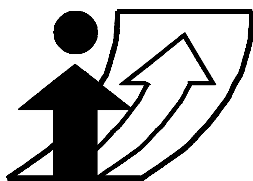# Networks, biographies and travel:
First empirical and methodological results

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1   The social content of travel

Travel is the price we pay to be with other people, at least it is a very substantial part of the generalised cost of meeting others. If we accept this proposition, and consider that vast majority of travel services activities with others, then one has to wonder, why the social content of the activities and the constraints arising from co-ordination with others has received so little attention so far in transport research. It has only been in the last couple of years that some research has begun to probe the questions arising from such a viewpoint. This paper will not attempt to review the work so far, but will focus one particular realisation of this viewpoint, or better the specific question of how the geographical spread of the home and other major locations of the members of a social network, e.g. work, second homes, regular holiday locations, most frequently used shopping centre, influence the destination choice of everybody concerned. It will omit the theoretical discussion of how the assumed trends in the spread or size of social (network) geographies influence the size and structure of the underlying social networks, but see Axhausen (2005 and Forthcoming). The main item of discussion of the paper will be the survey challenges arising and some first empirical results from first tests of the relevant survey formats.

Transport models, operational models in particular, focus on the generalised costs of travel to explain the observed choices. The generalised cost of a trip is the risk and comfort adjusted weighted sum of the resources consumed for travel: travel time and perceived monetary expenditure. In such models the benefits arising from the activity participation are captured, poorly, through the activity purpose. Many models try to improve the description through market segmentation employing concepts, such as "role" captured through the socio-demographics of the traveller, or milieux and live style as indicated by particular attitudes and values. The market segmentation is complemented or sometimes replaced through explicit

modelling of the distribution of the taste parameters in latent class or mixed choice models (see Train, 2003 and Greene and Hensher, 2003). Taking the social content of the activities seriously (see below) it becomes clear, that geography of the social networks constrains choices, but that the social capital inherent in the network enables travel. The joint mental map of the social network members is a main resource here. Introducing the mental map and also the social network as explanatory concepts requires the analyst to query the biography of the traveller, as both are the results of this particular time-space trajectory.

The social content of an activity is the set of social implications of an activity, above and beyond the immediate actions. These implications are primarily the social obligations fulfilled with the activity, but also the contributions such an activity makes to the image and self-image of the traveller. It would be a start, if transport analysis would describe the activities better. Axhausen, 2006 suggests the following items for this purpose:

- "A more detailed coding of the actions involved, perhaps at the level of detail typical for time-use studies
- A description of the social purpose of the activity and of the obligations fulfilled with it
- The beneficiaries of the activity
- Composition of the party travelling together to the activity
- Composition of the party participating in the event and having meaningful interactions with the traveller
- The locations of the fellow travellers and participants prior to the trip or activity, to assess their costs to be involved in the activity or the movement
- Distribution of the travel and activity costs among the participants and beneficiaries.
- The planning horizon of the activity
- Number of previous visits to that location, in particular, if it was the first visit ever.
- The secondary activities undertaken during the trip and the activity, if any".

This set would allow the analyst to start to understand how social capital is created and how it allows the persons involved to achieve their aims. The underlying understanding of social

capital is narrower then usually found in the literature (Putnam, 2000; Grieco, 1996; Granovetter, 1973). Axhausen (2005, 2006) proposes that it is the joint skilful ability of the members of a network to perform, act and enjoy each other as the result of their joint history, commitments, references and understandings. In daily life, it encompasses both productive and hedonic aspects of joint human action. As defined here it only works for its owners if they act together, otherwise it is dead. Still, this capital implies a commitment, a debt, a goodwill which can be mobilised in the form of various resources: time, money, information or attention spent for the benefit of the other or a third party nominated by the other. It is this final aspect which most of the literature stresses, but for the understanding of activity and travel the other aspect is primary.

A traveller can belong to multiple social networks (see for example Bidart and Lavenu, 2005; Buchanan, 2002; Freeman, 2004; Watts, 1999 and 2003; Keupp and Röhrle, 1987; Laumann, 1973; Mitchell, 1969). A social network is defined as a group of pairs of persons, in which any member can reach any other through a sequence of active ties, i.e. the relationship between a pair of members. The nature of the tie varies by the type of network, but always entails a certain minimum flow of resources and commitments between the two persons: being related to one another, working for the same group or firm, having studied with the same teacher, belonging to the same sport clubs, attending the same games, being a regular at the same bar, driving the same antique car model, having grown up in the same place (at the same time), etc. As the possible number of overlays of types of ties is nearly endless, it seems pointless to speak just of strong and weak ties. Each tie entails a certain commitment and with it certain duties and rights. The differences in these rights and duties also segment the in principle universal net encompassing all human beings into a set of many smaller networks, which have different levels of awareness of their respective existence.

2   Hypotheses and research questions

The integration of social networks into thinking about travel behaviour generates new hypotheses which could be tested with appropriate data. The view, that the utility of an activity derives from the set of persons with which it is performed, implies a large variance of the utility, which cannot be captured by type and duration alone, the two variables currently available. (The items presented above should be able to capture this better). Still, currently, one would expect the distribution of the network contacts will affect destination choice, in particular that the activity space of the travellers will grow with the social geography of their networks. It becomes more likely, that the higher utility available from an activity with good friends outweighs the higher generalised cost of travel to further destinations (See also Blinde and Schlich, 2000). On the other hand, the absence of local contacts makes it more likely that travellers can only choose among those modes, which they have personally available. Ride sharing becomes less likely, if the cost of the pick-up increases; the same applies to informal car sharing among friends. One would further expect that the rate of behavioural innovation, i.e. new locations and new activity types per unit time, increases with the total number of contacts and with their spread. More people are more likely to be aware of more opportunity and the further they are spread, the small the overlap in their knowledge. The same reasoning leads to the expectation, that persons with large and widely spread networks will be able to perform their activities efficiently, i.e. cheaply, effectively, enjoyable. These effects are reinforced if the travellers themselves had a biography which involved a large number of moves across a wide range of locations.

3   Data challenge

The hypotheses discussed above have highlighted the potential importance of the number of social networks, the total number of contacts and their spatial spread. In addition, the role of the residential and employment mobility over the life course was stressed. To test them, we need to collect the relevant information from the respondents without overburdening them. The items of interest ideally are:

A comprehensive or at least relevant list of contacts

- The home (and work) location of each contact, the type of tie connecting the contact and the respondent, the resources available to the contact

- Plus information about the last meetings with the contacts (location, mode of travel, cost sharing, group composition) in addition to information about the frequency of electronic (email, IM, chat room, SMS, letter mail) and telephonic contacts.

In addition, one would need to characterise the biography of the respondent:

- The homes and workplaces over the life course of the respondent and supporting information about incomes, family situation and mobility tool ownership

These items are unusual for travel behaviour research, but some of them have long traditions in sociology, where social networks and the life course have been studied for decades. What is generally missing in those studies are the questions about locations, meetings and methods of contact (see review in Carrasco, 2006). If they are asked, they tend to request spatial data at a low resolution, say for example "in town", "in the county", "in state", "out of state" or similar categories. While the electronic methods of contact had attention for some time, the matching physical meetings received less or no systematic attention.

The life course research (Brückner, 1990; Wagner, 1990; Hollingworth and Miller, 1996; Vandersmissen, Séguin, Thériault and Claramunt, 2005) has demonstrated that it is possible

to recover information about past events with acceptable accuracy, while always acknowledging that panels, such as the US Panel on Income Dynamics (www.icpsr.umich.edu/), the German Sozioökonomische Panel (www.diw.de/deutsch/sop/index.html) or the Swiss Household Panel (www.swisspanel.ch) are superior, but substantially more expensive and slower data sources. Given the general emphasis in life course research on education, family and work, there was no experience with regards to the items of interest to travel behaviour research (mobility tool ownership and access, main mode, detailed work place information).

It is obvious from the list above, that these new items impose a very substantial respondent burden, especially if they were to be added to a travel diary or other survey instrument. The rather private questions about the personal networks raise the issue of how to win the commitment of the respondents to the task rather more strongly then the usual travel behaviour surveys. The retrospective nature of the questions about the life-course must lead to errors, if the reporting period is chosen too large. The challenge of the survey design is then to allocate the items to the appropriate survey mode (face-to-face, telephone, self-administered), to optimise the recruitment through the protocol chosen and possible incentives, while finally define an appropriate reporting period and set of items.

4   Example surveys

A series of recent surveys have addressed the challenges raised above. Axhausen and Beige, 2003 and Beige, 2004 report a 10 year retrospective mobility biography survey, which was carried out face-to-face as part of a larger omnibus study. Lanzendorf (2004) reports a small dedicated face-to-face survey of the mobility biography (Lanzendorf, 2003) of his respondents, i.e. a life course survey focusing on travel behaviour. Thirteen persons were interviewed about their life course and how certain events changed their travel behaviour and commitments to certain modes. Beige and Axhausen (2005 and 2006) conduct a dedicated

mobility biography survey, including additional information about the motivations behind the moves. The contents had been pre-tested jointly with an instrument about housing conditions and local shopping and green space use, but this joint survey had such a poor response that the two instruments were separated for their respective main studies (See Waldner, Löchl, Bürgle and Axhausen, 2005 for this second survey). The mobility biographical items are presented to the respondents as a matrix of items times the year. The reporting period is 20 years. This format has been used in previous work outside transport, but later test showed that most respondents find it confusing and difficult and that they prefer separate lists, one for each item (see the survey in the Appendix for the types of questions asked).

Carrasco (2006) reports the results of the 2004/2005 Connected Lives study, which covered the bulk of the social network items mentioned above (See also Wellman, Hogan, Berg, Boase, Carrasco, Coté, Kayahara, Kennedy and Tran, 2006). Drawing on the experiences of Wellman (1988, 1996 and 2001) the team constructed an effective procedure to obtain both the core and the wider social network of the respondents (Hogan, Carrasco and Wellman, Forthcoming). In line with literature (see Marsden, 2005 and Marsden, 1990) they asked the respondent to name those person outside they felt very close and somewhat close to. To gain insight into the structure of this group the respondents arranged them on a diagram of a set of concentric circles. The distance from the centres can be interpreted as distance from the ego (the respondent). In addition, the respondents indicated which of the on average 24 named contacts knew each other and which formed cliques or more intensively tied groups, say families. While it is not possible to obtain the information about the complete network, the information is richer than in the usual egocentric network surveys, which have no information about the social structure of named contacts at all. The respondents specified how often they contacted a subsample of their contacts for these types of interaction (cell phone, regular phone, email, instant message, face to face, meeting at a bar or restaurant, visiting or hosting as a visitor) (Note the Northamerican absence of SMS). For this subsample the home location was requested. A total of 87 interviews were completed (25% of those eligible). The respon-

dents received a Can\$ 20 incentive and were recruited from through a written self-administered instrument, which had a response rate of 56% and was conducted in East York, an older suburban part of the greater Toronto area.

In parallel Ohnmacht and Axhausen tested the items in face-to-face intensive interviews in Zürich and Berlin (Ohnmacht, 2004; Ohnmacht and Axhausen, 2005a, b and Ohnmacht, 2006). The interviews showed that the respondents, even in the presence of an interviewer, preferred a list format to a matrix format for the mobility biography questions. The prompt for the contacts was relatively unspecific and asked for persons to which the respondents had contacts and with whom joint activities were undertaken. No classification in terms of social closeness or importance was undertaken, but the classification was more formal employing the categories (partner, family or relative, friends, acquaintance from a club or hobby, colleague from work). The recruitment was informal through notices on message boards and approaches in the social networks of the interviewer. The 30 respondents received an incentive of SFr 50 for the two to three hour interviews.

Building on the work by Ohnmacht and Axhausen, Larsen, Urry and Axhausen (2005, 2006) revised and expanded the contents, while retaining the face-to-face approach. The 24 respondents were recruited in Manchester and Liverpool by a quota approach to achieve a range of socio-economic conditions. As the *Connected lives* – study, the respondents described the way and frequency of interaction with the named contacts (meeting, telephone, SMS and email) (See Geser, 2004 for the relevant background discussion of the changing role of the phone and other contact modes). The prompt for the contact varied between the pre-interview questionnaire and the post-interview questionnaire. Whereas the first asked for family and non-local friends, the second asked for the ten most important people. The second list overlapped with the first two, but not completely.

While the face-to-face interviews discussed so far were able to collect the information of interest, it is difficult to scale this approach to representative samples. In a recent experiment Frei and Axhausen tested two out of four alternatives: self-administered survey only, self-administered survey with motivation call or with computer-aided telephone interview for data retrieval, a face-to-face interview with an additional post-interview written questionnaire. Based on initial assumptions about response rates and efforts involved the options of written questionnaire plus motivation call (estimated costs of 67 sFr/response) and face-to-face interview (estimated costs of 110 sFr/response) were chosen, also to see, if there are major data quality differences. Using a random sample of 100 addresses with telephone numbers from the Zürich area both approaches were implemented in the fall and winter of 2005. The response rate of the protocol with the written questionnaire (see appendix) and the motivation call was substantially below expectations: 11.2% were the respondents were reached for the motivation call and only 4.4% were they were not. With this response rate, the face-to-face protocol is as expensive, but preferable due to the possibility to detect respondent difficulties and due to higher intensity of the contact with the respondent.

Table 1 shows the recruitment success of the on-going Zürich study. The aim is to obtain a total of 300 interviews.

Table 1   Recruitment rates for Zürich survey on social networks and mobility biographies

Phase	Pre-test	On-going main study	Share of total	Share of reached by phone
Sample	150	2400	100%	
Wrong address	0	28	1.2%	
Not reachable by phone	36	706	29.4%	
Reached by phone	113	1673	69.7%	100%
Recruited	14	179	7.5%	10.7%
Interviewed	13	172	7.2%	10.3%
Post-interview questionnaire returned	13	154	6.4%	9.2%

A remark: Response burden and response rates: This set of high response burden surveys invited the question, if the response rates could be predicted ex-ante. While the literature on survey methods (see Richardson, Ampt and Meyburg, 1995 or Dillman, 2000 for relevant textbooks) discusses response burden, there seems to be no literature on its ex-ante prediction, nor on the resulting link to the response rate. Still, market research firms have to estimate their interviewers' time requirements in advance to be able to calculate a budget for a study. Using their point system, Ursula Raymann of the local Gesellschaft für Sozialforschung, rated the self-administered surveys mentioned above plus others, which had been conducted by Axhausen and his collaborators in Switzerland. For this small sample of self-administered surveys, there is a very strong link between the independent assessment of respondent burden and the response (Figure 1 and Table 2). Two initial trends are visible: the response rate declines with the ex-ante estimate of the response burden and prior recruitment seems equivalent to a motivation call in building the commitment of the respondents. Clearly, these results need to be verified with a larger sample of surveys. It is also clear, that the response burden interacts with the characteristics of the respondents. In addition, the content of the survey has an impact, as shown for example by the differential response rates to different sets of SP experiments in the Swiss value of travel time savings study (Axhausen, König, Abay, Bates and Bierlaire, 2004).

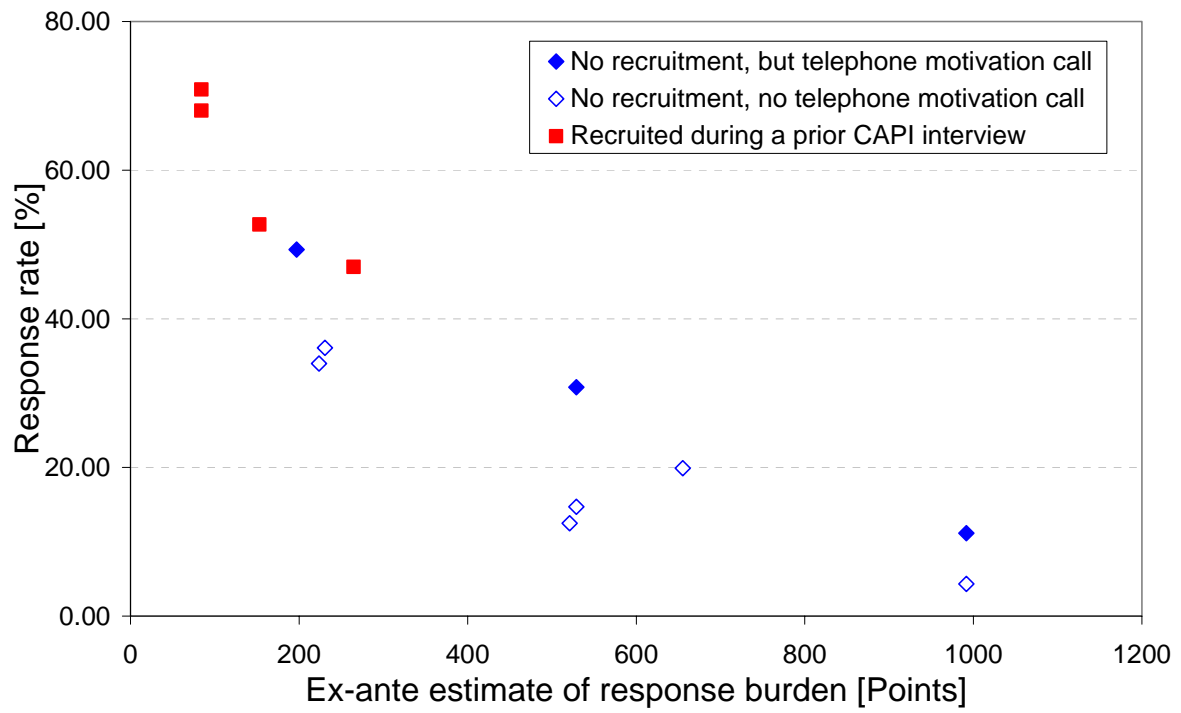Figure 1   Response rate and ex-ante assessment of response burden

Table 2   Response rate and ex-ante assessment of response burden

Content of the self-administered surveys	Ex-ante assessment of respondent burden	No prior recruitment		With recruitment
		Motivation call	No motivation call	
National SP survey on railway services	84.00			68.00
Regional mode and route choice SP	84.00			70.87
National SP on value of travel time savings	152.90			52.70
Regional SR on value of statistical life	197.00	49.30		
Regional SR on value of statistical life	223.60		34.00	
Home ownership and use of local facilities	230.70		36.10	
National SP on the impacts of road pricing	264.79			47.00
Mobility biographies and regular travel	521.00		12.49	
Mobility biographies	529.00	30.80	14.70	
Mobility biographies and home ownership	655.40		19.90	
Social networks and mobility biographies	991.75	11.17	4.35	

Sources in the order listed: Vrtic and Axhausen, 2004; Vrtic and Fröhlich, 2006; Axhausen, Hess, König, Abay, Bierlaire and Bates (2006); Locatteli (2004); Jäggle (2006); Waldner, Bürgle and Löchl, 2005; Vrtic, Schüssler, Erath and Axhausen, 2006; Schiffmann, 2005; Beige and Axhausen, 2005 (main study and pre-test) (also Beige, 2006); and the survey work report in this paper.

The current work on social networks in transport has no yet agreed on a standard prompt for the contacts. Frei and Axhausen, for example, asked for persons with whom the respondents discuss "important problems, with whom you stay in regular contact or which you can ask for help" and for persons with whom the respondents spend leisure time. While the first group is very similar to the "very close" category of the *Connected lives* – study or the "most important" classification of the Larsen, Urry and Axhausen interviews, the second is rather different from the "somewhat close" description of the *Connected lives* – study. At this early point of the development, one cannot expect convergence in practise, something which social network

research has not achieved either after 40 years, but it would be desirable. From earlier work it is clear, that the acceptable distance for a given journey frequency depends on the closeness between the persons involved (Figure 2). To cover the local environment the category "somewhat close" or "person, with whom you engage in joint leisure" would be appropriate, especially if the type of tie is also queried to gain a better understanding. For the longer distance aspects a category, such as "very close", "most important" would be better, as these occasional meetings are not registered as leisure in the everyday sense. An explicit, but separate prompt for relatives and family members would make sure, that one covers most persons.

Figure 2   Median distance between home locations by type of relationship and frequency of visit (2003 Thurgau survey)
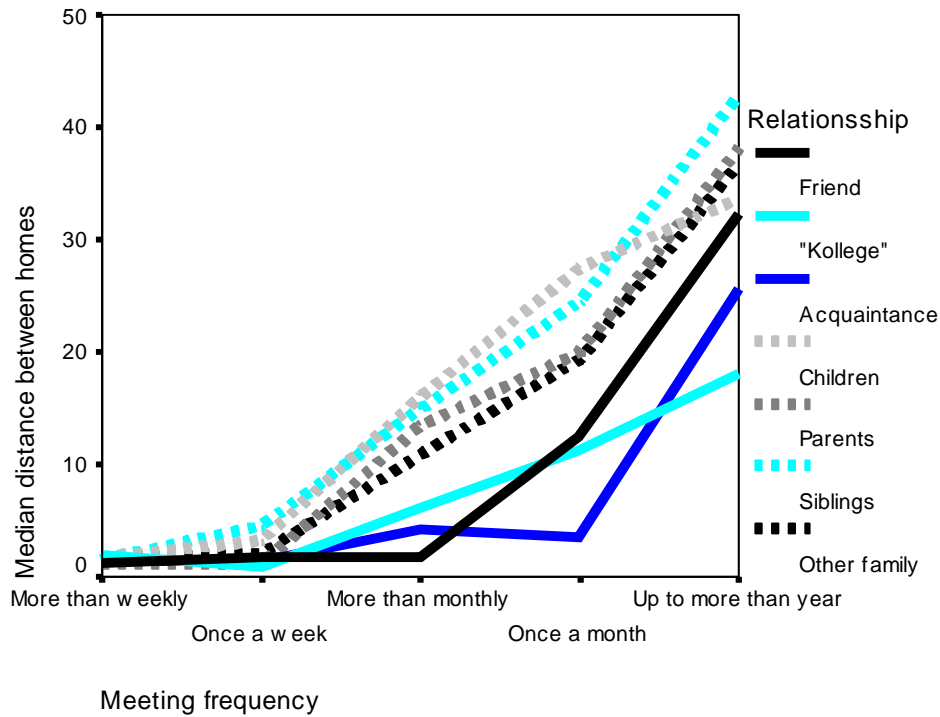
Note that "Kollege" in Swiss-German is a term covering everybody from work mate, school mate, fellow member of a sports clubs, fellow soldier to somebody who is more than just an acquaintance; Note as well, that it is well known, that people overestimate the frequency of rare events. Respondents had been asked to provide home location and frequency of visit for up to five members of the family and five friends. Sample size is 215.

Source: Löchl, Schönfelder, Schlich, Buhl, Widmer and Axhausen (2005); Axhausen, Löchl, Schlich, Buhl and Widmer (forthcoming)

Still, in terms of travel one might wish to add work-related commitments, which often offer the opportunity to add leisure elements to a business trip. Finally, one has to be aware, that any survey-based approach can only recover a small share of the total network of a person. Most surveys actually impose upper limits on the names to be reported for this reason. The surveys discussed in detail above, generally did not impose such limits, but for the implied limit of the number of lines in the survey forms. Larsen *et al*., 2005 were more specific, when they asked for a maximum of ten most important persons and ten non-local friends. From the

perspective of the social network geography this could be suboptimal, if the respondents prefer to report contacts living closer by.

The *connected – lives* study attempted to obtain information about the network structure of the contacts named. This adds valuable information about the egocentric network information collected. Otherwise, information about partial complete networks is only available for closed groups, such as school classes or members of a club. The networks are partial, as the links to persons outside the identified group are normally ignored. Kossinets and Watts (2006) have been able to increase the sample size of such a partial complete network by analysing the email message flow between students and staff of a mayor US university. Schnorf (2005) was able to trace all SMS and mobile phone contacts between a class of pupils and their outside peers through his access to the billing records of the phone company involved. Still, while these methods are promising in the long run, they offer only partial data as they are limited to one channel of communication and are not normally accessible to researchers. Egocentric network information will have to suffice for the time being keeping in mind that micro-simulation models could be used to generate complete networks.

5   First results

5.1   Current dataset

The work undertaken so far allows us to probe the data for its future possibilities. Mobility biographies and social network information is available from 128 respondents, as detailed in Table 3. The data collected in each of seven exercises is not completely consistent, but all cover the mobility biography and the core social networks of the respondents. The dedicated mobility biography surveys will be reported separately by Beige and Axhausen (2006).

Table 3   Source and contents of the initial data set

Sponsor/Location	Sample	Format	Contents
Institut für Mobilitätsforschung, Berlin (ifmo)			
Zürich/Berlin: Phase 1	15	f-to-f	Matrix format for biography, no limitation on the number of contacts
Zürich/Berlin: Phase 2	15	f-to-f	List format for biography, no limitations on the number of contacts
UK Department of Transport's Horizon Programme			
Lancaster/Liverpool	24	f-to-f	List format for biography, max ten non-local friends and ten most important persons
COST action 355 and ifmo			
Class room exercise[1]	6	written	List format for biography, implied limit through form for „leisure contacts" and important persons
Zürich: Pre-test 1	10	written	
Zürich: Pre-test 2	13	f-to-f; written	
Zürich: On-going main study	45	f-to-f, written	

[1] The students of the class room exercise had to fill in and discuss the questionnaire being pre-tested in Zürich. They took part in an international Master programme sponsored by Volkswagen for its employees.

5.2   Number of contacts

The number of contacts reported by the respondent is the first statistic of interest. Figure 3 shows the distribution of the number of contacts across all respondents. The average number of contacts is with 12.5, rather small compared to the average of 23.8 contacts, about half and half close and somewhat close, reported by Hogan, Carrasco and Wellman (Forthcoming). See also McCallister and Fischer, 1978 und Jackson, Fischer and McCallister, 1977 for earlier results on the size of reported ego-centric networks. The share of important or somewhat close contacts is 72.6 %, which means an average of 8.8 contacts. This is not so different from the reports in the literature. Figure 3 shows the distribution of the number of social contacts.

Figure 3   Distribution of the number of social contacts
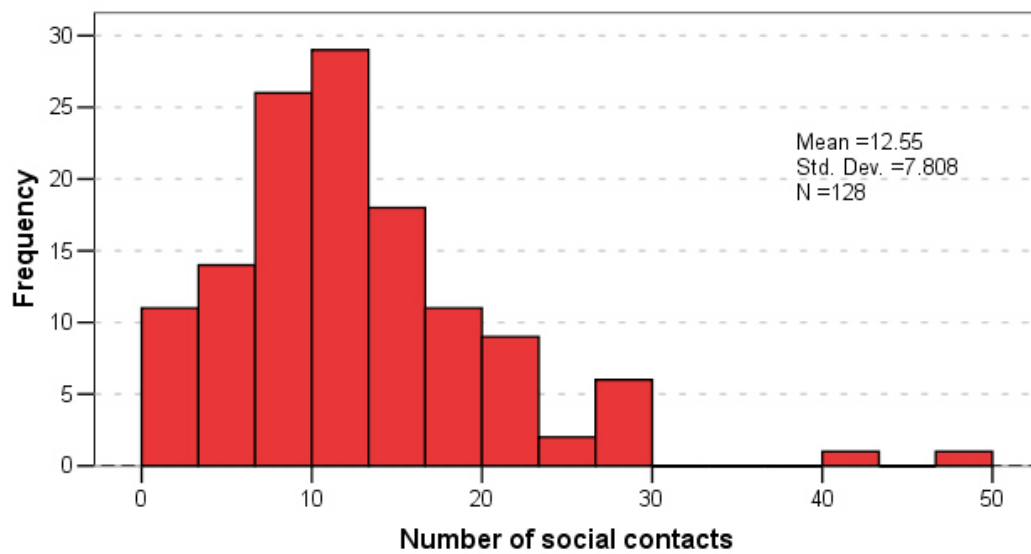
The standard deviation of 7.8 is relative to the mean quite high. The number of social contacts and socio-demographic attributes are compared in **Error! Reference source not found.**.

Table 4   Social contacts by socio-demographic characteristics

		Mean	Median	St. dev.
Gender	female	12.4	11	7.3
	male	12.7	12	8.2
Education	n.a.	12.9	13	1.8
	Compulsory school	14.3	10	13.4
	Apprenticeship	9.7	9	5.9
	Baccalaureat	14.1	13	7.4
	Professional tertiary	11.5	9	7.6
	University degree	14.6	13	7.7
Age [years]	Up to 29	15.4	14	8.2
	30 to 39	14.1	14	5.4
	40 to 59	9.7	8	8.2
	60 and more	10.9	10	8.4
Income [CHF/month]	n.a.	14.5	15	7.0
	0-1999	13.2	13	6.8
	2000-5999	12.3	11	8.5
	6000+	10.3	11	6.6

N = 128; pooled data from all surveys

Gender seems to have no influence on the numbers of social contacts. The education level indicates that a higher level of education increases the amount of social contacts, but there is not a clear trend. The group with a secondary school degree, which is rare in the dataset, reports a higher mean number of contacts than the group with a university degree, which is confirmed by the median. The age seems to makes the biggest difference, whereby the younger people seem to cultivate more contacts than the older ones. The income dependence is opposite to expectation. People with a lower income seem to maintain a bigger number of social contacts. Given the different prompts discussed above, there are differences between the three surveys (Table 5). The ifmo survey and the Horizon survey report a higher cumulative number of so-

cial contacts than the COST 355 survey. The main reason for this difference is already dis-cussed above and underlies the different name generator, which is in the COST 355 survey much stricter. The ifmo survey also included former contacts, where one has to consider that contacts mostly have not got an exact end in time and it is likely that in case of doubt contacts are rather mentioned as current than as former. Other influence factors for the number of con-tacts reported could also be the higher care in the two first mentioned surveys, which was much higher in comparison with the COST 355 survey.

Table 5   Social contacts by type and survey

Survey	Category	Mean	Median	St. dev.
ifmo	Previous contacts	6.4	6	4.3
	Current contacts	14.6	11	6.7
	All	21.0	17	8.1
Horizon	Family and relatives	4.2	4	1.7
	Non-local friends	6.5	6	2.7
	Most important persons (max of 10)	7.5	8	2.9
	All	14.1	14	3.5
COST 355	Important persons	7.0	7	4.0
	Persons with leisure interactions	3.1	3	4.1
	All	10.1	9	7.9

N = 128;

It seems that socio-demographic variables alone cannot explain the difference in the number of social contacts. Therefore socio-demographic, travel related, biographical and survey-specific dummy variables are employed to explain the number of social contacts using a re-gression. The number of social contacts represents count data, which should be explained us-ing the poisson-regression approach (Greene, 2000). After removing variables which correlate highly with each other (limit = 0.5; e.g. working status, age), variables with a significance level lower then 0.05 were stepwise removed. The parameter estimates are reported in Table 6 in both their standardized and unstandardized forms.

Table 6   Parameter estimates for the Poisson regression of the number of contacts

Variable	Mean	St. dev	Beta	Standard-ised beta	Sign.
Constant	-	-	3.753	-	0.000
Age [years]	45.68	19.08	-0.051	-0.124	0.000
$Age^2/1000$ [$years^2/1000$]	2.44	0.09	0.401	0.102	0.000
Data_horizon [y/n]	0.19	0.39	-0.289	-0.015	0.000
Data_COST 355 [y/n]	0.57	0.50	-0.256	-0.016	0.000
Number of relocations [n]	5.82	2.74	0.037	0.013	0.000
University degree [y/n]	0.28	0.45	0.116	0.007	0.045
N	128				
Adjusted R^2	0.16				
Pooled data from all surveys					

The determination coefficient is, as expected from the descriptive statistics, rather low (R^2=0.16). But for the explanation of human behaviour according to number of social contacts this value is comparable with other studies (e.g. Schlich and Axhausen, 2002).

The results are summarized as follows: The age of the respondents has got a U-shaped influence on the number of social contacts. Younger people have got many contacts and then the number declines with increasing age, before it starts again to increase. The different data sources have an influence as discussed. A higher education, at least a university degree, leads to a bigger number of social contacts than the number of relocations. The evidence of the positive influence of the number of relocations is that people keep their important friends after relocation even at a certain distance. By building up a social network at the new location and keep in touch with "old" friends, numbers of social contacts seems to increase.

5.3   Distance and contact mode

The distribution of the great circle distances (Figure 4) between the respondents and their contacts has three elements[1]. A good third of the contacts live locally within the same municipality, while in the bigger cities of Liverpool, Berlin or Zürich this might require substantial travel time for a meeting, but lacking detailed addresses, these are coded as zero distances. The bulk of the remaining distances are regional and national, but with a tendency to longer distances. A noticeable share of intercontinental links makes up the rest (Figure 4). The respondents mix local contacts of daily life with a multitude of non-local and often long distance contacts. The socio-demographic differences (Table 7) are driven by age, education and their interactions plus the attachment to personally more important contacts.

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[1] The great circle distances account for the shape of the earth, which is important for the contacts beyond the regional range.

Table 7   Descriptive statistics of the great circle distances between home locations of contact and respondents [km] (with and without local contacts)

Variable	Median		Mean		S.E. of the mean		Number of cases	
Category	with	w/o	with	w/o	with	w/o	with	w/o
Age								
Up to 30	76	292	1152	1660	142	198	464	322
30 to 40	46	252	796	1133	124	172	343	241
40 to 60	19	146	811	1342	206	331	182	110
60 and older	22	180	655	1099	122	200	389	232
Sex								
Female	19	131	626	1004	97	152	598	373
Male	82	328	1071	1571	103	146	780	532
Education								
n.a.	0	39	1708	3985	723	1573	49	21
Compulsory school	10	150	400	732	195	352	128	70
Apprenticeship	15	122	618	1012	126	201	280	171
Baccalaureat	121	514	2059	2831	280	367	220	160
Professional tertiary	96	190	762	963	118	147	349	276
University degree	35	338	522	887	83	135	352	207
Income [sFr/month]								
n.a.	107	131	1583	1962	214	259	259	209
0-1999	21	260	803	1285	163	253	253	158
2000-5999	23	285	648	1029	80	124	749	472
6000+	15	378	953	1690	311	535	117	66
Type of contact								
Others	0	123	459	1008	148	320	292	133
Friends	31	103	778	1069	253	343	99	72
Partner	0	41	164	647	138	538	63	16
Family	45	146	482	723	106	155	216	144
Work mates	0	79	272	585	124	264	200	93
All	37	250	878	1337	72	107	1378	905

Only the "most important" contacts of the Horizon interviews are included here.

Figure 4   Distribution of the great circle distances between respondents and their non-local contacts
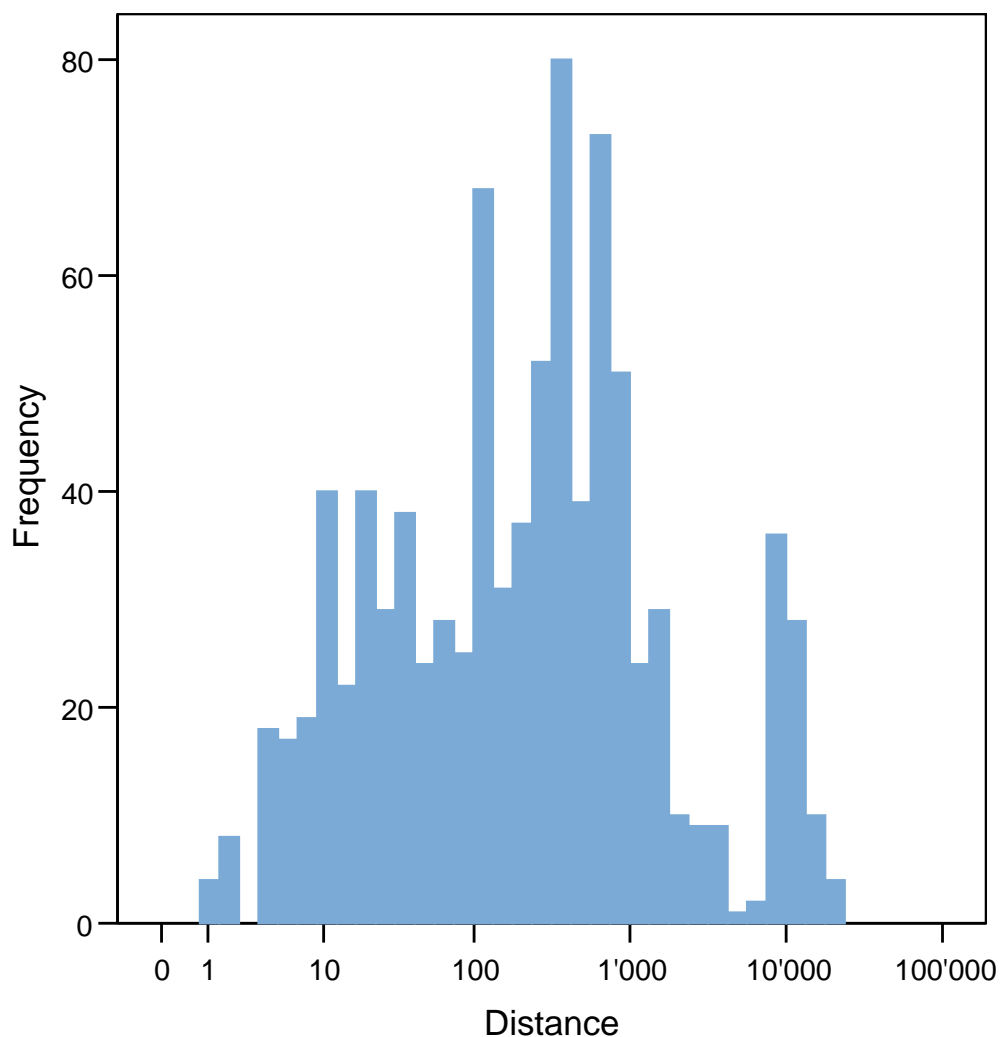
Pooled data of all surveys in Table 3; without contacts living in the same municipality

In contrast to the results shown in Figure 4 the family face-to-face contacts are not maintained over the longest distances (Figure 5). The peak of the weekly family visit is clearly visible, though. Still, it is clear that the respondents value the rare meetings enough to accept very substantial travel distances. We would expect that the visits would also be longer ones, which can substitute for the lack of frequency (See also Larsen, Urry and Axhausen, 2006).

Figure 5   Mean distance between home locations by type of relationship and frequency of face-to-face meeting (non-local contacts)
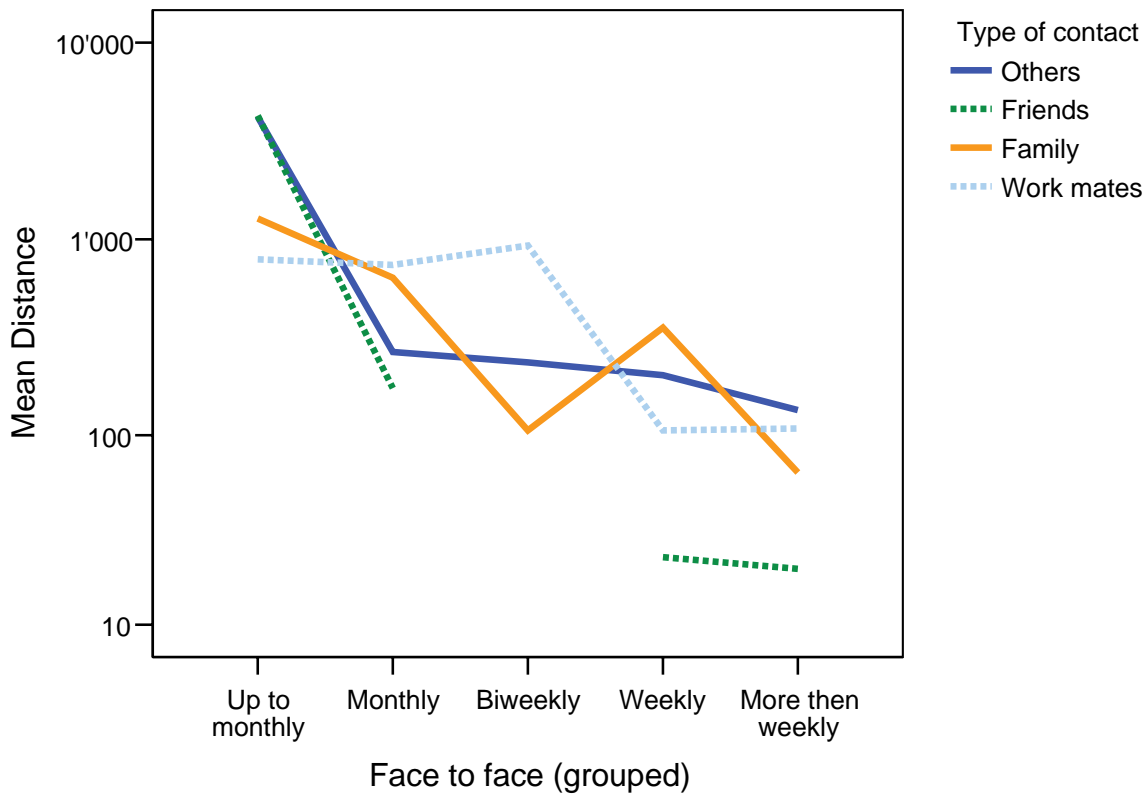

The sample size of the category "partner" is too small for this analysis

Figure 6 details this pattern by showing how the meeting frequencies of face-to-face contacts are distributed by distance quintile. The share of the weekly and more frequent meetings goes down very quickly with the distance between the persons involved.

The various electronic media allow maintaining and developing even without face-to-face meetings. That the share of these methods grows as a function of distance is clear from Figure 8. Please note that the medians of the quartiles of the male respondents are consistently larger than those of the female respondents. However, the absolute frequency of non-local contacts of the female respondents (Figure 7) is constant, and for the males the contact numbers only goes down for the highest quartile. As the younger respondents are not dominant in this sam-

ple, the role of email is attenuated here, while the phone remains the workhorse of the contacts between the persons involved. If one repeats the analysis with a finer classification of distances and includes all information about face-to-face contacts, it becomes clear that face-to-face contact frequencies appear to fall exponentially, while the electronic media contacts follow a different logic. The number of contacts locally is extremely high, reflecting the needs of activity co-ordination (see Geser, 2004 or Larsen, Urry and Axhausen, 2004). In the non-local, but still national, range the persons are in contact roughly twice a week across all electronic mode, including the phone. Beyond that, reflecting the higher costs, the frequency drops on average to slightly less than once a week.

Figure 6   Distribution of face-to-face contact frequency by distance quintile
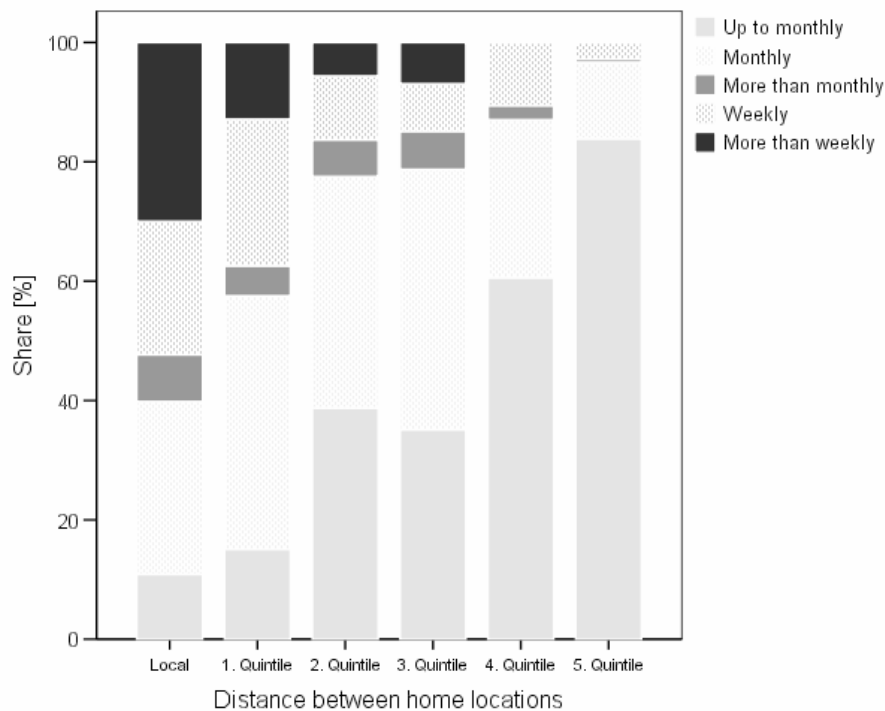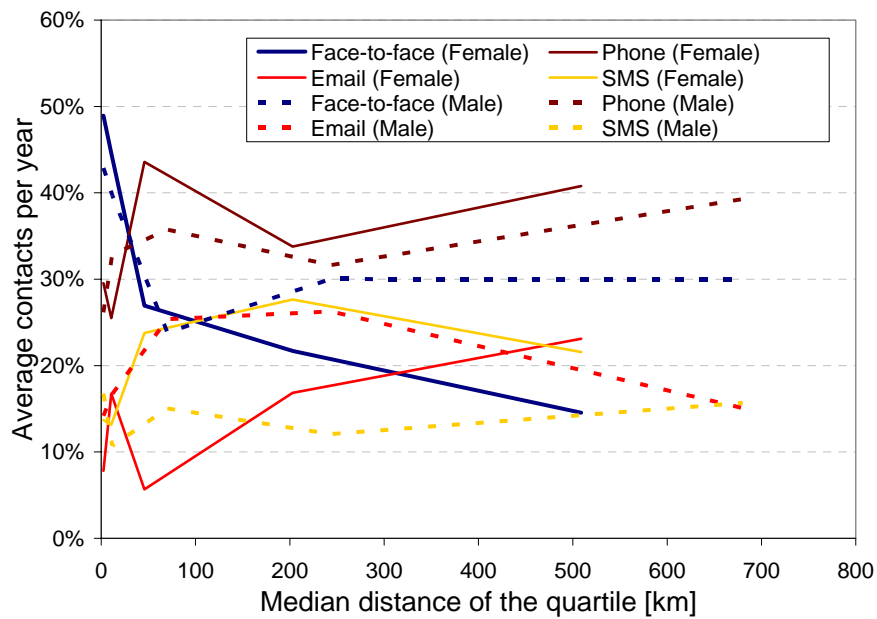

Pooled data of all surveys in Table 3; please note, that the local contacts make up one third of the total sample.

Figure 7   Mean number of annual contacts by mode and by distance
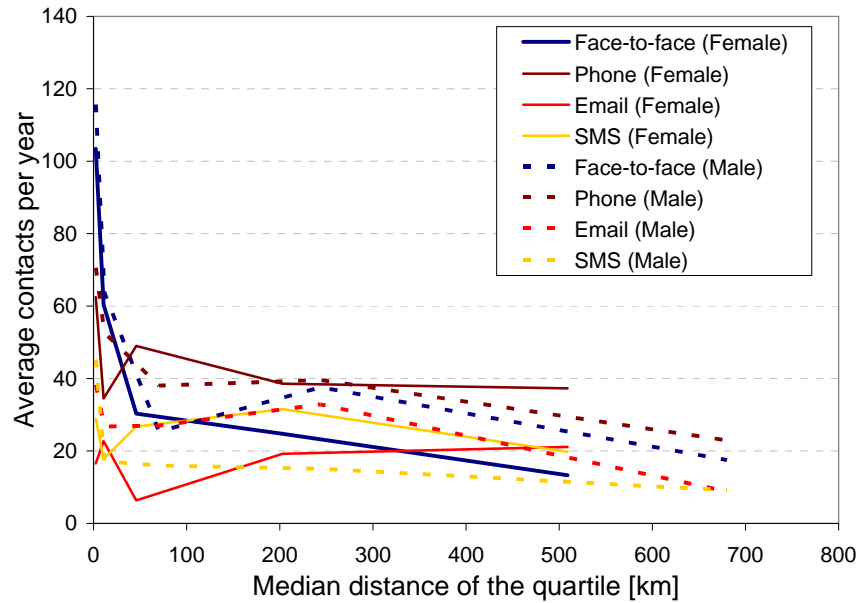
Pooled data of all surveys in Table 3, but without the ifmo survey; with local contacts

Figure 8   Market share of the modes of contact by distance and sex

Pooled data of all surveys in Table 3, but without the ifmo survey; with local contacts

An initial probit analysis of the market shares, conducted independently for the four contact modes, provides more insights into the observed patterns (Table 8). It is presented together with a linear analysis of the frequency of face-to-face contacts.

Table 8   Analysis of the market shares of the contact modes and the of the number of meeting for the non-local contacts

Variable	Freq. of face-to-face contacts	Market shares of contact modes			
Category		Face-to-face	Phone	Email	SMS
Constant	59.814	-	-	-	-
Age	-	-.004	.004	.006	-.007
Sex: Male	-	-.127	-	.624	-.526
Education					
Compulsory school	23.702	-.251	.186	.306	-.481
Apprenticeship	28.830	-.171	.254	-.278	.086
Baccalaureat	49.005	Reference	Reference	Reference	Reference
Professional tertiary	17.711	-.384	.329	.106	-.092
University degree	Reference	-.628	.915	-	-.587
Type of contact					
Others and friends	-28.097	.197	-.625	-2.126	-.459
Family and partner	-23.807	-	-.402	-2.344	-.355
Work mates	Reference	.600	-1.055	-1.907	-.779
Ln (distance)	-6.076	-.108	-	.132	0.31
Income	-	.028	-.048	.075	-.053
Income * Male		.048	-.021	-.138	.106
Adjusted R^2/Chi^2	0.12	10046	10235	13548	11690
N	383	381	381	381	381

All reported parameters are significant at the 0.05% level.

Income classes were translated as 1500, 4000 and 10000 sFr/Month.

The visual impression of the exponential decay of the contact frequency with distance is confirmed in the negative sign of the natural logarithm of the distance parameters in the probit model. Surprisingly, none of the other variables tested have an impact except the level of education and the type of contact.

In the models of market share, the log of distance has again a strong role, except for the phone, which is unaffected by distance. There are interesting interactions between sex and income revealing gender specific preference, in particular the opposite result with regard to email and SMS. It would be useful to add the sex and age of the contact in a future analysis. The age dependent reluctance to meet and to send text messages is no surprise, but the growing willingness to send emails is. The specific conditions under which work mates are met influence the pattern of the contact modes.

5.4   Social network geographies

The mapping of the social geographies (see for example Figure 9 for an individual case) shows that the respondents' reach is very varied: from the purely local to the global. The analysis above focussed on the distances between the respondents and their contacts, but ignored their pattern. Larsen, Urry and Axhausen (2005, 2006) extended the mapping approach by visualising the links and the biography of moves and work places of each respondent. Still, the information of maps has to be summarized for later analysis. Biologists and more recently transport planners had to address the identical question in their analysis of the 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, if rather problematic, approach is to calculate the size of the confidence ellipse, i.e. the two-dimensional generalisation of the confidence interval. It is a parametric approach, as the form of the approximation is fixed and the normal distribution of the locations is assumed, and results in often excessively large areas. If the home location is fixed as the midpoint of the con-

fidence ellipse its symmetry leads often to cases where half of the area covered by the ellipse is empty of locations. Rai, Balmer, Rieser, Vaze, Schönfelder and Axhausen (2006) suggest other geometries which overcome this problem, but at the expense of substantial computational costs. Recognising its shortfalls, this initial analysis retains the 95% confidence ellipse constructed around the mean home location for the simplicity of calculation and because it size estimates correlate highly with most of the alternative measurement approaches (see Figure 10 an overlay of 95% confidence ellipses).
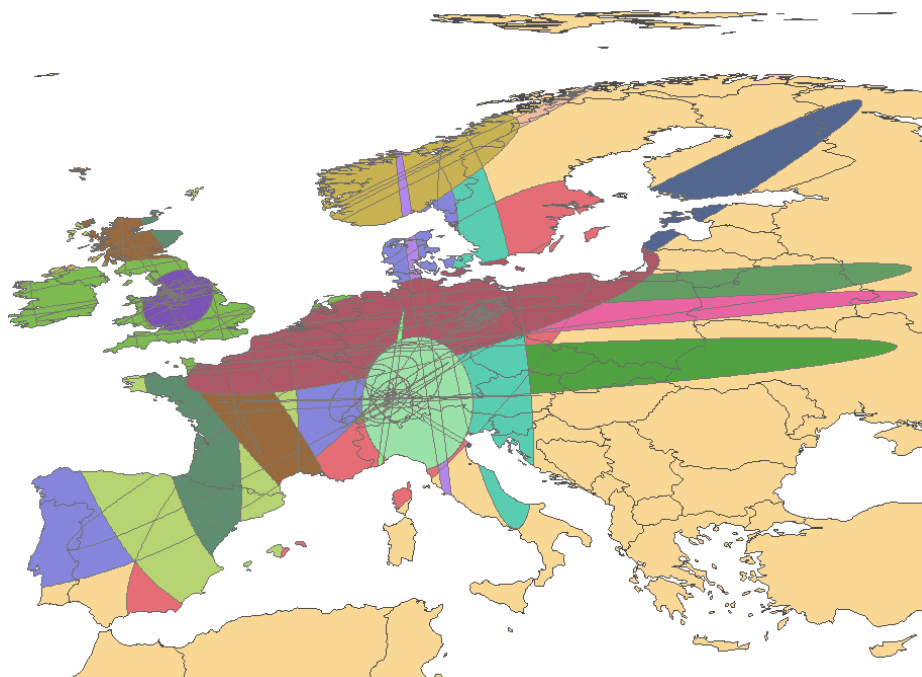
The distribution of the size of the 95% confidence ellipses seems to follow a log-normal distribution (Figure 11), if we ignore the seventh of the respondents who have an exclusively local set of contacts. The patterns of the socio-demographic differences follows generally the pattern of the distances to the contacts (Table 9), but the differences between males and females were the larger means, if small medians. The long distances of the highest income group do not result in the largest geographies. An analysis of variance shows that none of these differences are statistically significant. Only if one takes the logs of the sizes of the geographies, then the age differences are significant. A model of the logarithm of the size of the 95% confidence ellipses as a dependent variable has to be consider that the values are all non-negative, with 16 zero values in a total of 117 observations. Conventional regression-methods, as the least square method, are not adequate for such censored values (Greene, 2000). A model which is able to differentiate between limit-observations and non-limit-observations is the Tobit Model. After removing variables which correlate highly with each other (limit=0.5), variables with a significance level lower then 0.05 were stepwise removed. The parameter estimates are reported in Table 10 in both their standardized and unstandardized forms.

Figure 9   Example social geography
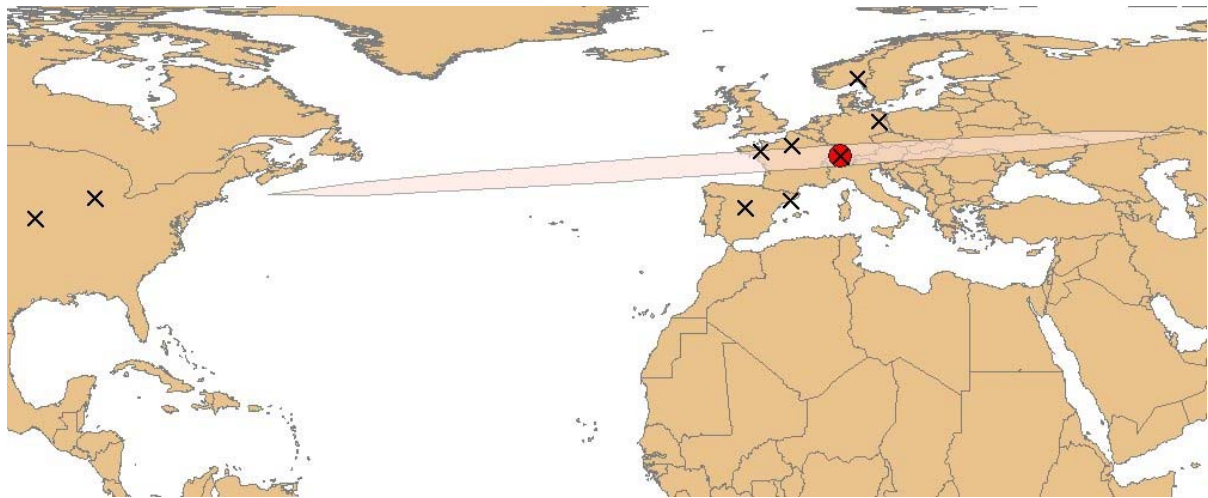
The respondent is female, 35 years old, full time employed and has moved 8 times in the last 22 years. The red circle tags the current home location and the black crosses are the home locations of the social contacts.

Figure 10   95% confidence ellipses of the social network geographies for a Europe-based set of the respondents

For the calculation of the confidence ellipse see Schönfelder and Axhausen, 2003a, b

Figure 11   Distribution of the social network geometries measured as the size of 95% confidence ellipse [km^2]
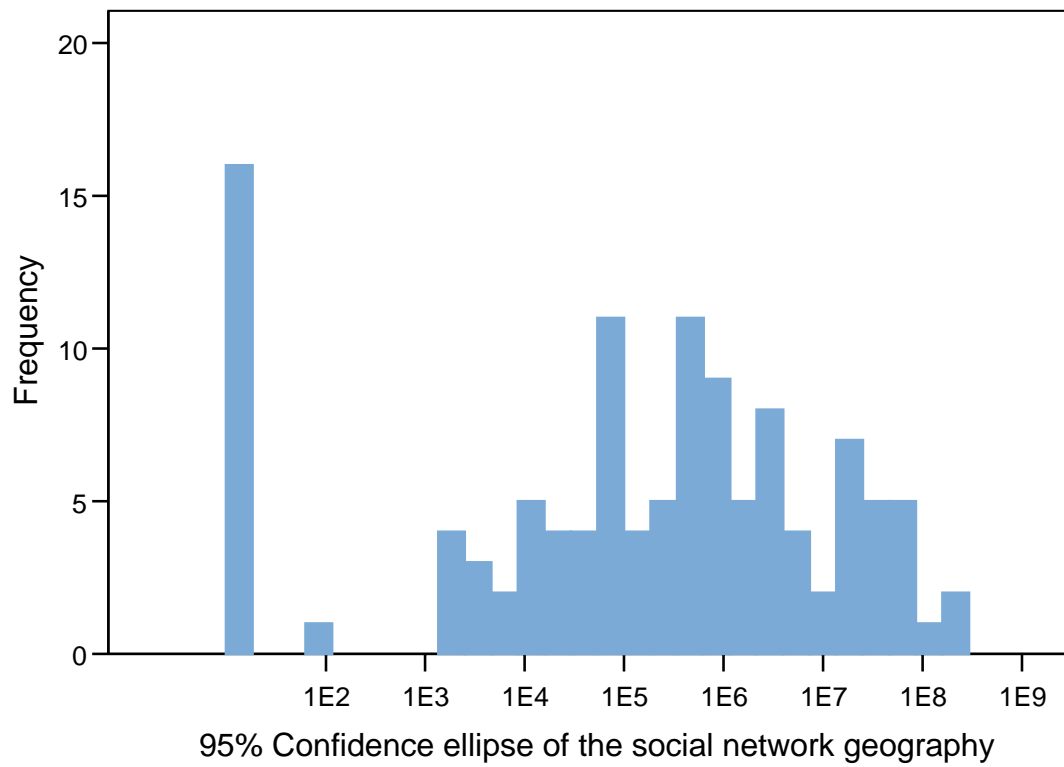
N = 118; pooled data from all surveys

Table 9   Descriptive statistics of 95% confidence ellipses of the social network geographies [10^6km^2] (with and without local contacts)

Variable	Median		Mean		S.E. of the mean		Number of cases	
Category	with	w/o	with	w/o	with	w/o	with	w/o
Age								
Up to 30	1.03	1.03	18.84	18.84	8.59	8.59	34	34
30 to 40	.77	.89	15.55	16.09	5.60	5.77	30	29
40 to 60	.06	.12	2.58	3.87	1.75	2.59	24	16
60 and older	.04	.35	2.76	3.60	2.15	2.79	30	23
Sex								
Female	.18	.44	10.71	13.73	5.20	6.61	50	39
Male	.48	.52	10.53	11.37	3.50	3.76	68	63
Education								
n.a.	.02	.02	8.52	8.52	6.88	6.88	6	6
Compulsory school	.05	.08	.49	.65	.27	.35	12	9
Apprenticeship	.06	.24	7.31	10.44	5.17	7.32	30	21
Baccalaureat	1.26	1.49	15.82	16.87	6.87	7.26	16	15
Professional tertiary	.44	.49	4.81	5.32	1.85	2.01	21	19
University degree	.89	.94	18.82	19.41	8.70	8.95	33	32
Income [sFr/month]								
n.a.	.89	1.09	19.35	22.76	8.25	9.50	20	17
0-1999	.21	.25	11.36	12.11	6.00	6.37	16	15
2000-5999	.25	.43	9.31	10.51	4.19	4.71	70	62
6000+	.06	.56	2.60	3.90	2.11	3.12	12	8
All	.30	.50	10.61	12.27	2.98	3.42	118	102

Purely local social network geographies were assumed to be 10 km^2 large.

Table 10   Parameter estimates for the Tobit regression of the logarithm of the 95% confidence ellipses

Variable	Mean	St. dev	Beta	Standard-ised beta	Sign.
Data_ifmo [y/n]	0.26	0.43	2.309	0.184	0.048
Male [y/n]	0.57	0.50	2.293	0.212	0.021
Age [years]	44.72	18.92	-0.078	-0.277	0.002
University degree [y/n]	0.28	0.45	2.286	0.192	0.047
Car ownership [y/n]	0.52	0.50	3.842	0.358	0.000
Annual or monthly public transport ticket [y/n]	0.90	0.32	6.585	0.398	0.000
Number of relocations [n]	5.87	2.74	0.634	0.325	0.000
N	117				
Adjusted R^2	0.48				

Pooled data from all surveys.

Besides the influence of the data source, which is described in Chapter 4 and 5.1, there are three groups to identify which influence the social geographies. The first group is constructed by socio-demographic variables. The model results indicate that male and young people with a high education tend to maintain a more spatial distributed social network. The ownership of mobility tools, which is represented through the ownership of car and annual or monthly public transport tickets, seems to have a higher influence. Even if the ownership of these tools doesn't support the maintenance of contacts over great distances, it seems that it is an indicator of mobile people. The number of relocations is a biographical influence on the social geographies. It seems that being lesser anchored in space has a positive influence on the social geographies, while surprisingly, the spatial distribution of the relocations, measured by confidence ellipses, hasn't a significant influence on them.

Overall the model explains 48% of the dispersion of the social network geographies.

6   Next steps

The work reported concerned the survey methods needed to obtain a relevant sample of the social contacts of the respondents and some initial analysis of the trends in that data, especially with respect to the size of the social geographies encountered today. It has become clear, that travellers maintain face-to-face interactions with their contacts, but that the prominence of that mode on the distances involved. For the longest distances the asynchronous and the free at the point-of-use email channel becomes the preferred mode of contact. The size of social geographies can be explained to some extend with the biographies and the socio-demographics of the respondents, but the majority of the variance remains currently unexplained.

The obvious next step is to refine the survey approaches and to increase the samples available for analysis. Surveys will always be limited to retrieve only information about a sample of the total contacts of a respondent and to egocentric networks. As this sample is chosen by the respondents, there is always a danger that it is biased, even if the survey specifies a careful and complete series of prompts. It would therefore be useful to develop tools which extract contact names from the copious written records of our interactions, such as email, telephone bills, chat room archive, mobile phone address books, private address databases and address books. This would relieve the respondent of some work, which could be redirected to the final part of the work programme outlined at the start of the paper: the capture of the interaction between the social network geography and the geography of daily life and of non-local travel. The survey work undertaken so far, has not spent enough effort in capturing representative examples about joint meetings; Carrasco (2006) is a partial exception.

7 Acknowledgements

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Appendix A: Questionnaire

Part 1:Person form

When were you born?

| Month | | Year | |

Are you ...?

☐ Male   ☐ Female

Are you a?

☐ Swiss national

☐ Other nationality, please specify:

☐ Naturalised, if yes when (Year):

Are you mainly ...?

☐ In education or apprenticeship   ☐ Job-seeking

☐ Full-time employed   ☐ Home working

☐ Part-time employed   ☐ Retired

Where is your current place of education or employment located?

Post code and municipality

Which qualifications have you acquired? (Tick all, which apply)

☐ Primary school   ☐ Apprenticeship

☐ Secondary school   ☐ University of applied science degree

☐ Baccalauréat   ☐ University degree/ETH degree

What type of education or employment are you mainly engaged in?

Education/Employment:

If you are employed, where is your working place in the main?

☐ At home

☐ Varying places

☐ At a fixed place of work outside the home

Do you own a car driving licence?   If yes, since when?

☐ No   ☐ Yes   Year of acquisition [   ]

How often is a car available to you?

☐ Always   ☐ Frequently   ☐ Infrequently   ☐ Never

Do you own one or several of the following public transport tickets?

☐ None   ☐ Regional annual or monthly ticket

☐ National annual ticket   ☐ Point-to-point season ticket

☐ Half-fare discount ticket   ☐ Other: [   ]

Part 2: Mobility Biography

Please fill in the following tables chronologically.

Please note:

- At the top of every table is an **example**.
- The questions concerning the different places of residence include the exact **address**, preferably as **post code**, **municipality**, **street** and **house number**. If you can not remember the address exactly, please enter the name of the **municipality** and in case of bigger towns the **name of the neighborhood**.
- If you did **live abroad**, we are also interested in the information about your residences there.

Life events and living

Please assign important live events to specific periods!

Examples: Birth of siblings, school/education, moving out of parents' house, marriage, divorce, birth of children, deaths in the family, retirement, etc.					
Life events	From	To	Life events	From	To
e.g. birth of brother	*1981*	*1981*			
(and 6 more lines)					

Please indicate your places of residence from your year of birth!

Place of residence	From	To
e.g. Bahnhofstrasse 1, 8001 Zurich	*1982*	*1985*
(and 8 more lines….)		

Employment and Income

Please indicate your places of work!

Place of work	From	To	Main mean of transport
e.g. Wolfsburg	*1978*	*1999*	*Car*
(and ten more lines)			

Please indicate your personal gross income per month!

Income classes:					
(1) 0 to 999 Fr.		(3) 2 000 to 5 999 Fr.		(5) 10 000 to 13 999 Fr.	
(2) 1 000 to 1 999 Fr.		(4) 6 000 to 9 999 Fr.		(6) 14 000 Fr. and more	
Income class	From	To	Income class	From	To
e.g. 3	*1979*	*1999*			
(and 8 more lines)					

Mode of transport, ownership of public transport tickets and car availability

Please indicate your main mode of transport!

Mode of transport:					
(1) car, motorcycle, moped		(3) on foot			
(2) train, tram, bus		(4) bicycle	(5) others: _____		
Mode of transport	From	To	Mode of transport	From	To
e.g. 1	*1979*	*1999*			
(and 5 more lines)					

Please indicate your ownership of public transport tickets!

Public transport tickets: (1) half-fare discount ticket (2) national annual ticket (3) regional annual or monthly ticket (4) other					
Public transport ticket	From	To	Public transport ticket	From	To
e.g. 3	*1979*	*1999*			
(and 4 more lines)					

Please indicate your car availability!

Availability: (1) always (3) Infrequently (2) frequently (4) never					
Availability	From	To	Availability	From	To
e.g. 2	*1979*	*1999*			
(and 4 more lines)					

Memberships in groups that meets periodically for a shared activity

Please indicate your memberships including the frequency of meetings in groups that meets regular for a shared activity!

Types of groups which meets periodically for a shared activity: religion, sport, politics, social, nature, etc.			
Type of group	Your attendance frequency	From	To
e.g. nature	*2 times per month*	*1981*	*1990*
(and 4 more lines)			

Annotations and commentaries

Do you have any comments or additions?

Thank you very much for your assistance!

Part 3:Social networks

In this part of the questionnaire we have some questions about the persons with whom you interact privately. These persons can be family members, friends or acquaintances. Please note:

- On the top of the lists is always one **example**.
- The questionnaire has two parts. Please start with the **person-data-sheet** and fill in the **contact-description** according the numbers after that. The person-data-sheet and the contact-description are once more divided in two parts, while the first part is indicated by the letter **A** and the second part by **B**.
- Please name in the person-data-sheet as many persons as relevant.
- The **contact-description** is located in a separate part of the questionnaire to make it easier for you to assign the person-numbers.
- **Photo albums** or **address books** could help you in remembering persons.
- As Names you can also indicate **nicknames**.
- The questions concerning the places of residence of your contacts also include the exact **address**, preferably as **post code**, **municipality**, **street** and **house number**. If you can not remember the address exactly, please enter the **name of the municipality** and in case of bigger towns the **name of the neighbourhood**.

Person-data-sheet

Please indicate persons with whom you discuss important problems, with whom you stay in regular contact or which you can ask for help!

A					
Nr.	**Name**	**Nr.**	**Name**	**Nr.**	**Name**
A X	*e.g. Flo*	A 6		A 12	

Please indicate further people with whom you undertake leisure activities!

B					
Nr.	**Name**	**Nr.**	**Name**	**Nr.**	**Name**
B X	e.g. Jenny	**B 11**		**B 22**	

Holidays and acquaintances

Please specify holidays which you made with an acquaintance!

Holiday area	Year	Who you made known?	Transport mean
e.g.: New York/USA	*2001*	*Friend from the USA, Nr. A2*	*Airplane*

Contact-description - A

Con-tacts	Please tick how you met the person.						In con-tact since...	Please specify the frequency of contact by each mode. (Specify the frequency of contact as accurately as possible. E.g. 3 per week; 2 times per year; etc.)				Where have you met this person the last time?	Contact's place of residence
Nr.	acquaint-ance from/of the...			Family			Association, others...	Year	face-to-face	by tele-phone	by email	by SMS	Please indicate the manner of the location (restaurant, zoo, holidays, etc.) and the location.	Please indicate as far as possible post code, munici-pality, street and house number.
	Work	Education	Partner	1.Degree	Relatives	Partner								
								(And twelve more lines)						

Contact-description - B

Con-tacts	Please tick how you met the person.						In con-tact since...	Please specify the frequency of contact by each mode. (Specify the frequency of contact as accurately as possible. E.g. 3 per week; 2 times per year; etc.)				Where have you met this person the last time?	Contact's place of residence
Nr.	acquaint-ance from/of the...			Family			Association, others...	Year	face-to-face	by tele-phone	by email	by SMS	Please indicate the manner of the location (restaurant, zoo, holidays, etc.) and the location.	Please indicate as far as possible post code, munici-pality, street and house number.
	Work	Education	Partner	1.Degree	Relatives	Partner								
								(And twelve more lines)						

48