. This indicates that men tend to spend less time commuting, but do not necessarily cover shorter distances in this context. However, in the literature, it is widely stated that the work trips of women are normally shorter than that of men (for example, Lee and McDonald, 2003; Madden, 1981; Susilo and Maat, 2007). In this study, this association is perhaps obscured by other variables. A lower level of professional education shows the same negative relationship, as does a lower level of employment, again confirming results of Giuliano (1998), Lee and McDonald (2003) as well as of Susilo and Maat (2007). One obvious difference between the two models concerns the driving licence ownership and the car availability. Both variables have a negative effect on the time spent for the commute, while the corresponding distance is increased by an available car with unrestricted access. This is related to the higher speed associated with motorised private transport. This does not apply to public transport. In both models, the ownership of public transport tickets with a high commitment shows a positive influence. Interestingly, an increasing household income decreases the commuting time, being consistent with findings by Gordon *et al.* (1989) as well as by Zhao *et al.* (2011). More cars in a household lead to longer commuting trips, both with

respect to distance and time covered, confirming results of Cervero and Duncan (2006). Again, the summarised times spent commuting by other employees in the household have a positive effect. Additionally, a higher number of household members with a work place is connected to shorter trips for the individual.

With respect to the explanatory variables describing the home and work place, the share of inhabitants aged less than 18 years in the residential statistical area influences the commuting times in a positive way, while the share of inhabitants aged from 30 to 64 years has the opposite effect. An increasing share of persons with a migration background leads to less time spent on the trip to work. In comparison to the share of employees working in the public domain of the tertiary sector, the share of employees working in the trade, accommodation and restaurant business has a positive and the share of employees working in the transport, communication, finance and insurance business a negative impact. With increasing density of employees per hectare, the propensity to commute longer is reduced. Regarding the home location, persons living in the outer boroughs spent more time on the commuting trip, in comparison to the referential borough Mitte in the centre of Berlin. Consistent with this finding, a place of residence in the inner ring is also related to shorter commuting times. The share of male inhabitants living in the statistical area where the work place is located has a negative influence on the time spent in order to travel to work, as does the rate of unemployment. A higher migration balance, indicating a dynamic area, leads to longer commuting times. The share of employees working in the tertiary or service sector as well as the density of inhabitants and employees and the density of enterprises show a negative effect. Considering the land use, the share of the area dedicated to buildings and their surroundings, once again, decreases the commuting times, while the share of the area dedicated to supply and disposal facilities has a positive influence. A higher intensity of the land use, expressed by the floor space index, raises the probability to travel longer to work. Employees in East Berlin tend to live closer to their work place, whereas persons working in the inner ring of Berlin commute longer. As in the model for the commuting distances, the parameters for the two variables indicating that the home and work place are both situated in the Eastern or Western part, respectively, show a negative sign.

Table 3   Linear regression for the commuting times

Explanatory variables	Non-standardised regression coefficient	Standardised regression coefficient	Significance
Person related variables			
Gender (male)	− 1.382	− 0.036	0.000
Highest professional education: Apprenticeship, vocational school, business school	− 0.896	− 0.022	0.013
Employment: Employed	+ 2.275	+ 0.031	0.001
Part-time (less than 18 hours per week)	− 4.185	− 0.035	0.000

Table 3 is continued …

Table 3 continued ...

Explanatory variables	Non-standardised regression coefficient	Standardised regression coefficient	Significance
Car driving licence ownership	− 1.577	− 0.028	0.003
Car availability: unrestricted	− 1.977	− 0.052	0.001
Car availability: no car	+ 0.362	+ 0.027	0.093
Public transport ticket ownership: high commitment	+ 11.087	+ 0.290	0.000
Household related variables			
Number of adults	+ 1.104	+ 0.044	0.000
Monthly net income in 1'000 €squared	− 0.099	− 0.030	0.006
Number of cars	+ 1.265	+ 0.049	0.001
Household context related variables			
Number of household members with work place	− 2.977	− 0.091	0.000
Sum of commuting times of other household members	+ 0.069	+ 0.092	0.000
Variables describing the home place (on the level of the statistical areas or boroughs, respectively)			
Share of inhabitants aged under 18 years	+ 44.613	+ 0.060	0.000
Share of inhabitants aged from 30 to 64 years	− 19.303	− 0.043	0.000
Share of inhabitants with migration background	− 13.170	− 0.097	0.000
Share of employees working in the trade, accommodation and restaurant business of the tertiary sector	+ 3.752	+ 0.017	0.064
Share of employees working in the transport, communication, finance and insurance business of the tertiary sector	− 2.777	− 0.016	0.088
Density of employees per hectare	− 0.021	− 0.030	0.017
Home place located in the borough Mitte as referential category			
Home place located in the borough Pankow	+ 3.107	+ 0.053	0.000
Home place located in the borough Spandau	+ 4.128	+ 0.049	0.000
Home place located in the borough Neukölln	+ 1.589	+ 0.023	0.016
Home place located in the borough Treptow-Köpenick	+ 5.818	+ 0.079	0.000
Home place located in the borough Marzahn-Hellersdorf	+ 9.625	+ 0.131	0.000
Home place located in the borough Lichtenberg	+ 5.905	+ 0.083	0.000
Home place located in the borough Reinickendorf	+ 1.404	+ 0.018	0.069
Home place located in the inner ring of Berlin	− 1.058	− 0.027	0.078
Variables describing the work place (on the level of the statistical areas or boroughs, respectively)			
Share of male inhabitants	− 53.172	− 0.051	0.000
Unemployment: Rate of unemployment with respect to all civilly employed persons	− 27.629	− 0.035	0.001
Balance of migration in % of the number of inhabitants of the previous year	+ 7.418	+ 0.016	0.090

Table 3 is continued ...

Explanatory variables	Non-standardised regression coefficient	Standardised regression coefficient	Significance
Share of employees working in the tertiary sector	– 2.633	– 0.023	0.023
Density of inhabitants and employees per hectare	– 0.018	– 0.077	0.001
Density of enterprises per hectare	– 0.152	– 0.042	0.013
Land use: Share of the area dedicated to buildings and their surroundings Share of the area dedicated to supply and disposal facilities	– 7.061 + 7.082	– 0.048 + 0.013	0.000 0.188
Floor space index (without subsidiary building)	+ 4.590	+ 0.152	0.000
Work place located in East Berlin	– 3.991	– 0.100	0.000
Work place located in the inner ring of Berlin	+ 1.081	+ 0.028	0.039
Variables describing the home and work place			
Home and work place located in East Berlin	– 12.734	– 0.283	0.000
Home and work place located in West Berlin	– 11.206	– 0.292	0.000
Further variables			
Constant	+ 76.381		0.000
Number of observations			9747.700
Adjusted ρ^2			0.295

3.3 Commuting distances and times in the household context

Regarding the distances and times covered on the commuting trip in single-, double- and multiple-earner households, certain differences are observable. Both, the average distances and times are considerably longer, as the number of employees within a household increases, supporting findings by Rouwendal and Rietveld (1994) and Surprenant-Legault and El-Geneidy (2010). The mean commuting distance amounts to 13.9, 14.9 and 15.8 kilometres for households with one employee, two employees and more than two employees, respectively. The corresponding values for the mean commuting time are 34.0, 34.8 and 39.0 minutes.

To better understand the commuting behaviour within the household context, the share which each working household member covers of the entire household commuting distance and time is analysed. These shares are presented in Figure 4. Overall, the two distributions shown are very similar. As mentioned above, about 60% of all persons are the only employee in their household and, therefore, accountable for the whole commuting. Another peak appears for a share of 50%, meaning that the commuting distance and time are equal for two workers in a household. Interestingly, this peak is slightly more distinct for the time than for the distance, with 7.7% vs. 6.6%, respectively. Further peaks are observed for the shares of the ratios of one-third, two-thirds and two-fifths.

Number of observations: 11645
Mean: 79.690%
Standard deviation: 28.915%

Number of observations: 11706
Mean: 79.656%
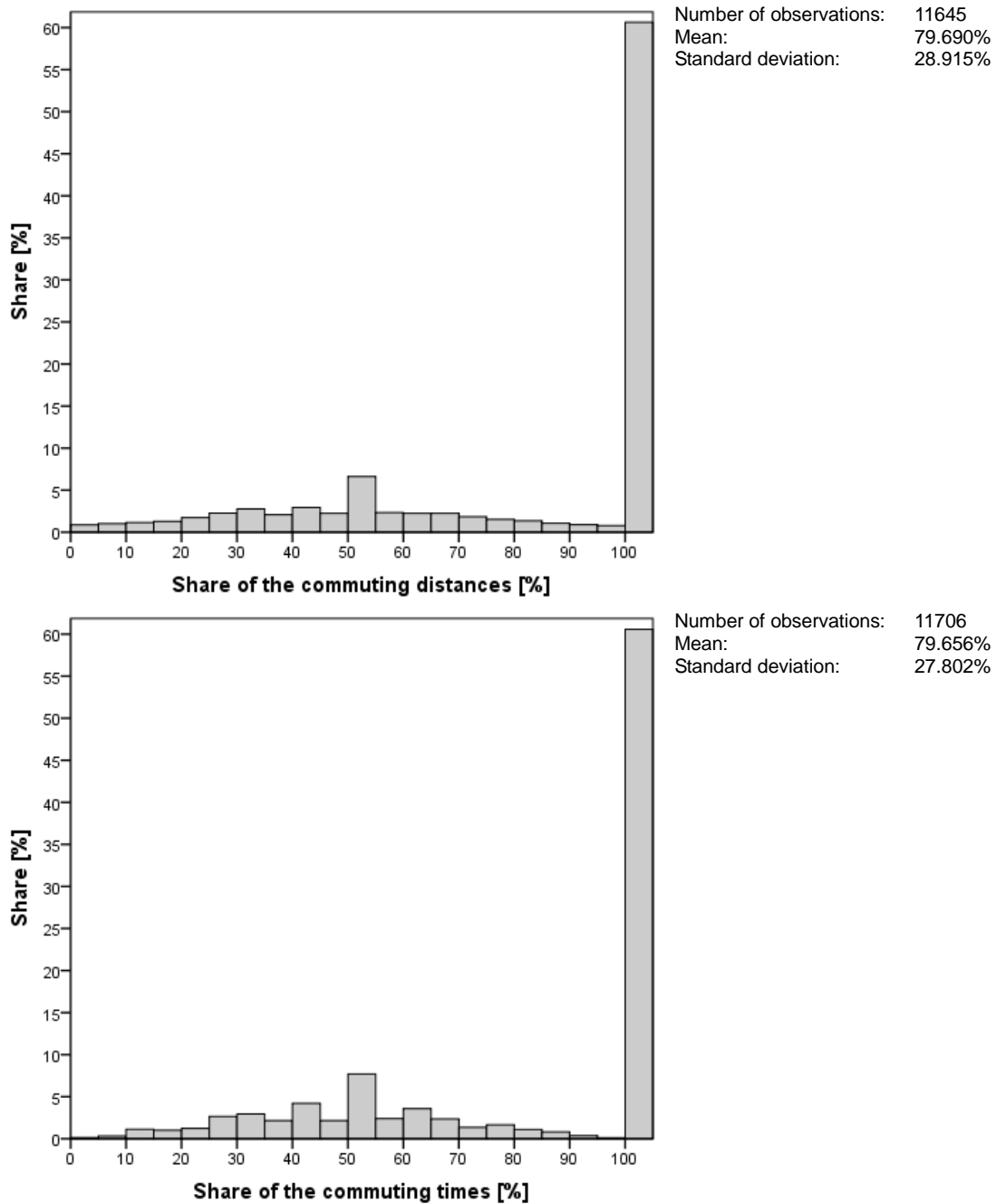Standard deviation: 27.802%

Figure 4   Distribution of the shares of the commuting distances and times within a household

In order to estimate a linear regression, the shares with values ranging from 0 to 1 are transformed to an open range of values applying the commonly used logit transformation. The logit function is defined as follows

$$\text{logit}\,(p) = \log\left(\frac{p}{1-p}\right) = \log(p) - \log(1-p).$$

Generally, the natural logarithm with the base e is used.

In Table 4, the corresponding results of a linear regression for the logit transformed shares of the commuting distances within a household are presented.

Table 4   Linear regression for the shares of the commuting distances within a household

Explanatory variables	Non-standardised regression coefficient	Standardised regression coefficient	Significance
Person related variables			
Age in years	– 0.046	– 0.103	0.000
Gender (male)	+ 0.931	+ 0.093	0.000
Age in years * Gender (male)	– 0.017	– 0.077	0.005
Highest school graduation: Graduation from high school	+ 0.232	+ 0.023	0.002
Highest professional education: Technical college, college of cooperative education	+ 0.240	+ 0.015	0.029
Employment: Employed	+ 1.145	+ 0.060	0.026
Degree of employment	+ 6.287	+ 0.365	0.000
Full-time	– 1.829	– 0.159	0.000
Car availability: restricted	– 0.269	– 0.033	0.000
Household related variables			
Age in years of the oldest household member	+ 0.067	+ 0.152	0.000
Number of persons	+ 0.460	+ 0.105	0.000
Number of adults	– 0.325	– 0.049	0.002
Number of children aged up to 6 years	+ 0.515	+ 0.042	0.000
Number of employees	– 5.429	– 0.674	0.000
Number of employees working part-time	+ 0.223	+ 0.022	0.084
Number of employees working part-time (less than 18 hours per week)	+ 1.991	+ 0.087	0.000
Monthly net income in 1'000 €	– 3.803	– 0.825	0.000
Monthly net income in 1'000 € squared	+ 0.384	+ 0.443	0.000
Monthly equivalent net income in 1'000 €	+ 4.045	+ 0.539	0.000
Monthly equivalent net income in 1'000 € squared	– 0.517	– 0.265	0.000
Number of operable bicycles	+ 0.078	+ 0.023	0.011
Variables describing the home place (on the level of the statistical areas or boroughs, respectively)			
Share of female inhabitants	– 8.693	– 0.031	0.000
Unemployment: Share of unemployed persons aged from 15 to 65 years	– 4.715	– 0.025	0.003
Balance of migration in % of the number of inhabitants of the previous year	– 8.129	– 0.014	0.044

Table 4 is continued …

Table 4 continued ...

Explanatory variables	Non-standardised regression coefficient	Standardised regression coefficient	Significance
Turnover of enterprises in 1'000'000 €	+ 0.000	+ 0.012	0.078
Land use: Share of the area dedicated to settlement and transport	– 0.493	– 0.015	0.042
Variables describing the work place (on the level of the statistical areas or boroughs, respectively)			
Share of inhabitants aged from 18 to 29 years	– 2.558	– 0.026	0.003
Mean monthly net income per capita	– 0.001	– 0.016	0.044
Number of inhabitants in 1'000	+ 0.002	+ 0.013	0.066
Density of enterprises per hectare	+ 0.020	+ 0.021	0.004
Land use: Share of the area dedicated to supply and disposal facilities	+ 4.256	+ 0.029	0.000
Work place located in East Berlin	+ 0.360	+ 0.034	0.001
Variables describing the home and work place			
Home and work place located in East Berlin	– 0.599	– 0.051	0.000
Further variables			
Constant	+ 14.204		0.000
Number of observations			9697.900
Adjusted ρ^2			0.560

With increasing age, these shares decrease. Male respondents tend to cover longer portions of the entire household commuting distance, up to an age of 54 years. Education and employment show an overall positive effect. Contrary to the expectation, restricted car availability is related to a lower share, but this is both with respect to unrestricted access to a car and no available car at all. The household related variables play a much greater role in this model than in the model describing the commuting distances. The age of the oldest household member influences the share of the commuting distance an individual holds within a household in a positive way. With increasing household size, the share also increases, while the number of adults has a negative and the number of children aged up to 6 years a positive effect. A higher number of employees in a household leads to lower shares, as the entire commuting distance is divided among more people. The number of employees working merely part-time has the opposite impact. The net income and the equivalent net income per month show contrary relations. Overall, the household income has a positive effect for the lower income groups up to approximately 3'000 € and with incomes rising further, this trend is reversed. A higher number of operable bicycles available within a household is connected to a greater share of the commuting distance for an individual.

With respect to the explanatory variables describing the home and work locations, their impact on the share is not as distinct as in the previous models. The portion of female inhabitants in the statistical area of residence has a negative influence, as does the share of the unemployed persons aged from 15 to 65 years. This also applies to the balance of migration

in % of the number of inhabitants of the previous year. With an increasing turnover generated by the enterprises located in the home area, the share of the commuting distance covered by a person rises. Regarding the land use, the portion of the area dedicated to settlement and transport leads to a lower share. The share of young adults, aged from 18 to 29 years, living in the statistical area of the work place has a negative effect. The higher the mean monthly net income per capita, the lower is the share an individual covers of the entire household commuting distance. The size of the statistical area where a person is employed shows a positive influence. This also applies to the density of enterprises per hectare as well as to the share of the area dedicated to supply and disposal facilities. In the case that the work place is located in East Berlin, the share held of the commuting distance rises, whereas this share decreases when both, the home and work place are situated in East Berlin.

Table 5 shows the results of a linear regression for the shares of the commuting times an individual accounts for within a household. The model is very similar to the one for the shares of the commuting distances; merely a few different significant explanatory variables are excluded and included.

Table 5   Linear regression for the shares of the commuting times within a household

Explanatory variables	Non-standardised regression coefficient	Standardised regression coefficient	Significance
Person related variables			
Age in years	− 0.052	− 0.118	0.000
Highest school graduation: Graduation from high school	+ 0.211	+ 0.021	0.005
Highest professional education: Technical college, college of cooperative education	+ 0.217	+ 0.014	0.044
Employment: Degree of employment	+ 5.574	+ 0.328	0.000
Part-time	+ 1.617	+ 0.125	0.000
Car availability: restricted	− 0.168	− 0.021	0.006
Car availability: no car	+ 0.127	+ 0.037	0.001
Public transport ticket ownership: high commitment	+ 0.138	+ 0.014	0.071
Household related variables			
Age in years of the oldest household member	+ 0.064	+ 0.148	0.000
Number of children aged up to 18 years	+ 0.475	+ 0.072	0.000
Number of children aged up to 6 years	+ 0.538	+ 0.044	0.000
Number of male adults	+ 0.178	+ 0.020	0.021
Number of employees	− 5.226	− 0.657	0.000
Number of employees working full-time	− 0.202	− 0.028	0.091
Number of employees working part-time (less than 18 hours per week)	+ 1.929	+ 0.085	0.000

Table 5 is continued …

Table 5 continued ...

Explanatory variables	Non-standardised regression coefficient	Standardised regression coefficient	Significance
Monthly net income in 1'000 €	– 3.765	– 0.826	0.000
Monthly net income in 1'000 € squared	+ 0.367	+ 0.428	0.000
Monthly equivalent net income in 1'000 €	+ 4.111	+ 0.554	0.000
Monthly equivalent net income in 1'000 € squared	– 0.519	– 0.269	0.000
Number of cars	+ 0.332	+ 0.050	0.000
Number of operable bicycles	+ 0.080	+ 0.024	0.008
Variables describing the home place *(on the level of the statistical areas or boroughs, respectively)*			
Share of male inhabitants	+ 9.734	+ 0.035	0.000
Unemployment: Share of unemployed persons aged from 15 to 65 years	– 5.821	– 0.031	0.000
Balance of migration in % of the number of inhabitants of the previous year	– 7.888	– 0.014	0.044
Variables describing the work place *(on the level of the statistical areas or boroughs, respectively)*			
Share of inhabitants aged under 18 years	+ 1.581	+ 0.011	0.151
Share of inhabitants aged from 18 to 29 years	– 2.270	– 0.023	0.007
Mean monthly net income per capita	– 0.001	– 0.018	0.025
Number of inhabitants in 1'000	+ 0.002	+ 0.013	0.066
Density of enterprises per hectare	+ 0.022	+ 0.024	0.001
Land use: Share of the area dedicated to supply and disposal facilities	+ 4.433	+ 0.031	0.000
Work place located in East Berlin	+ 0.368	+ 0.036	0.001
Variables describing the home and work place			
Home and work place located in East Berlin	– 0.547	– 0.047	0.000
Further variables			
Constant	+ 4.513		0.000
Number of observations			9684.000
Adjusted ρ^2			0.563

An increasing age, again, reduces the share an individual holds of the entire household commuting time. The level of education and employment has a positive effect. Restricted access to a car decreases the share of the commuting time, whereas no available car is related to higher shares. The latter also applies to the ownership of a public transport ticket with a high commitment. The age of the oldest household member leads to greater shares, as does the number of children aged up to 6 years and aged up to 18 years. With an increasing number of male adults living in a household, the share of the commuting time an individual is accountable for also rises. Higher employment has in general a positive influence. The monthly net income and the equivalent net income show, once more, contrary relations, with a positive effect for lower incomes up to about 3'000 € per month and a then reversed trend.

The number of cars as well as the number of operable bicycles in a household increase the shares of the commuting time.

With respect to the home place, the portion of the male population shows a positive effect, while with greater unemployment and a higher migration balance, the commuting time shares of an individual within a household are reduced. The share of inhabitants aged less than 18 years and living in the statistical areas where the work place is situated influences these shares in a positive way, whereas the share of inhabitants aged from 18 to 29 years have the opposite effect. Again, a higher income level is related to lower shares. The number of inhabitants, the enterprise density as well as the share of the area dedicated to supply and disposal facilities increase the portion of the commuting time. A work place location in East Berlin has the same effect. Persons living and working in the Eastern part of Berlin tend to cover lower shares of the entire household commuting time.

4.   Conclusions

The locations of the home and work place play an important role with respect to the commuting behaviour. On the one hand, a differentiation between East and West Berlin becomes visible. Persons residing in boroughs in East Berlin tend not to work there, whereas in West Berlin the opposite is observable. At the same time, persons working in East Berlin are more likely to live in the same borough. On the other hand, individuals living in the inner ring of Berlin are more likely to commute within the same borough, while employees in the inner ring of Berlin are more likely to reside in another borough. As one expects, commuting distances and times are significantly shorter when individuals both, live and work in the same borough of Berlin, being consistent with results of Wang and Chai (2009).

With respect to the distances and times covered on the work trip, the same diametrically opposed commuting pattern emerges. Inhabitants of the Eastern part have longer commutes than persons living in West Berlin, whereas employees in East Berlin tend to travel shorter for work purposes than individuals employed in the Western part. Only in the case, that both, home and work place are located within either East or West Berlin, the trips to and from work are likely to be shorter. A place of residence in the inner ring is related to shorter commuting trips, while persons living in the outer boroughs cover more distance and time. However, individuals working in the inner ring of Berlin commute longer.

The differences between the Eastern and Western part of Berlin are the consequence of historical developments. East Berlin was designed for commuting. Especially higher-level work places were located and concentrated on purpose in the eastern inner city, an area mainly corresponding to the borough Mitte. In West Berlin, too, work places were primarily found in the city centre. However, commuting in a classical sense was not possible due to the separation of Berlin, so people had to live rather close to their places of employment. Furthermore, there still exits a surplus of work places in the Western part of Berlin, attracting employees from all over.

Regarding the commuting distances and times, the outcome of corresponding regression models indicates that the levels of education and employment have a positive effect, concurrent with findings in the literature (for example, Giuliano, 1998; Lee and McDonald, 2003; Susilo and Maat, 2007). With an increase in the household income, the commutes tend to be shorter. The accessibility of a car and the ownership of a public transport ticket show

overall a positive association with the length of the work trip. However, the direction of this connection is not clear, i.e., whether individuals acquire mobility tools in order to accommodate a long commute or whether an already available car or public transport ticket enables and even promotes employees to choose a work place located farther away. The various explanatory variables describing the locations of the home and work place show mainly contrarian influences, indicating that these areas tend to have different characteristics.

Comparing the commuting trip in single-, double- and multiple-earner households, certain differences are observable. Both, the average distances and times are considerably longer, as the number of employees within a household increases, supporting findings by Rouwendal and Rietveld (1994) as well as by Surprenant-Legault and El-Geneidy (2010). The household context and the work situation of other employed members have a significant impact on the commute of an individual. Both, the summarised distances and times covered by other employees in the household show a positive effect, indicating that the commuting burden is more or less equally distributed among all household members, confirming results by Plaut (2006).

Analysing the share which each working household member covers of the entire household commuting distance and time, a proportion of 100% is observed for about 60% of all persons, since these respondents are the only employee in their household and, therefore, accountable for the whole commuting. Another peak in the distribution of the shares appears for 50%, meaning that the commuting distance and time are equal for two workers in a household. Further peaks are observed for the shares of the ratios of one-third, two-thirds and two-fifths.

Regression analyses for the logit transformed shares of the commuting distances and times within a household show that with increasing age, these shares decrease. Male respondents tend to cover longer portions of the entire household commuting distance, up to an age of 54 years. Education and employment show an overall positive effect. The net income and the equivalent net income per month show contrary relations. Overall, the household income has a positive influence for the lower income groups up to approximately 3'000 €, and with incomes rising further, this trend is reversed. Overall, the household related variables play a much greater role in these models than in the models for the commuting distances and times. In contrast, regarding the explanatory variables describing the home and work locations, their impact on the shares is not as distinct as in the latter models.

Acknowledgements

References

Cervero, R. and M. Duncan (2006) Which reduces vehicle travel more: Jobs-housing balance or retail-housing mixing?, *Journal of the American Planning Association*, **72** (4) 475-490.

Clark, W. A. V. and S. Davies Withers (1999) Changing jobs and changing houses: Mobility outcomes of employment transitions, *Journal of Regional Science*, **39** (4) 653-673.

Dieleman, F. M. (2001) Modelling residential mobility: A review of recent trends in research, *Journal of Housing and the Built Environment*, **16** (3-4) 249-265.

Giuliano, G. (1998) Information technology, work patterns and intra-metropolitan location: A case study, *Urban Studies*, **35** (7) 1077-1095.

Giuliano, G. and K. A. Small (1993) Is the journey to work explained by urban structure?, *Urban Studies*, **30** (9) 1485-1500.

Gordon, P., A. Kumar and H. W. Richardson (1989) The influence of metropolitan spatial structure on commuting time, *Journal of Urban Economics*, **26** (2) 138-151.

Häussermann, H., A. Werwatz, D. Förste and P. Hausmann (2010) Monitoring Soziale Stadtentwicklung 2010: Fortschreibung für den Zeitraum 2008 - 2009, final report on behalf of the Senate Department for Urban Development.

Kaufmann, V. (2002) *Re-thinking Mobility: Contemporary Sociology*, Ashgate, Aldershot.

Lee, B. S. and J. F. McDonald (2003) Determinants of commuting time and distance for Seoul residents: The impact of family status on the commuting of women, *Urban Studies*, **40** (7) 1283-1302.

Madden (1981) Why women work closer to home, *Urban Studies*, **18** (2) 181-194.

Miller, E. J. and A. Ibrahim (1998) Urban form and vehicular travel: Some empirical findings, *Transportation Research Record*, **1617**, 18-27

Peng, Z.-R. (1997) The jobs-housing balance and urban commuting, *Urban Studies*, **34** (8) 1215-1235.

Plaut, P. O. (2006) The intra-household choices regarding commuting and housing, *Transportation Research Part A: Policy and Practice*, **40** (7) 561-571.

Rouwendal, J. and P. Rietveld (1994) Changes in commuting distances of Dutch households, *Urban Studies*, **31** (9) 1545-1557.

Rouwendal, J. and A. van der Vlist (2005) A dynamic model of commutes, *Environment and Planning A*, **37** (12) 2209-2232.

Schwanen, T., F. M. Dieleman and M. Dijst (2003) Car use in Netherlands daily urban systems: Does poly-centrism result in lower commute times?, *Urban Geography*, **24** (5) 410-430.

Schwanen, T. and M. Dijst (2002) Travel-time ratios for visits to the workplace: The relationship between commuting time and work duration, *Transportation Research Part A: Policy and Practice*, **36** (7) 573-592.

Surprenant-Legault, J. and A. M. El-Geneidy (2010) The spatial patterns affecting home to work distances of two-worker households, paper presented at the *89th Annual Meeting of the Transportation Research Board*, Washington, D.C., January 2010.

Susilo, Y. O. and K. Maat (2007) The influence of built environment to the trends in commuting journeys in the Netherlands, *Transportation*, **34** (5) 589-609.

Van Ommeren, J. N. (2000) Job and residential search behaviour of two-earner households, *Papers in Regional Science*, **79** (4) 375-391.

Van Ommeren, J. N., P. Rietveld and P. Nijkamp (1998) Spatial moving behavior of two-earner households, *Journal of Regional Science*, **38** (1) 23-41.

Wang, D. and Y. Chai (2009) The jobs-housing relationship and commuting in Beijing, China: The legacy of Danwei, *Journal of Transport Geography*, **17** (1) 30-38.

Zhao, P, B. Lü and G. de Roo (2011) Impact of the jobs-housing balance on urban commuting in Beijing in the transformation era, *Journal of Transport Geography*, **19** (1) 59-69.