Chapter 5

Mobilities and Social Network Geography: Size and Spatial Dispersion – the Zurich Case Study

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Introduction

During the last few decades, we have witnessed enormous changes in the movement of goods, information and people. Communication techniques and transport potential have been considerably expanded and general costs of travel and communication have been substantially reduced. Due to these developments, diversity of choice has been widely expanded and exploited, producing interaction on a national and global scale through almost universal communication and transport networks. Thus, it can be argued that the world is shrinking – physically, socially and imaginatively – due to a substantial increase in accessibility through various transportation and communication systems (Axhausen et al. 2008). On a micro-societal level, social, political, economic and cultural opportunities – and enforcements – encourage us to be 'on the move' (Urry 2008a). Ongoing market globalisation with increased international competition, changing demographic structures, values, attitudes and expectations has allowed new spatial settings to evolve.

All these factors have contributed to the emergence of a new research field that is now discussed in joint projects between transport researchers, sociologists and geographers. This new research field is based on basic principles of mobility in modern life, and the related interplay between the size and structure of social networks with new forms of communication and transport (Ohnmacht et al. 2008; Larsen et al. 2006; Carrasco and Miller 2006).

In this chapter, we first give a brief overview of relevant issues in both social science and transport planning as they relate to size and structure of social network geographies. We evaluate debates about patterns of inequality structures (for a conceptual discussion of mobilities and inequality see Ohnmacht, Maksim and Bergman in this volume). Second, we focus on methodological challenges to survey data on social networks and personal mobilities. Third, we examine the size and spatial spread of social contacts

in Zurich, Switzerland.[1] Based on what we believe to be the largest new quantitative survey on egocentric social networks and personal mobilities, we will try to answer the following questions:[2] what size and spatial dispersion do the social networks have and how are our findings related to patterns of inequality structures? Fourth, we conclude by summarising our main empirical findings against the patterns of inequality and suggest further research questions.

Mobilities and Social Networks

This section consists of a brief overview on relevant mobilities and social networks literature. We present theoretical debates in both transport studies and social sciences giving an overview of this relatively new research field. We will focus primarily on spatial distribution, the main topic in the empirical part of this contribution. We then consider the relevance of this research field against the background of contemporary debates on social inequality.

Mobilities and Social Networks in Social Science

Recent research puts relations between society and space at the centre stage of social theory. Since Beck (2008); Urry (2008a); Sheller and Urry (2006); Kaufmann et al. (2004) proclaimed a new 'mobilities paradigm' in social sciences, the analysis of spatial distance and social processes is no longer just an issue of transport studies and transport geography:

> Most social science has not seen distance as a problem or even as particularly interesting (except for transport studies and transport geography). This mobilities paradigm, though, treats distance as hugely significant, as almost the key issue with which social life involving a complex mix of presence and absence has to treat). (Urry 2008b, 19)

Due to this 'spatial turn' in social science, geographical space is no longer seen only as a passive container. Interestingly, geographical space was already considered relevant in early sociological theory, e.g. in work by Simmel (1908), who ascertained that spatial distance determines social proximity. But before we can re-think physical space in relation to the ordering of social relations, it

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2 The closest comparable study was undertaken independently at about the same time in Toronto by a team involving sociologists and transport planners (Carrasco et al. 2008).

is necessary to understand how space has been defined in current social science debates. Inspired by German studies, Löw (2001) has developed geographical space as a key concept in sociology. She points out that space should to be understood as a socially constituted relational concept, shaped by its social, political, cultural and economic conditions. On a micro-sociological level, people are actively integrated, constructing space using various ordering processes, thus defining space as a 'relational ordering of living beings and social goods' (Löw 2005, 2). This definition assumes that every social formation produces or reconstructs its specific 'social spatialisation' (Shields 1991, 31) which is largely built up by both the living places and locations of social contacts. Social contacts, with their spatial arrangement, form and reform the social network geography. This phenomenon can also be interpreted to some extent as activity space, since intermittent visits are necessary to maintain social contacts in most cases (Urry 2008a).

Contemporary trends, such as globalisation, transnationalisation, worldwide markets with increased international competition and changing demographic structures with different values, attitudes and expectations produce new social relations spatial patterns. Therefore, we hypothesise that spatial locations' arrangements of social network members are likely to become more remote and dispersed. Numerous studies explore the increasing possibilities for organising one's life around workplace location, place of education, partner's residence, etc. Thus, it is logical to argue that 'travel distances between members of social, familial and work-related networks have substantially increased since the 1950s; on average, social networks are more spread out and less coherent' (Cass et al. 2005, 545). Spatially distant social relations mean that people have to travel long distances to meet, and need to plan their social activities further ahead of time, possibly weakening their social network, an important source of social capital.

The impact of personal mobilities on social networks needs to be measured. Numerous researchers have conducted empirical research on physical space and social impact, such as the challenge of maintaining contacts at a distance (Latane et al. 1995; Butts 2003), social proximity in immediate surroundings (Blake et al. 1956; Caplow and Foreman 1950; Snow et al. 1981), modes of transportation and communication usage and arrangement of social network geography (Larsen et al. 2006) and life cycle and arrangement of social network geography (Ohnmacht et al. 2008; Sommer 1996).

In recent debates, the concept of 'mobility biography' has become very important in discussing the development of both geographical social space and travel behaviour. In Prillwitz et al. (2006), the term mobility biography refers to a set of an individual's longitudinal trajectories in the mobility domain. It assumes the existence of events at certain moments in an individual's life that change their travel patterns to an important degree, e.g. relocation, car ownership, or other mobility characteristics (also Beige and Axhausen 2006; Scheiner 2007). Empirically, changes that have occurred over the life cycle

can be portrayed as events in a mobility biography. According to Hine and Grieco (2003, 301), '[l]life cycle stages have a consequence for mobility and accessibility'. Consequently, life cycle stages (in this understanding certain events in a mobility biography) have an effect on 'social accessibility' (Handy and Niemeier, 1997; Götz, 2007).

In summary, we hypothesise that different degrees of personal mobilities may lead to a certain 'spatialisation' of social relations, explainable to a certain degree by mobility options exercised in a person's life trajectory, here understood as a mobility biography. Further examination is necessary on spatial dispersion of relationships for social groups involved in numerous geographical changes due to education, job, etc. (Ohnmacht et al. 2008), and whether the different personal networks overlap less (Wellman 1996). A further interesting research topic concerns spatially dispersed social networks' risk that relationships become weaker, more transient and therefore more coupled to a contemporary life cycle due to increased distance (Latane et al. 1995; Butts 2003).

Transport Planning and Social Network Geography

Transport planning aims to understand, describe and model the travel choices that people make during their daily lives, including frequent journeys outside their daily activity space (Schönfelder and Axhausen 2003). Over the last few decades, the motives and determinants of individual travel behaviour have been analysed from different perspectives. While the main approach explains personal mobility due to the travellers' socio-demographics and the generalised costs of travel, travel behaviour research has added several sociologically driven analysis directions such as role patterns, household interactions, time budgets, activity planning, life and mobility styles, etc. Another factor in understanding travel behaviour is social activity travel due to physical absence of significant others. This is particularly true for leisure travel, which dominates the travel market in terms of miles travelled and trips undertaken and is primarily motivated by the need to be with others or meet them in person (Axhausen et al. 2007; Larsen et al. 2006).

Recognising the ongoing pluralisation and differentiation within western societies and the increasing degrees of social and geographical mobility, it is crucial to investigate social realities to understand travel behaviour in greater detail. As part of these developments, it is essential to understand the geography of travellers' social networks if one wants to understand destination choices. If travel is generally about meeting others, then it is important to ascertain the starting point of trips, the meeting point, to know whether travellers are informed about the opportunities offered by a destination, and to know which constraints limit their choices or availability and therefore the choices of the full group meeting. Unfortunately, researchers in sociology have had no reason to characterise and measure social networks' geographies until now (cf. Larsen

et al. 2006). They have focused mainly on the structure of social networks and their impact on the social processes (Wasserman and Faust 1994). Information obtained about the locations of members in complete or egocentric networks is spatially rough, if available at all. Geographers have generally ignored this issue, so transport planners have recently undertaken new surveys to satisfy their information needs, while drawing on the extensive sociological experience in the capturing of egocentric networks (see, for example, Marsden 2005).

Social Network Geography and Inequality

In the following section, we examine how the social dimension of inequality is rooted in social network geography, especially in the interplay between space and mobilities. New mobilities regimes have serious consequences for people's lives. In fact, differential access to mobility tools generates new kinds of social inequality. Much movement is to effect face-to-face contacts with significant others. Because mobility is often a matter of obligation and burden, one must ask how and whether people can maintain their social networks over distance. Recently, social networks have been studied to determine the relevance of mobilities in maintaining social contacts (Larsen et al. 2006).

With special emphasis on intimacy and help, Schubert (1994) focuses on spatial distance between significant others. Several forms of private care for the elderly within family networks are linked to a need for proximity, because sometimes family members are forced to be close to elderly members needing care. Within family research, the nuclear family has traditionally been considered as a spatial dense network. However, in recent years, the notion of 'modified extended families' has arisen, encompassing nuclear families living at a distance. Given that options have increased substantially in postmodernity, 'Gemeinschaft' (Tönnies 1991) is not necessarily local. Thus, distance has altered helping structures. Findings in Germany indicate that the older people get, the more they rely on help from their relatives (Schubert 1994, 230). In addition, people who need help are more likely to maintain kinship contacts in their immediate spatial surrounding (neighbourhood, community etc.), particularly when they live in rural areas (Schubert 1994, 232).

In order to explore the interaction between physical distance and intimacy, Holmes (2004) examines couples living in distance relationships. Whereas the most common reasons for long-distance distant relationships in the past were war and seafaring, today's pattern is driven by the demand for spatial flexibility required for careers (e.g. double-career couples). Holmes (2004) argues that today these 'Living Apart Together' (LATs) lives are not only dictated by men's work, but also women's desire and possibilities to follow a career, attributable to changes in gender roles. To maintain relationships, one has to interact face-to-face, using mobility tools, such as public transport, season tickets, driver's licence and so on. To tackle the problem of long-distance relationships, one has to rely on large amounts of time and monetary resources, both of which

relate highly to patterns of social inequality. Thus, mobilities contribute highly to social inclusion and travel is a key activity in obtaining physical proximity to significant others.

Grieco et al. (2001) reveal that the socially excluded are not clustered together spatially; instead they are scattered, sometimes over a large area. This is particularly the case for diasporic cultures, such as migration groups. Mobilities are necessary to fulfil social obligations, such as weddings, funerals, stag nights and so forth (Beck-Gernsheim 2007). For instance, Hine and Grieco (2003) focus explicitly on the 'scattered' and 'clustered' arrangements of partner, spouse, friends, relatives and so forth. They note that, especially for spatially dispersed social networks, the use of information and communication technologies (ICTs) is very important in maintaining social contacts at a distance. As for actual transport, recent literature on the issue of transport-related social exclusion provides little information on the importance of adequate transport to visit family, friends and other relevant persons. Walking and public transport are very important for meetings, while place-to-place tangential connections to spatially distant others often require cars, long-distance trains and planes. For maintaining spatially distant contacts, economic and time constraints are key factors in determining the scheduling of time-space interaction. Thus, difficulties develop for low-income and time restricted groups in attempts to be proximate with friends, family, relatives, etc. Hine and Grieco (2003, 303) argue that 'transport researchers and transport policy makers have been insufficiently focused on the consequences of a networked society for the total reorganisation of transport and travel'. On a policy level, the 'social sprawl' problem can be solved by providing all-access public transport cards to people at risk of social exclusion. This may enable social inclusion facilitated by transport as a counterbalance to dispersed social networks; e.g. high access to mobility through low generalised costs can increase opportunities to participate in society through social inclusion journeys.

We have discussed different types of transport and sociological research concerned with social networks and mobilities. From these discussions, we draw the following conclusions: changes in social network space through modernisation have been identified as interplay between significantly expanded transport and communication systems, lowered generalised costs and changing social practices. These dynamics lead to new spatial network patterns. The patterns must be addressed in greater detail for a deeper understanding of social-activity travel and social processes in general. Overall, we concluded that it is still necessary to study social relations and space together in order to understand travel in a more social way. We must focus on the question of how 'social networks involve diverse connections, which are more or less at a distance, more or less intense, and more or less mobile' (Larsen et al. 2006, 3) against the background of physical travel to fulfil social contacts. Focusing on the absence of social contacts is a chance for mobility and travel research

to forge new insights into the dynamics of modern life and their effects on mobilities. For the remaining part of the chapter, we are mainly interested in two issues; first, discussing methodological challenges to research mobilities and social networks and second, examining the structure of social network geographies in Zurich, Switzerland.

Methodological Challenges: Mobilities and Social Networks

When focusing on mobilities and social networks and their mutual dynamics, it is necessary to develop and apply 'mobile field methods' in data gathering to explore and examine recent dynamics in greater detail. This section explains the Zurich survey, how it was conducted and how representative the sample obtained was. We follow with a discussion about the name generator used in the survey to help respondents name their social contacts. In addition, we highlight the methodological challenge of measuring spatial spread of a social network.

Survey

Our survey was derived from an *a priori* set of hypotheses sketched by Axhausen (2007), that cover discussion in its final form (Axhausen, 2008), initial qualitative work (Ohnmacht and Axhausen 2005; Larsen at al. 2006), related quantitative work on mobility biographies (Beige and Axhausen 2006; Ohnmacht et al. 2008) and a substantial pre-test (Frei 2007). The survey instruments address the following elements: first, basic socio-demographics of the respondent today, second, various 'mobilities' of the respondents, such as the mobility biography of residential and employment moves over a lifetime, including information about income levels, mobility tool ownership and main modes of transport to work and third, four name-generators and a name interpreter, that include exact home location of the respondents' social contacts and the frequency of their interactions by four modes: face-to-face, phone, email and texting (short-message-service – SMS). The survey tries to shed new light on current social practices in building and maintaining social networks. The survey overcomes the limitations of previous sources about the spatial patterns of social interactions, which were, by definition, partial to a particular mode: travel and activity diaries (face-to-face contacts), telecommunication diaries (phone plus a subset of the electronic channels: email, SMS, chat). It is also more comprehensive than the small number of previous surveys that covered multiple modes, but did not identify social network members involved (combined travel and (tele)communication surveys).

Data Collection

Data collection was conducted from December 2005 to December 2006. During a pre-test (Axhausen et al. 2006 and Frei, 2007), three different survey methodologies (self-completion, face-to-face, mixed face-to-face and self-completion) were tested to identify a survey format that could minimise missing values (due to fatigued interviewees) and reduced recall problems for retrospective survey items. The mixed method was the most effective approach with an acceptable cost per response (110 CHF/usable response). For the survey, 4,200 Zurich residents with available addresses and telephone numbers were chosen randomly. Following an announcement letter, the subjects were contacted on different days of the week and times of day, and then recruited during the telephone interview, including arranging appointments for the face-to-face interviews. With the reminder notice for the interview, respondents received the written form allowing them to raise questions during the upcoming interview. The written part consists of a person form and a form with mobility biographical questions about relocations, former and current job locations, usage of mobility tools, important life events and memberships in groups that meet periodically (see Beige 2006 for detailed information about mobility biographies). The one hour face-to-face interview covered the social contact questionnaire, but was also used to detect and address respondent difficulties and to establish rapport with the respondent.

The interviewers reached 2,714 (64.4 per cent) subjects by phone within five attempts. Of these, they could recruit 332 people, of whom 307 (10.7 per cent) were interviewed and completed the questionnaire. (For further details see Frei 2007.) The interviewees received no incentive. Due to the high response burden, the response rate is acceptable and within expectations. Furthermore, the response rate is satisfactory, given that the questionnaire was comprehensive.

Table 5.1 shows the socio-demographic characteristics of respondents in comparison with the general Zurich population, as observed in the Swiss Microcensus Travel 2005 (Swiss Federal Statistical Office and Swiss Federal Office for Spatial Development 2007) and the Swiss Census 2000 (Swiss Federal Statistical Office 2000). The income information is not directly comparable because the Microcensus measures household income, while this study is person-based. The comparison shows that the Zurich population is somewhat older, slightly better educated and has a higher share of public transport season tickets. Obviously, there is a slight bias towards a better-educated and public transport-oriented urban milieu. Still, an overall reweighing of the data seems unnecessary, given the relatively small deviations.

Table 5.1 Socio-demographic comparison between the characteristics of the Zurich respondents and the Zurich population*

Variable	Survey mean	Population mean	Difference
Age	**50.76**	**46.76**	**+8.5%**
Variable	**Survey share**	**Population share**	**Difference**
Male	**43.6%**	**47.9%**	**–4.3%**
Education			
NA	5.2%	12.5%	+7.3%
Obligatory schooling	8.0%	19.2%	–11.2%
Vocational training	31.8%	31.3%	–0.5%
High school diploma	8.3%	9.2%	–0.9%
Further technical training	20.8%	10.7%	+10.1%
University degree	26.0%	17.1%	+8.9%
Car available			
Always	44.6%	42.8%	+1.8%
Frequently and rarely	17.0%	18.4%	+1.4%
Public transport tickets			
50% discount card	49.5%	37.9%	+11.6%
National season (GA)	24.6%	14.2%	+10.4%
Regional season	13.8%	18.7%	–4.9%
Personal income (SFr/month)			
NA	12.8%		
0–1999	13.8%		
2000–5999	46.4%		
6000+	27.0%		

* As observed in the *Swiss Census 2000* (Bundesamt für Statistik, 2000) for age, gender and education and *Microcensus Travel 2005* (Bundesamt für Statistik und Bundesamt für Raumentwicklung, 2007) for the rest.

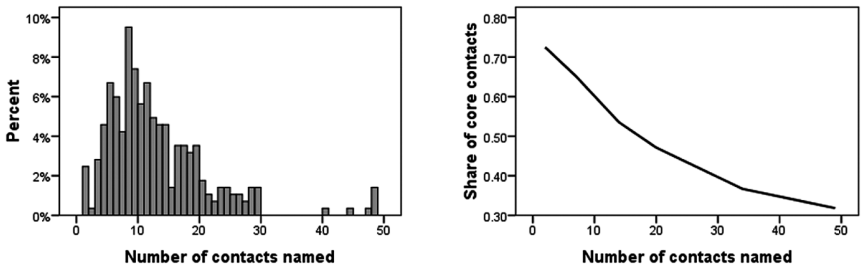
Surveying the Size of Social Contacts

To get a clear picture when surveying social network size, it is necessary to review the methodology of information gathering from respondents. We focus on egocentric (personal) networks, meaning that we use the respondent (alter) as the core of the social network and specifically capture his or her social contacts (alteri). To survey egocentric networks, name-generators and name-interpreters are used. The name generator specifies the type of relationship that the survey wants the respondent, the ego, to list. Often, researchers set an arbitrary maximum number of contacts to be listed (see, for example, Diaz-Bone 1997). The name-generator defines the egocentric network and is the basis for further analysis. The name-interpreters then pose further questions to detail the description of the contact, alter, e.g. socio-demographic data or characteristics of the relationship.

Most egocentric networks surveys today use name-generators appropriate to a stimulus. With a stimulus, a certain kind of activity is suggested, e.g. discussing important matters, for which the interviewee names alteri. For our research goal – measuring size and structure of social network geographies against the background of a concrete activity space – it is important to survey those alters with co-present intermittent visits. We used an adapted, appropriate set of name-generators as stimuli, and each respondent was handed two lists with two different name-generators. The first name generator was a variation of Burt's and Fischer's survey instrument (Burt 1984 and Fischer 1982) that asked for contacts with whom the respondents 'discuss important problems, with whom you stay in regular contact or who you can ask for help'. The second name generator asked for persons with whom the respondents spend leisure time. This generator targets weaker ties with the rationale that leisure travel makes up the largest share of long distance travel. The name-interpreter asked (for all of the named contacts) how they met, how long the relationship has existed, frequency of contacts by different modes (face-to-face, telephone, email and SMS – short message service via mobile phone), where they met the last time and the contact's place of residence. The origin of the acquaintance was categorised as family, subdivided in first degree, relatives or partner, work-related, education or partner or 'other'. Attempts were made to specify frequency of contacts as accurately as possible; e.g. every week, or twice a year. The contact's place of residence was clarified as much as possible with postal code, municipality, street and house number.

A first point of discussion concerns answer validation. Respondents were able to name a total of 17 relationships with the first name-generator and 32 with the second, producing a total of 49 alteri. In fact, the lists could have been extended if necessary. The range of named relationships is 1 to 49. The maximum number of reported relationships was reached once and the mean was 12.35 relationships. Compared to the possible number of 49 relationships, the exhaustion rate is 25.2 per cent, indicating that respondents had sufficient

possibilities to cite relationships. Figure 5.1a indicates distribution of the number of relationships. The distribution is left skewed and has a variance of 73.0. The share of important relationships is 52 per cent and drops, as expected, with an increasing number of reported relationships (Figure 5.1b).



a) b)

Figure 5.1 Distribution of the number of relationships

Measuring Spatial Dispersion of Social Network Geography

We will now describe the approach taken to capture spatial dispersion of social network geography to model respondents' differences in the empirical part of the chapter. Both biologists – and more recently, transport planners – have had to address the question of measuring spatial distributions in their analysis of daily activity spaces. They proposed parametric, semi-parametric, and non-parametric approaches to measure the size of the activity spaces (see Schönfelder 2006 for a review). The most popular (but also problematic) approach is to calculate the size of the confidence ellipse, i.e. the two-dimensional generalisation of the confidence interval (see Figure 5.2 for an example).

It is a parametric approach; the form of the approximation is fixed and the normal distribution of locations is assumed. The symmetry of the confidence ellipse often produces cases where half the area covered by the ellipse is empty of locations and therefore too big. Rai et al. (2007) suggest other geometries which overcome this problem, but incur substantial computational costs. They also found that the complex geometries correlate highly with the confidence ellipse.

The easiest way to capture the geography would be summing up the distances of egocentric social network ties. Unfortunately, this approach fails because the distance variable alone ignores the contacts' spatial distribution pattern, e.g. the agglomeration of contacts, which cannot be measured just by distance and its distribution patterns. The frequency-weighted sum of contact distances correlates very weakly with the 95 per cent confidence ellipses.

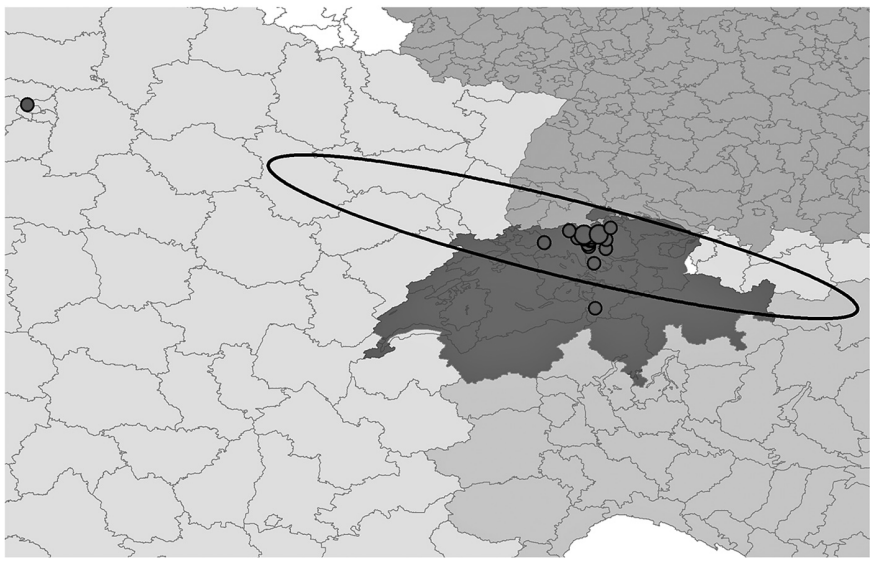


Figure 5.2 Example social geography measured by confidence ellipse

Note: The respondent is female, 61 years old, a homemaker and has moved four times in the last 46 years. The circles tag the home locations of the acquaintances and the sizes are proportional to the number of face-to-face contacts.

Empirical Results: Size and Spatial Dispersion

The following section highlights several major empirical findings on mobilities and social networks in detecting patterns of inequality. We begin with a size analysis of the egocentric network. Additionally, we focus on the spatial dispersion of social network geographies measured as confidence ellipses, followed by an analysis of differences between respondents.

Social network size The number of social relationships reported is compared in Table 5.2, differentiated by respondents' socio-demographic characteristics. Age makes a large difference, with younger people cultivating more relationships than older ones. The share of important relationships appears to increase with age, but decreases slightly in the oldest age class. Gender seems to have no influence on the numbers of relationships. A higher level of education seems to increase the number of relationships, but the differences are small and there is no clear trend visible. The share of important relationships is slightly higher for persons with higher levels of education. There seems to be no income dependence.

In further analysis, it is necessary to determine the probability distribution that represents the data set to capture a wide range in the number of social relationships. Figure 5.1 shows that the data follows a left skewed bell-shaped

Table 5.2 Number of social relationships by socio-demographic characteristics

Variable	Median		Mean		St. dev.	
Category	**Strong ties**	**All**	**Strong ties**	**All**	**Strong ties**	**All**
Age						
Up to 30	6	12.5	7.1	15.1	3.6	9.4
30 to 40	5	14.0	6.8	14.0	3.3	5.4
40 to 60	5	10.0	6.7	12.4	4.4	9.2
60 and older	5	9.0	5.6	10.6	3.6	8.0
Sex						
Female	5	11.0	6.4	12.6	4.0	7.8
Male	5	11.0	6.2	12.3	3.6	8.7
Education						
N.A.	5	11.0	4.9	10.8	1.6	4.4
Obligatory schooling	5	8.0	5.5	12.5	2.7	11.9
Vocational training	5	11.0	6.1	11.6	3.9	8.0
High school diploma	5	12.0	6.5	14.1	4.0	9.0
Further technical training	5	8.5	6.1	10.6	3.9	6.4
University degree	5	13.0	7.2	14.5	3.4	8.2
Income (SFr/month)						
N.A.	5	10.0	6.0	11.3	3.3	6.6
0–1999	5	12.5	5.9	12.5	3.1	6.1
2000–5999	5	11.0	6.6	13.1	3.9	8.7
6000+	5	11.0	6.3	12.1	4.3	9.4
All	5	11.0	6.0	12.0	4.0	8.0

curve. To deal with the skew of number of relationships, a negative binomial distribution is used to represent this shape. For modelling the number of relationships, six persons reporting very high numbers (above 30 relationships) were removed as potential outliers.

Socio-demographic, travel-related, biographical and survey-specific dummy variables are employed to explain the number of social contacts using a negative binominal regression. After removing variables that correlate highly with each other (limit = 0.5; e.g. working status and place of work), variables with a significance level lower then 0.05 were removed stepwise. The parameter estimates are reported in Table 5.3.

Table 5.3 Parameter estimates for the negative binominal regression of the number of contacts

Variable	Mean	St. dev.	Beta	b/St. err	Sign.
Constant			3.10	10.17	0.00
Age (years)	53.3	19.2	–0.04	–3.11	0.00
Age^2/1000 (years^2/1000)	3.2	2.1	0.35	2.81	0.01
Annual or monthly public transport ticket (yes)	0.9	0.9	0.24	2.04	0.04
Number of relocations (n)	5.9	3.1	0.04	3.02	0.00
University degree (yes)	0.2	0.4	0.18	1.92	0.05
Part-time employed (yes)	0.2	0.4	–0.26	–2.32	0.02
Retiree (yes)	0.3	0.5	–0.30	–2.00	0.05
Children in the household < 18 y (yes)	0.3	0.4	0.18	2.31	0.02
N			300		
Adjusted R^2			0.13		

The goodness-of-fit is, as expected from the descriptive statistics, rather low (R^2 = 0.13), but the F-statistic is significant. Furthermore, the results show that age of the respondents shows a U-shaped influence. Younger people maintain many contacts and then the number declines with increasing age, whereas every additional year causes a lower decrease of the number of social relationships. Ownership of public annual or monthly transport ticket has a positive influence on the number of social relationships. Maintaining a larger social network seems to be influenced by ownership of mobility tools, but only an annual or monthly subscription to public transport tickets was highly significant. The number of relocations influences the number of relationships. However, the positive influence of even a number of relocations indicates that people keep their important friendships after moving, even over distance. By building up a social network at the new location and keeping in touch with 'old friends', numbers of social contacts increase. A higher education, at least a university degree, leads to a larger number of social contacts. But there is no clear trend visible between the number of social contacts and education. Working status has a strong influence on the number of social relationships. In 27.3 per cent of cases, the origin of the acquaintance is work (41.0 per cent friends, 25.9 per cent family, 4.9 per cent partner and 0.9 per cent others), making it the second most frequent original context. The big influence of work status is not surprising. Part-time employees and retired people have fewer

social relationships than full-time employees and equivalents, e.g. students. It is noteworthy that children in the household have a positive influence on the number of social contacts. One might expect that the additional workload for parents would decrease the number of social relationships, but children facilitate possible new contacts: e.g. other parents with small children, parent-teacher conferences etc., which outweigh the first effect.

Spatial Dispersion – The Social Network Geography

To analyse spatial spread, we apply multivariate models. In a model of the 95 per cent confidence logarithm ellipses as a dependent variable, the values are all nonnegative, with 33 zero values in a total of 276 observations.[3] Conventional regression-methods, as the ordinary least square method, are not adequate for such censored values (Greene 2000).

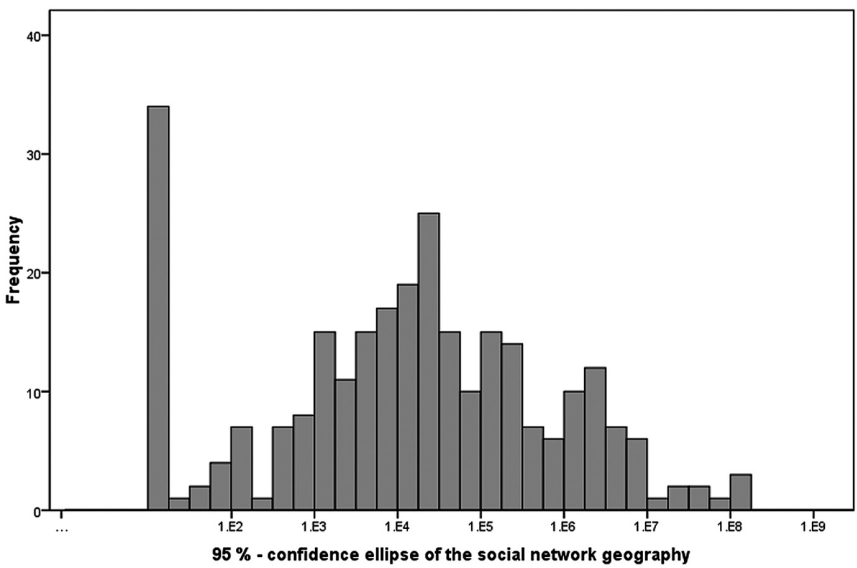


Figure 5.3 Distribution of the social network geometries measured as 95% confidence ellipses (km^2)

Note: Social network geographies of less than 10 km^2 were coded as 0.

3 The smaller sample comes from respondents with three or fewer distinct geocodes for their contacts, for which no ellipses can be calculated.

The size distribution of the 95 per cent confidence ellipses seems to follow a log-normal distribution (Figure 5.3), if we ignore the third of the respondents who have a local set of contacts. The fit statistics for a lognormal distribution are good and do not reject this distribution at the 0.05-level (chi-square, Kolmogorov-Smirnov and Anderson-Darling Test) (estimated with ExpertFit – Version 7.00 see Averill M. Law and Associates 2006). In comparison, other distributions – such as the Weibull, Gamma, log-Logistic and several others – performed less well.

The Tobit model is able to differentiate between limit- and non-limit-observations. This model assumes that the limit outcome is determined by the level of the non-limit outcome. To test this assumption, a different model, also appropriate for the data, can be compared to the Tobit model. This is Cragg's Model for Censored Data (Cragg 1971). It is used when the assumption of the Tobit model (where the non-limit outcome is determined apart from the level of the non-limit outcome) is not true. Cragg's Model is a combination of the Probit model (for $y = 0$) and the truncated regression (for $y>0$). The zeroes in our data have their origin in two different problems. First, only 44 per cent of the geocodes have street address accuracy; the rest have only zip-level accuracy, leading to just one geocode for several contacts. Second, the confidence ellipse needs at least three spatially distinct locations to be calculated. The origin of the zeros in the data leads to the assumption that the non-limit outcome is determined by the same level as the limit outcome, which is shown through the Probit and Tobit results (Table 5.4).

The Tobit model was calculated after removing variables that correlate highly with each other (limit = 0.5). Variables with a significance level lower than 0.05 were removed stepwise. The parameter estimates are reported in Table 5.4.

Analysis of the Tobit results shows that there are different factors influencing social network geographies. The first group consists of socio-demographic variables. The model results indicate that young people with high education and low or middle income tend to maintain a more spatially distributed social network. The influence of age and education is similar to their influence on the numbers of relationships. The influence of income is unexpected, as a spatially more distributed social network is expensive to maintain. One interpretation of the negative influence could be that a higher income is often linked to a higher workload and more responsibility, leading to a higher time value for these persons. Since travel costs have decreased (see, for example, Fröhlich et al. 2006), time costs now seem to exceed the financial costs of travelling. Car ownership has a positive influence on the size of social network geographies; even if ownership does not contribute to maintenance of contacts over distance (see above), it is an indication of mobility. Number of relationships has an influence, as mentioned above, because it is correlated with the share of non-core contacts. It is now possible to spatially maintain more widely distributed networks of weaker ties with less frequent face-to-

Table 5.4 Parameter estimates for the Tobit regression of the logarithm of the size of the 95% confidence ellipses and the associated Probit model of the Cragg approach

			Tobit model		Probit model	
Variable	**Mean**	**St .dev.**	**Beta**	**Sign.**	**Beta**	**Sign.**
Constant	-	-	9.92	0.00	2.45	0.03
Age (years)	53.4	19.3	-0.29	0.00	-0.11	0.01
$Age^2/1000$ ($years^2/1000$)	3.2	2.1	2.94	0.00	1.10	0.01
Car ownership (yes)	0.5	0.5	1.60	0.01	0.19	0.37
Number of relationships	12.5	8.4	0.20	0.00	0.09	0.00
Education/workplace changes	3.3	2.4	0.28	0.02	0.06	0.28
Further technical training (yes)	0.2	0.4	2.48	0.00	0.58	0.04
University degree (yes)	0.2	0.4	2.61	0.00	0.40	0.16
Income >6000 CHF (yes)	0.3	0.4	-1.64	0.03	-0.28	0.24
N		286			241	
Goodness-of-fit		Adjusted $R^2 = 0.25$			Chi^2 (8 df) = 47.31	

face contacts by using telecommunication contacts (see Axhausen 2007 for details). The number of education or workplace moves has a biographical influence on the social network geographies. Apparently, being less anchored in space and being professionally flexible have a positive influence on the size of the social network geographies. Surprisingly, spatial distribution of education and workplace changes, measured by their confidence ellipses, has no significant influence on them. Overall, the model explains 25 per cent of the variance of social network geographies. The parameters of the Probit model exactly follow the parameters of the Tobit model (See Table 5.4). The resulting predictions are 100 per cent correct for the 1s (y>0) and 22.5 per cent correct for the 0s, resulting in overall 89.2 per cent correct values. As the parameters of the Probit model show, limit outcome is determined by the level of non-limit outcome, so the estimates of the truncated model for non-limit observations are omitted.

Conclusion

Our primary goal for this chapter was to present insights into the conceptual background of the issue of mobilities and social networks. We first discussed relevance for social sciences and transport studies by presenting the pertinent strands of discussion in recent literature. We then explained methodological challenges in data gathering to examine personal mobilities and social networks. Finally, we presented several main empirical findings from a representative Zurich survey. In the following, we briefly conclude by discussing the empirical result.

Social network geographies indicate geographical patterns of personal relationships, especially how spatially distributed they are. We found that size and spatial dispersion of social network geographies differ according to various stratification dimensions, which in turn are related to various mobilities and inequality patterns.

In general, the analysis shows that the distribution of network geographies is very wide – from local ties to international ties – and a remarkable share of intercontinental ties. We examined the effects of residential change on spatial dispersion of an egocentric network (see also Ohnmacht et al. 2008). An explanatory factor is mobility biography. We see evidence that the more 'events' producing change occur – here especially measured by the number of relocations – the more spatially dispersed the network geography is. This finding can be linked to the forms of life flexibility discussed, for instance, by Kesselring (2008, 78):

> Within the mobile risk society people are self-responsible for the roads (metaphorically speaking: the authors) and trajectories they choose during their life course.

According to this sociological diagnosis and empirical findings, subjects might free themselves from both local obligations and responsibilities, falling back on local contacts. The consequence is a movement toward more flexibility in organising ones life and disappearance of the traditional 'normal biography'. This results in spatial diversity and social differentiation. Beck, for instance, talks about 'Issue-Communities' which are not necessarily locally integrated, but are instead based on reciprocal interests, such as leisure time activities, etc. (Beck 1992). Thus, for certain groups, social life becomes more fluid and dispersed, as well as long- distance (Lash and Urry 1994).

In summary, new questions evolve. What is the impact of having widespread social relations and how can one maintain it? What other factors cause social networks to become more spatially dispersed over time, influencing our travel behaviour? Why is it suddenly necessary for many people to travel long distances to meet with friends, relatives and partners? Which 'mobility tools' such as cars, public transport, bicycles and the new age of low-cost airlines,

(and to what extent) are necessary to meet them in person and to maintain the relationship? Long distance ties figure in more than half of egocentric networks. This fact is reflected in long distance travel statistics where the highest share involves visiting friends and relatives (e.g. Federal Statistical Office and Swiss Federal Office for Spatial Development 2007). It should be noted in further research and modelling that social network geographies have a certain structure at a certain size. These first results in analysing social network geographies patterns show that the ego's characteristics, (mainly socio-demographics and mobility biography events), can to a certain extend explain them.

References

Averill M. Law and Associates (2006), *ExpertFit Version 7* (Tuscon: Unifit).

Axhausen, K.W. (2007), 'Activity Spaces, Biographies, Social Networks and their Welfare Gains and Externalities: Some Hypotheses and Empirical Results', *Mobilities* 2:1, 15–36.

Axhausen, K.W. (2008), 'Social Networks, Mobility Biographies and Travel: The Survey Challenges' *Environment and Planning B* 35:6, 981–96.

Axhausen, K.W., Frei, A. and Ohnmacht, T. (2006), 'Networks, Biographies and Travel: First Empirical and Methodological Results', paper presented at the 11th International Conference on Travel Behaviour Research, August, Kyoto.

Axhausen, K.W., Löchl, M., Schlich, R., Buhl, T. and Widmer P. (2007), 'Fatigue in Long Duration Surveys', *Transportation* 34:2, 143–60.

Axhausen, K.W., Dolci, C., Frölich, P., Scherer, M. and Carioso, A. (2008), 'Constructing Timescaled Maps: Switzerland from 1950 to 2000', *Transport Review* 28:3, 391–413.

Beck, U. (1992), *Risk Society: Towards a New Modernity* (London: Sage Publications).

Beck, U. (2008), 'Mobility and the Cosmopolitan Perspective', in Canzler, W., Kaufmann, V. and Kesselring, S. (eds), *Tracing Mobilities: Towards a Cosmopolitan Perspective* (Aldershot: Ashgate), 25–36.

Beck-Gernsheim, E. (2007), 'Transnational Lives, transnational Marriages: A Review of the Evidence from Migrant Communities in Europe', *Global Networks* 7:6, 271–88.

Beige, S. and Axhausen, K.W. (2006), 'Long-term Mobility Decisions during the Life Course: Experiences with a Retrospective Survey', paper presented at the 11th International Conference on Travel Behaviour Research, August, Kyoto.

Blake, R., Rhead, C., Wedge, B. and Mouton J.S. (1956), 'Housing Architecture and Social Interaction', *Sociometry* 19:2, 133–9.

Burt, R.S. (1984), 'Network Items should be included in the General Social Survey', *Social Networks* 6:4, 293–339.

Butts, C.T. (2003), 'Predictability of Large-scale Spatially Embedded Networks', in Breiger, R., Carley, K.M. and Pattison, P. (eds), *Dynamic Social Network Modeling and Analysis: Workshop Summary and Papers* (Washington, DC: National Academies Press), 313–23.

Caplow, T. and Foreman, R. (1950), 'Neighborhood Interaction in a homegenous Community', *American Sociological Review* 15:3, 357–66.

Carrasco, J. and Miller, E.J. (2006), 'Exploring the Propensity to perform Social Activies: A social Network Approach', *Transportation*, 33:5, 463–80.

Carrasco, J., Hogan, B., Wellman, B. and Miller, E.J. (2008), 'Collecting Social Network Data to Study Social Activity-Travel Behavior: An Egocentric Approach', *Environment and Planning B* 35:6, 961–80.

Cass, N., Shove, E. and Urry, J. (2005), 'Social Exclusion, Mobility and Access', *Sociological Review* 53:3, 539–55.

Cragg, J. (1971), 'Some Statistical Models for limited dependent Variables with Application on the Demand for Durable Goods', *Econometrica* 39:5, 829–44.

Diaz-Bone, R. (1997), *Ego-zentrierte Netzwerkanalyse und familiale Beziehungssysteme* (Wiesbaden: Deutscher Universitäts-Verlag).

Federal Statistical Office and Swiss Federal Office for Spatial Development (2007), *Mikrozensus zum Verkehrsverhalten 2005* (Bern: Bundesamt für Statistik).

Fischer, C.S. (1982), 'What Do We Mean by 'Friend?' An Inductive Study', *Social Network* 3:4, 287–306.

Frei, A. (2007), 'Feldbericht zu den sozialen Netzwerkbefragungen', Working Paper, *Arbeitsberichte Verkehrs- und Raumplanung*, 440, IVT, ETH Zürich, Zürich.

Fröhlich, P., Tschopp, M. and Axhausen, K.W. (2005), 'Entwicklung der Erreichbarkeit der Schweizer Gemeinden: 1950 bis 2000', *Raumforschung und Raumordnung* 63:6, 385–99.

Götz, K. (2007), *Freizeit-Mobilität im Altag oder Disponible Zeit, Auszeit, Eigenzeit – warum wir in der Freizeit raus müssen* (Berlin: Duncker und Humblot).

Greene, W.H.H. (2002), *Econometric Analysis* (New York: Prentice Hall).

Grieco, M., Turner, J. and Hine, J.P. (2001), 'Transport, Employment and Social Exclusion', *Local Work*, vol. 26 (Manchester: Centre for Local Economic Strategies).

Handy, S.L. and Niemeier, D.A. (1997), 'Measuring Accessibility: An Exploration of Issue and Alternatives', *Environment and Planning A* 29:7 1175–94.

Hine, J.P. and Grieco, M. (2003), 'Scatters and Clusters in Time and Space: Implications for delivering integrated and inclusive Transport', *Transport Policy* 10:4, 299–306.

Holmes, M. (2004), 'An Equal Distance? Individualisation, Gender and Intimacy in Distance Relationships', *Sociological Review* 52:2, 180–200.

Jones, P.M., Dix, M.C., Clarke, M.I. and Heggie, I.G. (1983), *Understanding Travel Behaviour* (Aldershot: Gower).

Kaufmann, V., Bergman, M.M. and Joye, D. (2004), 'Motility: Mobility as Capital', *International Journal of Urban and Regional Research* 28:4, 745–65.

Kesselring, S. (2008), 'The Mobile Risk Society', in Canzler, W., Kaufmann, V. and Kesselring, S. (eds), *Tracing Mobilities: Towards a Cosmopolitan Perspective* (Aldershot: Ashgate).

Larsen, J., Urry, J. and Axhausen, K.W. (2006), *Mobilities, Networks, Geographies* (Aldershot: Ashgate).

Latane, B., Liu, J.H., Nowak, A., Bonevento, M. and Zheng, L. (1995), 'Distance Matters: Physical Space and Social Impact', *Personality and Social Psychology Bulletin* 21:8, 795-804.

Löw, M. (2001), *Raumsoziologie* (Frankfurt/Main: Suhrkamp).

Löw, M. (2005), 'The Constitution of Space. The Double Existence of Space as Structural Ordering and Performative Act', lecture at Paris I/Sorbonne 14 March 2005, <http://www.raumsoziologie.de> (homepage), accessed 21 May 2008.

Marsden, P.V. (2005), 'Recent Developments in Network Measurement', in Carrington, P.J., Scott, J. and Wasserman, S. (eds), *Models and Methods in Social Network Analysis* (New York: Cambridge University Press), 8–30.

Ohnmacht, T. and Axhausen, K.W. (2005), ''Wenn es billiger ist als die Bahn – na ja, warum nicht?': Qualitative Auswertung zu Mobilitätsbiographien, Mobilitätswerkzeugen und sozialen Netzen', Working Paper, *Verkehrs- und Raumplanung*, 313, IVT, ETH Zürich, Zürich.

Ohnmacht, T., Frei, A. and Axhausen, K.W. (2008), 'Mobilitätsbiografie und Netzwerkgeografie: Wessen soziales Netzwerk ist räumlich dispers?', *Swiss Journal of Sociology* 31:1, 131–64.

Ortuzar, J.D. and Willumsen, L.G. (2001), *Modelling Transport* (Chichester: Wiley).

Prillwitz, J., Harms, S. and Lanzendorf, M. (2006), 'Impact of Life Course Events on Car Ownership', *Transportation Research Records* 1985, 71–7.

Rai, R.K., Balmer, M., Rieser, M., Vaze, V.S., Schönfelder S. and Axhausen, K.W. (2007), 'Capturing Human Activity Spaces: New Geometries', *Transportation Research Record* 2021, 70–80.

Scheiner, J. (2007), 'Mobility Biographies: Elements of a Biographical Theory of Travel Demand', *Erdkunde* 61:2, 161–73.

Schönfelder, S. (2006), 'Urban Rythms: Modelling the Rythms of Individual Travel Behaviour', dissertation, ETH Zürich, Zürich.

Schönfelder, S. and Axhausen, K.W. (2003), 'Activity Spaces: Measures of Social Exclusion?', *Transport Policy* 10:4, 273-86.

Schubert, S. (1994), 'Zur Bedeutung von räumlichen Entfernungen und sozialen Beziehungen für Hilfe im Alter', *Geographische Zeitschrift* 82:4, 226–38.

Sheller, M. and Urry, J. (2006), 'The New Mobilities Paradigm', *Environment and Planning A* 38:2, 207–26.

Shields, R. (1991), *Places on the Margin. Alternative Geographies of Modernity* (London: Routledge).

Simmel, G. (1908), *Soziologie. Untersuchungen über die Formen der Vergesellschaftung* (Berlin: Duncker und Humblot Verlag).

Snow, D.A., Leahy, P. and Schwab, W. A. (1981), 'Social Interaction in a Heterogeneous Apartment: An Investigation of the Effects of Environment upon Behaviour', *Sociological Focus* 14:4, 309–19.

Sommer, R. (1996), *Personal Space* (Englewood Cliffs, NJ: Prentice Hall).

Swiss Federal Statistical Office (2000), *Eidgenössische Volkszählung (VZ) 2000* (Bern: Bundesamt für Statistik).

Swiss Federal Statistical Office and Swiss Federal Office for Spatial Development (2007), *Mikrozensus zum Verkehrsverhalten 2005* (Neuchâtel and Berne: Swiss Federal Statistical Office and Swiss Federal Office for Spatial Development).

Tönnies, F. (1991), *Gemeinschaft und Gesellschaft: Grundbegriffe der reinen Soziologie* (Darmstadt: Wissenschaftliche Buchgesellschaft).

Urry, J. (2008a), *Mobilities* (Oxford: Blackwell).

Urry, J. (2008b), 'Moving on the Mobility Turn', in Canzler, W., Kaufmann, V. and Kesselring, S. (eds), *Tracing Mobilities: Towards a Cosmopolitan Perspective* (Aldershot: Ashgate), 13–24.

Wasserman, S. and Faust, K. (1994), *Social Network Analysis: Methods and Applications* (New York: Cambridge University Press).

Wellman, B. (1996), 'Are Personal Communities Local? A Dumptarian Reconsideration', *Social Networks* 18:4, 347–54.

Wellman, B. (1979), 'The Community Question: The Intimate Networks of East Yorkers', *The American Journal of Sociology* 84:5, 1201–31.

Wittel, A. (2001), 'Towards a Network Sociality', *Theory, Culture and Society* 18:1, 51–76.